ARCHITECTURAL ASSISTANT

2nd Semester

TRADE THEORY

SECTOR: Construction, Construction Material & Real Estate

Directorate General of Training

DIRECTORATE GENERAL OF TRAINING
MINISTRY OF SKILL DEVELOPMENT & ENTREPRENEURSHIP
GOVERNMENT OF INDIA

NATIONAL INSTRUCTIONAL MEDIA INSTITUTE, CHENNAI

Post Box No. 3142, CTI Campus, Guindy, Chennai - 600 032

Sector : Construction, Construction Material & Real Estate

Duration : 2 - Years

Trades : Architectural Assistant 2nd semester - Trade Theory

First Edition : June 2015 Copies : 1,000
First Reprint : July 2016 Copies : 1,000

Rs.120/-

Published by:

NATIONAL INSTRUCTIONAL MEDIA INSTITUTE
P. B. No.3142, CTI Campus, Guindy Industrial Estate,
Guindy, Chennai - 600 032.
Phone: 044 - 2250 0248, 2250 0657
Fax : 91 - 44 - 2250 0791
email : nimi_bsnl@dataone.in
Website: www.nimi.gov.in

FOREWORD

The National Instructional Media Institute (NIMI) is an autonomous body under the Directorate General of Employment and Training (DGE&T) Ministry of Labour and Employment has been developing, producing and disseminating Instructional Media Packages (IMPs are extensively used in the Industrial Training Institutes/Training centres in Industries to impart practical training and develop work-skills for the trainees and the trainers

The Ministry of Labour & Employment constituted Mentor Councils (MCs) to revampcourses run / to be run under National Council of Vocational Training (NCVT) in 25 sectors. The MCs have representatives from thought leaders among various stakeholders viz. one of the top ten industries in the sector innovative entrepreneurs who have proved to be game-changers, academic/professional institutions (IITs etc.), experts from field institutes of DGE &T, champion ITIs for each of the sectors and experts in delivering education and training through modern methods like through use of IT, distance education etc. The technical support to the MCs is provided by Central Staff Training and Research Institute (CSTARI), Kolkata and National Instructional Media Institute (NIMI), Chennai. Some of the MCs are also supported by sector-wise Core Groups which were created internally in the Ministry (in 11 sectors).

A Steering Committee to provide overall coordination and guidance to Mentor Councils has also been constituted and has representation from the MCs, Chair positions to be endowed by the Ministry, trade unions, and experts on distance education and training. The MCs are mandated to work towards revamping/suggesting new courses, improving assessment systems, overall learning etc. for subjects under the purview of the NCVT.

Accordingly NIMI with the support and assistance of MC has developed **Architectural Assistant Trade Theory 2nd Semester** in **Construction, Construction Material & Real Estate sector** to enhance the employability of ITI trainees across the country and also to meet the industry requirement.

I have no doubt that the trainees and trainers of ITIs & Training centres in industries will derive maximum benefit from these books and that NIMI's effort will go a long way in improvement of Vocational Training.

I complement Director, Mentor Council members, Media Development Committee (MDC) members and staff of NIMI for their dedicated and invaluable contribution in bringing out this publication.

ALOK KUMAR, I.A.S.,
Director General of Employment &
Training/ Joint Secretary
Ministry of Labour and Employment
Government of India

New Delhi - 110 001

PREFACE

This National Instructional Media Institute (NIMI) was set up at Chennai by the Directorate General of Employment and Training (DGE&T) Ministry of Labour and Employment, Government of India with technical assistance from the Govt. of the Federal Republic of Germany. The prime objective of this institute is to develop and disseminate instructional materials for various trades as per the prescribed syllabi under the Craftsmen and Apprenticeship Training Schemes.

The instructional materials are developed and produced in the form of Instructional Media Packages (IMPs). An IMP consists of Trade Theory book, Trade Practical book, Test and Assignment book, Instructor guide, Wall Charts and Transparencies.

Hon'ble Union Minister of Finance during the budget speech 2014-2015 mentioned about developing **Skill India** and made the following announcement

"A national multi-skill programme called Skill India is proposed to be launched. It would skill the youth with an emphasis on employability and entrepreneur skills. It will also provide training and support for traditional professions like welders, carpenters, cobblers, masons, blacksmiths, weavers etc. Convergence of various schemes to attain this objective is also proposed."

The Ministry of Labour & Employment constituted Mentor Councils (MCs) to revamp courses run / to be run under National Council of Vocational Training (NCVT) in 25 sectors which will give a sustained skill based employability to the ITI trainees as the main objective of Vocational training. The ultimate approach of NIMI is to prepare the validated IMPs based on the exercises to be done during the course of study. As the skill development is progressive the theoretical content on a particular topic is limited to the requirement in every stage. Hence the reader will find a topic spread over a number of units. The test and assignment will enable the instructor to give assignments and evaluate the performance of a trainee. If a trainee possesses the same it helps the trainee to do assignment on his own and also to evaluate himself. The wall charts and transparencies are unique, as they not only help the instructor to effectively present a topic but also helps the trainees to grasp the technical topic quickly. The instructor guide enables the instructor to plan his schedule of instruction, plan the raw material requirement ,

Thus the availability of a complete Instructional Media Package in an institute helps the trainer and management to impart an effective training. Hence it is strongly recommended that the Training Institutes/Establishments should provide at least **one IMP** per unit. This will be small, one time investment but the benefits will be long lasting.

The **Architectural Assistant Trade Theory 2nd Semester in Construction, Construction Material & Real Estate sector** is one of the book develop by the core group members of the Mentor Councils (MCs). The 1st semester book includes **Module 1 - , Module 2 - , Module 3 - .**

The **Architectural Assistant Trade Theory 2nd semester** is the outcome of the collective efforts of Members of Mentor Council which includes academic/professional institutions (IITs etc.), experts from field institutes of DGE&T, champion ITIs for each of the sectors, and also Media Development Committee (MDC) members and staff of NIMI.

NIMI wishes that the above material (Trade Practical & Trade Theory) will fulfil to satisfy the long needs of the Trainees and Instructor and helps the trainees for their employability in vocational training.

NIMI would like to take this opportunity to convey sincere thanks to all the Mentor Council members and Media Development Committee (MDC) members.

A.MAHENDIRAN
Director, NIMI.

Chennai - 600 032

ACKNOWLEDGEMENT

National Instructional Media Institute (NIMI) sincerely acknowledges with thanks for the co-operation and contribution extended by the following Media Developers and their sponsoring organisation to bring out this IMP **(Trade Theory)** for the trade of **Architectural Assistant** under the **Construction, Construction Material & Real Estate** Sector for Craftsman Training Scheme. This Book is prepared as per Revised Syllabus.

MEDIA DEVELOPMENT COMMITTEE MEMBERS

Dr. N. Dhang	-	Professor. D/O Civil Engineering, Indian Institute of Technology, Kharagpur Chairman, Mentor council.
Shri. M.C. Sharma	-	Joint Director (TTC), DGE&T, New Delhi, Mentor, Mentor council.
Smt. Arpana Singh	-	Training Officer, NVTI(W),Noida. Team leader, Mentor council.
Smt. P. Kavitha Shankar	-	Vocational Instructor, NVTI (w), Noida, Member, Mentor Council.
Shri. R.N.Manna	-	Training Officer CSTARI, Kolkatta. Co-ordinator, Mentor Council.
Shri.V.Gopalakrishnan	-	Training Officer NIMI, Chennai-32. Co-ordinator, NIMI, Chennai.

NIMI records its appreciation of the Data Entry, CAD, DTP Operators for their excellent and devoted services in the process of development of this Instructional Material.

NIMI also acknowledges with thanks, the invaluable efforts rendered by all other staff who have contributed for the development of this Instructional Material.

NIMI is grateful to all others who have directly or indirectly helped in developing this IMP.

INTRODUCTION

TRADE THEORY

The manual of trade theory consists of theoretical information for the Second Semester course of the Architectural Assistant Trade. The contents are sequenced according to the practical exercise contained in the manual on Trade practical. Attempt has been made to relate the theoretical aspects with the skill covered in each exercise to the extent possible. This co-relation is maintained to help the trainees to develope the perceptional capabilities for performing the skills.

The Trade theory has to be taught and learnt along with the corresponding exercise contained in the manual on trade practical. The indicating about the corresponding practical exercise are given in every sheet of this manual.

It will be preferable to teach/learn the trade theory connected to each exercise atleast one class before performing the related skills in the shop floor. The trade theory is to be treated as an integrated part of each exercise.

The material is not the purpose of self learning and should be considered as supplementary to class room instruction.

TRADE PRACTICAL

The trade practical manual is intented to be used in workshop . It consists of a series of practical exercies to be completed by the trainees during the Second Semester course of the Architectural Assistant trade supplemented and supported by instructions/ informations to assist in performing the exercises. These exercises are designed to ensure that all the skills in the prescribed syllabus are covered.

The manual is divided into four modules. The distribution of Exercises for the practical in the four modules are given below.

Module 1	21 Exercises
Module 2	19 Exercises
Module 3	06 Exercises
Total	46 Exercises

The skill training in the shop floor is planned through a series of practical exercises centred around some practical project. However, there are few instance where the individual exercise does not form a part of project.

While developing the practical manual a sincere effort was made to prepare each exercise which will be easy to understand and carry out even by below average traninee. NIMI, looks forward to the suggestions from the experienced training faculty for improving the manual.

CONTENTS

Lesson No.	Title of the Lesson	Page No.
	Module 1 :	
2.1.01 - 2.1.11	Computer theory - Basic	1
2.1.12 - 2.1.21	Factors considered in architectural design	13
	Module 2 :	
2.2.01	Drawing of different types of arches	30
2.2.02	Drawing of different types of lintels	37
2.2.03 - 2.2.10	Draw plan and elevation of straight stairs	39
2.2.11	Draw the different components of floor	51
2.2.12	Draw the details of cement concrete floor	55
2.2.13	Draw the details of wooden floor (upper floor)	59
2.2.14	Draw lean to roof details	62
2.2.15	Draw flat roof detail	69
2.2.16	Draw fixing detail of AC sheets and corrogated sheets	71
2.2.17	Draw details of king post roof truss	75
2.2.18	Draw details of queen post roof truss	77
2.2.19	Draw details of steel roof truss	79
	Module 3 :	
2.3.01	Draw the water supply layout plan for toilet & kitchen	84
2.3.02	Draw drainage layout plan for toilet and kitchen	91
2.3.03	Draw gully trap details	99
2.3.04	Draw man hole detail	104
2.3.05	Site plan showing building services	107
2.3.06	Draw rain water harvesting detail	108

Nimi

Computer theory - Basic

Objectives: At the end of this lesson you shall be able to
- **computer and its structure**
- **softwares and its types**
- **operating system**
- **windows**
- **networking.**

Computer

A computer is a general purpose device that can be programmed to carry out a set of arithmetic or logical operation automatically. Computers are so important that without them life would not be the same as we see today. Computers are capable of performing almost any task/ job. Their behaviour concludes that computers act upon information. This information or data cows in all shape and sizes from a mathematical equation to the required details about all company work force necessary to produce a payroll ie the methods of recording manipulation information. (Fig 1)

Fig 1

Peripheral devices

It consists of

1 Input devices (Keyboard, Mouse, Joystick, Digital cameras)

2 Output devices (Video display unit, Printers, Plotters)

3 Storage devices (Memory - Primary & Secondary)

1 Input devices

The data and instruction must be entered into the memory of computers. This task is carried out by input devices. Some standard input devices are

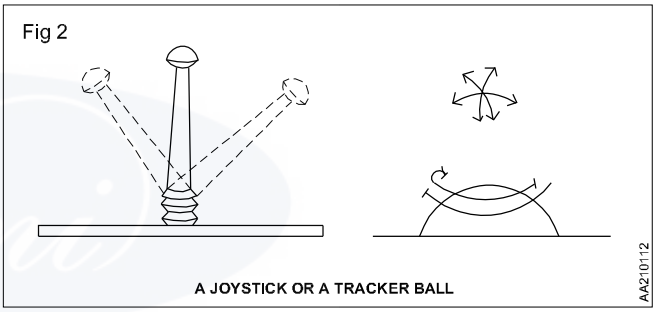
a) Keyboard

A keyboard is a typewriter style device which uses an arrangement of buttons or keys to act as mechanical levers or electronic switches. A keyboard typically has characters engraved or printed on the keys and each press of the key typically corresponds to a single written symbol. However, to produce some symbols require pressing and holding several keys simultaneously or in sequence. Despite development of alternate input devices, such as mouse, touch screen, pen devices, character recognition and voice recognition the keyboard remains the most commonly used device for direct input of alphanumeric data into computer.

b) Joystick or Trackerball

These are pointing devices and used for same purpose as mouse. Joystick is mainly used for game programmer. The trackball has a ball, which can be rotated by hand in any direction. It is normally used in medical computers

Fig 2



like brain and body scanner, etc. (Fig 2)

2 Output devices

This job of output device is to bring out the result to the outside world. The commonly used output devices are:

1 Video display unit

2 Printers

3 Plotters

Video display unit

A.T.V like screen is called video display uit or monitor. It displays graphics and characters on its screen. The screen consists of several tiny points (pixels). These tiny points are illuminated in such a pattern that we recognize the object. (Fig 3)

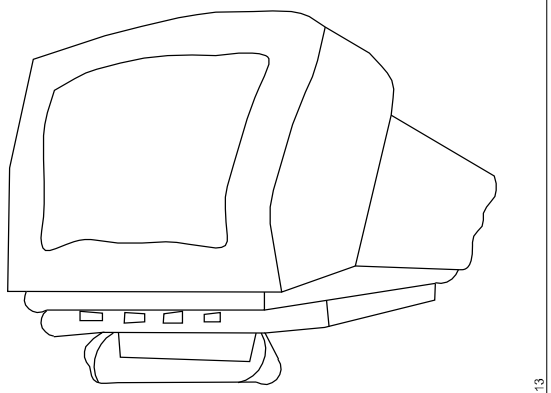
Printers

Printers are populated out of all device. The output information is a permanent readable form and is called hard copy. They may be classified into:

a. Character printer -> Prints one character at one time.
eg. Dot matrix

b. Line printer -> Prints one line of text at a time.
eg. Chain printer

Fig 3



MONITOR

AA210113

c. Page printer -> Prints complete page at a time. eg. Laser printer

Shown in given figure (a 5x7 matrix is illustrated). The print head moves across the paper. The needless strike the paper. The needless strike the paper through inked ribbon.

Dot matrix printer cannot operate continuously due to over heating of print selenoids, since the character size may vat it is not possible to classify a dot matrix printer in term of the number of character per line. However for normal 7x9 printing 80/132 columns printers with speed varying from 50 to 600 characters per sec or available.

Daisy wheel printer

The daisy wheel printer(so called because of the shape of the print head circulating about a central hub) is a flat disk which has a set of spoke each having a single character embossed at the tip. The hub of the wheel rotate to bring the desired character into position and is then struck by a hammer mechanism to form an image on paper. Several types of fonts are available and can be interchanged quickly to suit application need. They offer high quality type and speed range from 20 to 80 character per seconds. In most of the daisy wheel printers facilities such as directional printing, proportional spacing text, justification shadow printing, upper and lower case lettering under scroing and centering are available. Printing speed depends on the type of print wheel and the text to be produced but are typically of the order of 30-80 characters per seconds.

Inkjet printer

It uses fine nozzles, which are arranged similar to that of the pins of dot matrix head, which spray a stream of electronically charged ink towards the paper. Before reaching the nozzles, the spray passes through an electrical field which arrange the charged particles into the desired character. The most commonly used inkjet printer is the 1BM 6640 which operates using plane paper and forms character on the basis of a 24x40 dot matrix. These printers can have a speed of about 200 characters per seconds. The inkjet can suffer from clogging. The print may also be liable to smearing because of the water-based ink. Inkjet printer is preferred when we require colored printout.

Plotter

Plotter like computer graphic terminals are quite useful when a graphic or pictorial representation are required. They have already been used in western countries and in INDIA for a variety of application, which include graphics, making maps, plotting contour lines and detailing of civil engineering structure or machine components. A high accuracy can be achieved even to 1000^{th} of an inch, plotter may be driven on line or offline. If we are using the computer for design work, then we can use it for graphic application, then we can driven them off line by some special equipment. These special equipment will obtain the instruction from magnetic or paper tape produced by the users graphic programmer.

Drum or incremental plotters are normally use with main frame computer system. In these plotters, the pen is mounted on a carriage with mover, across the width of paper only. The paper is mounted around a horizontal drum and held in position by holes and pines at the paper edge. During plotting operations, the drum drives the paper, backward and forward as the pen moves across the width of the paper. The plot size be very large with paper width of upto 1m and almost indefinite paper length.

Memory

Memory is an essential part of a computer. Since it is needed for storing the instructions and data that are executed by the CPU. This function block is called the storage, main memory or primay storage. Each memory location is identified by a unique address. The location store the data in the form of bits. Thus a memory is a location place. Where data and instruction can be stored into and retrieved from whenever required by other funcitonal blocks of a computers.

The memory where both reading and writing can take place is called as read-write memory. Random Access Memory (RAM) is a common example for this.

There are portions in the computer memory where number writing is allowed. The contents are pre-written and can only be read. Such memories are called Read Only Memory (ROM).

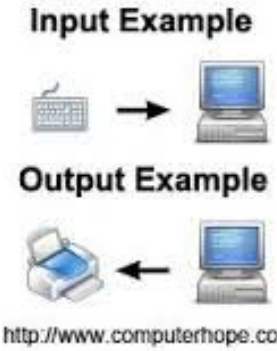
The main memory consists of RAM and ROM. RAM is used as the work area where users instructions and data can be stored and read. ROM contains those instruction and data which will be required for the operation and is pre-written and would not change.

Input/Output device

In computing input/output inputs are the signals or data received by the system and outputs are the signals or data sent from it. For instance, a keyboard or mouse is an input device for a computer, while monitors and printers are output devices for communication between computers, such as modems and network cards, typically perform both input and output operations.

In computer architecture, the combination of the CPU and main memory, to which the CPU can read or write directly using individual instructions, is considered the brain of a computer. Any transfer of information to or from the CPU/memory combo, for example by reading data from a disk drive, is considered I/O. The CPU and its supporting circuitry may provide memory-mapped I/O that is used in low-level computer programming, such as in the implementation of device drivers, or may provide access to I/O channels. An I/O algorithm is one designed to exploit locality and perform efficiently when exchanging data with a secondary storage device, such as a disk drive. (Fig 4)

Fig 4



An input device sends information to a computer and an output device receives information from a computer. For example, as you can see in the image, a keyboard sends electrical signals to your computer which display text or tell the computer to perform a function. Then in the lower half, you can see a computer sending data to a printer that will be reproduced on a piece of paper.

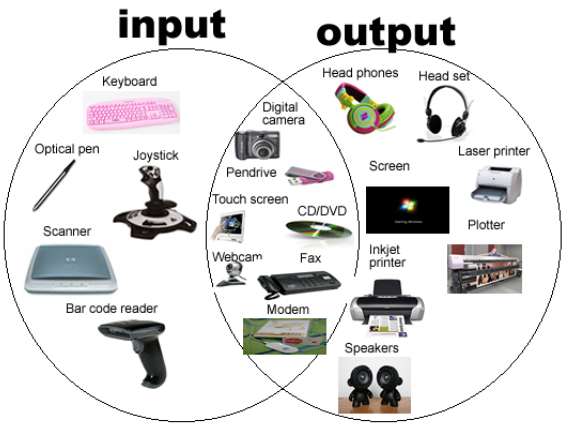
More examples

An input device, such as a computer keyboard or mouse, can send information(input) to the computer, but it cannot receive information (output) from the computer.

An output device, such as a computer monitor or printer, can receive information (output) from the computer, but it cannot send information (input) to the computer.

An input/output device, such as a CD-RW drive or USB flash drive, can both send information (input) to a computer and receive information (output) from a computer. (Fig 5)

Fig 5



Computer software, or simply software is any set of machine-readable instructions that directs a computer's processor to perform specific operations. Computer software contrasts with computer hardware, which is the physical component of computers. Computer hardware and software require each other and neither can be realistically used without the other. Using a musical analogy, hardware is like a musical instrument and software is like the notes played on that instrument.

Computer software includes computer programs, libraries and their associated documentation. The word software is also sometimes used in a more narrow sense, meaning application software only. Software is stored in computer memoryand is intangible, i.e. it cannot be touched

Software written in a machine language is known as "machine code". However, in practice, software is usually written in high-level programming languages that are easier and more efficient for humans to use (closer to natural language) than machine language. High-level languages are translated, using compilation or interpretation or a combination of the two, into machine language.

Software can be grouped into a few broad categories

Purpose, or domain of use

Based on the goal, computer software can be divided into:

i) **Application software,** which uses the computer system to perform special functions or provide entertainment functions beyond the basic operation of the computer itself. There are many different types of application software, because the range of tasks that can be performed with a modern computer is so large.

ii) **System software,** which is designed to directly operate the computer software, to provide basic functionality needed by users and other software, and to provide a platform for running application software.

System software includes:

i) **Operating systems,** which are essential collections of software that manage resources and provides common services for other software that runs "on top" of them. Supervisory programs, boot loaders, sheels and window systems are core parts of operating systems. In practice, an operating system comes bundled with additional software (including application software) so that a user can potentially do some work with a computer that only has an operating system.

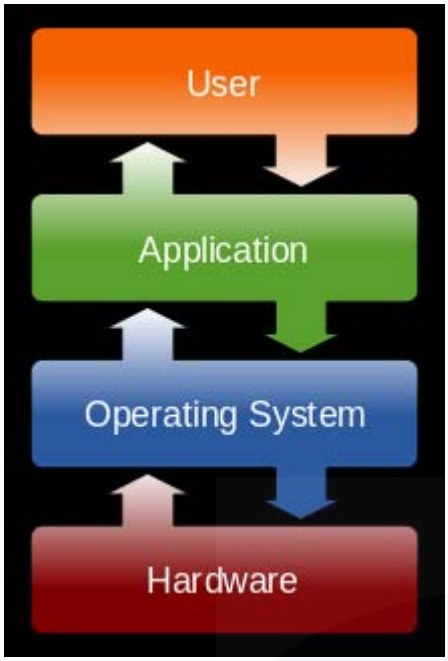
ii) **Device drivers,** which operate or control a particular type of device that is attached to a computer. Each device needs at least one corresponding device driver; because a computer typically has at minimum at least one input device and at least one output device, a computer typically needs more than one device driver.

iii) **Utilities,** which are computer programs designed to assist users in maintenance and care of their computers.

iv) **Malicious software or malware,** which are computer programs developed to harm and disrupt computers. As such, malware is undesirable. Malware is closely associated with computer-related crimes, though some malicious programs may have been designed as practical jokes.

Types of software (Fig 6)

Fig 6



A diagram showing how the operating system software and application software are layered on a typical desktop computer. The arrows indicate information flow.

Nature, or domain of execution

i) Desktop applications such as web browsers and Microsoft Office, as well as smartphone and tablet applications (called “apps”).

ii) JavaScript scripts are pieces of software traditionally embedded in web pages that are run directly inside the web browser when a web page is loaded without the need for a web browser plugin. Software written in other programming languages can also be run within the web browser if the software is either translated into JavaScript, or if a web browser plugin that supports that language is installed; the most common example of the latter is ActionScript scripts, which are supported by the Adobe Flash plugin.

iii) Server software, including:

iv) Web applications, which usually run on the web server and output dynamically generated web pages to web browsers, using e.g. PHP, Java or ASP.NET, or even JavaScript that runs on the server. In modern times these commonly include some JavaScript to be run in the web browser as well, in which case they typically run partly on the server, partly in the web browser.

v) Plugins and extensions are software that extends or modifies the functionality of another piece of software, and require that software be used in order to function;

vi) Embedded software resides as firmware within embedded systems, devices dedicated to a single use or a few uses such as cars and televisions

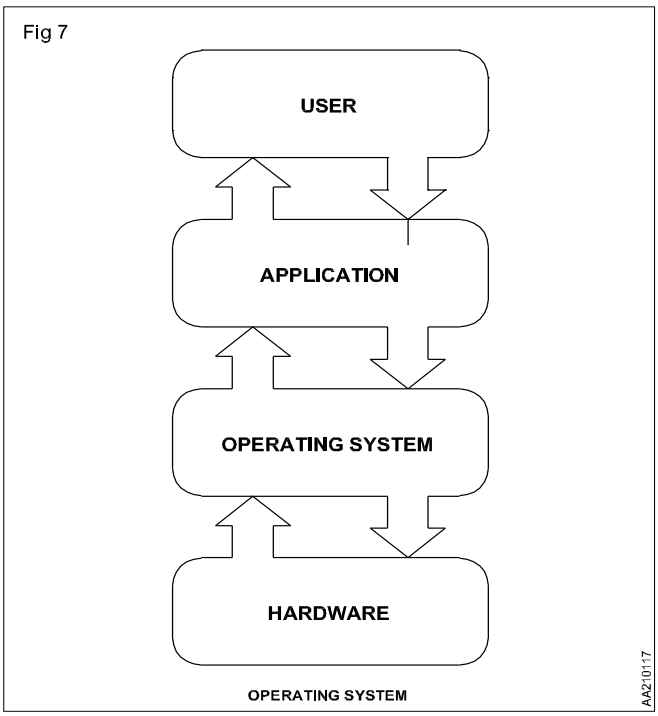
vii) Microcode is a special, relatively obscure type of embedded software which tells the processor itself how to execute machine code, so it is actually a lower level than machine code. It is typically proprietary to the processor manufacturer, and any necessary correctional microcode software updates are supplied by them to users (which is much cheaper than shipping replacement processor hardware). Thus an ordinary programmer would not expect to ever have to deal with it.

Programming tools

Programming tools are also software in the form of programs or applications that software developers (also known as programmers, coders, hackers or software engineers) use to create, debug, maintain (i.e. improve or fix), or otherwise support software. Software is written in one or more programming languages; there are many programming languages in existence, and each has at least one implementation, each of which consists of its own set of programming tools. These tools may be relatively self-contained programs such as compilers, debuggers, interpreters, linkers, and text editors, that can be combined together to accomplish a task; or they may form an integrated development environment(IDE), which combines much or all of the functionality of such self-contained tools. IDEs may do this by either invoking the relevant individual tools or by re-implementing their functionality in a new way. An IDE can make it easier to do specific tasks, such as searching in files in a particular project. Many programming language implementations provide the option of using both individual tools or an IDE.

Operating system (Fig 7)

Fig 7



An operating system (OS) is software that manages computer hardware and software resources and provides common services for computer programs. The operating system is an essential component of the system software in a computer system. Application programs usually require an operating system to function.

Time-sharing operating systems schedule tasks for efficient use of the system and may also include accounting software for cost allocation of processor time, mass storage, printing, and other resources.

For hardware functions such as input and output and memory allocation, the operating system acts as an intermediary between programs and the computer hardware, although the application code is usually executed directly by the hardware and will frequently make a system call to an OS function or be interrupted by it. Operating systems can be found on almost any device that contains a computer—from cellular phones, and video game consoles to supercomputers and web servers.

Examples of popular modern operating systems include Android, BSD, iOS, Linux, OS X, QNX, Microsoft Windows,Windows Phone, and IBM z/OS. All these examples, except Windows, Windows Phone and z/OS, share roots in UNIX.

Types of operating systems

Real-time

A real-time operating system is a multitasking operating system that aims at executing real-time applications. Real-time operating systems often use specialized scheduling algorithms so that they can achieve a deterministic nature of behavior. The main objective of real-time operating systems is their quick and predictable response to events. They have an event-driven or time-sharing design and often aspects of both. An event-driven system switches between tasks based on their priorities or external events while time-sharing operating systems switch tasks based on clock interrupts.[citation needed] Time-sharing operating systems schedule tasks for efficient use of the system and may also include accounting software for cost allocation of processor time, mass storage, printing, and other resources.

Multi-user

A multi-user operating system allows multiple users to access a computer system at the same time. Time-sharing systems and Internet servers can be classified as multi-user systems as they enable multiple-user access to a computer through the sharing of time. Single-user operating systems have only one user but may allow multiple programs to run at the same time.[citation needed]

Multi-tasking vs. single-tasking

A multi-tasking operating system allows more than one program to be running at the same time, from the point of view of human time scales. A single-tasking system has only one running program. Multi-tasking can be of two types: pre-emptive and co-operative. In pre-emptive multitasking, the operating system slices the CPU time and dedicates one slot to each of the programs. Unix-like operating systems such as Solaris and Linux support pre-emptive multitasking, as does AmigaOS. Cooperative multitasking is achieved by relying on each process to give time to the other processes in a defined manner. 16-bit versions of Microsoft Windows used cooperative multi-tasking. 32-bit versions of both Windows NT and Win9x, used pre-emptive multi-tasking. Mac OS prior to OS X used to support cooperative multitasking.

Microsoft windows

Microsoft Windows or Windows is a metafamily of graphical operating systems developed, marketed, and sold by Microsoft. It consists of several families of operating systems, each of which cater to a certain sector of the computing industry. Active Windows families include Windows NT, Windows Embedded and Windows Phone; these may encompass subfamilies, e.g. Windows Embedded Compact (Windows CE) or Windows Server. Defunct Windows families include Windows 9x and Windows Mobile.

Microsoft introduced an operating environment named Windows on November 20, 1985 as a graphical operating system shell for MS-DOS in response to the growing interest in graphical user interfaces (GUIs).Microsoft Windows came to dominate the world's personal computer market with over 90% market share, overtaking Mac OS, which had been introduced in 1984. However, it is outsold by Android on smartphones and tablets.

As of April 2014[update], the most recent versions of Windows for personal computers, smartphones, server computers and embedded devices are respectively Windows 8.1, Windows Phone 8.1, Windows Server 2012 R2 and Windows Embedded 8.

Windows 1.0, the first version, released in 1985

The history of windows dates back to September 1981, when Chase Bishop, a computer scientist, designed the first model of an electronic device and project "Interface Manager" was started. It was announced in November 1983(after the Apple lisa, but before the Macintosh) under the name "Windows", but Windows 1.0 was not released until November 1985. Windows 1.0 was to compete with Apple's operating system, but achieved little popularity.

i) Windows 2.0

ii) Windows 3.0 and 3.1

iii) Windows 9x

iv) Windows NT

v) Windows XP

vi) Windows vista

vii) Windows 7

viii)Windows 8

Computer Network

A computer network or data network is a telecommunications network that allows computers to exchange data. In computer networks, networked computing devices pass data to each other along data connections. Data is transferred in the form of packets. The connections (network links) between nodes are established using either cable media or wireless media. The best-known computer network is the Internet.

Network computer devices that originate, route and terminate the data are called network nodes.[1] Nodes can include hosts such as personal computers, phones, servers as well as networking hardware. Two such devices are said to be networked together when one device is able to exchange information with the other device, whether or not they have a direct connection to each other.

Computer networks differ in the physical media used to transmit their signals, the communications protocols to organize network traffic, the network's size, topology and organizational intent. In most cases, communications protocols are layered on (i.e. work using) other more specific or more general communications protocols, except for the physical layer that directly deals with the physical media.

Computer networks support applications such as access to the World Wide Web, shared use of application and storage servers, printers, and fax machines, and use of email and instant messaging applications.

A computer network or data network is a telecommunications network that allows computers to exchange data. In computer networks, networked computing devices pass data to each other along data connections. Data is transferred in the form of packets. The connections (network links) between nodes are established using either cable media or wireless media. The best-known computer network is the Internet.

Network computer devices that originate, route and terminate the data are called network nodes.[1] Nodes can include hosts such as personal computers, phones, servers as well as networking hardware. Two such devices are said to be networked together when one device is able to exchange information with the other device, whether or not they have a direct connection to each other.

Computer networks differ in the physical media used to transmit their signals, the communications protocols to organize network traffic, the network's size, topology and organizational intent. In most cases, communications protocols are layered on (i.e. work using) other more specific or more general communications protocols, except for the physical layer that directly deals with the physical media.

Computer networks support applications such as access to the World Wide Web, shared use of application and storage servers, printers, and fax machines, and use of email and instant messaging applications.

Home Networking

While other types of networks are built and maintained by engineers, home networks belong to ordinary homeowners, people often with little or no technical background. Various manufactures produce broadband router hardware designed to simplify home network setup. Home broadband routers allow devices in different rooms to efficiently share a broadband internet connection, enable people to more easily share their files and printers within the network, and help with overall network security.

Home networks have increased in capability with each generation of new technology. Years ago, people commonly set up their home network just to connect a few PCs, share some documents and perhaps a printer. Now its common for households to also network game consoles, digital video recorders, and smartphones for streaming sound and video. Home automation systems have also existed for many years, but these too have grown in popularity more recently with practical systems for controlling lights, digital thermostats and appliances.

Business networks

Small and home office(SOHO) environments use similar technology as found in home networks. Businesses often have additional communication, data storage, and security requirements that require expanding their networks in different ways, particularly as the business gets larger. Whereas a home network generally functions as one LAN, a business network tends to contain multiple LANs. Companies with buildings in multiple locations utilize wide-area networking to connect these branch offices together. Though also available and used by some households, voice over IP communication and network storage and backup technologies are prevalent in businesses. Larger companies also and network storage and backup technologies are prevalent in businesses. Larger companies also maintain their own internal web sites, called intranets to help with employee business communication.

Networking and the internet

The popularity of computer networks sharply increased with the creation of thw World Wide Web(WWW) in the 1990's. Public web sites, peer to peer (P2P) file sharing systems, and various other services run on internet servers across the world.

Wired vs. Wireless Networking

Many of the same network protocols, like TCP/IP, work in both wired and wireless networks. Networks with Ethernet cables predominated in businesses, schools, and homes for several decades. More recently, however, wireless alternatives have emerged as the premier technology for building new computer networks, in part to support smartphones and the other new kinds of wireless gadgets that have triggered the rise of mobile networking.

Question : What is Wireless Computer Networking?

Answer :

Wireless is a more modern alternative to tradional wired networking that relies on cables to connect networkable devices together. Wireless technologies are widely used in both home and business computer networks.

Types of Wireless Network Technologies

A variety of technologies have been developed to support wireless networking in different usages including:

Wi-Fi, especially popular in home networks and as a wireless hotspot technology.

Bluetooth, for low power and embedded applications.

Wireless home automation, standards like ZigBee and Z-Wave.

Advantages of Wireless over wired networking

A wireless computer network offers several distinct advantages compared to a wired network but is not without downsides. Advantages of wireless technology include mobility (portability and freedom of movement) and elimination of unsightly cables. Disadvantages of wireless include additional security concerns, plus the potential for ratio interference (due to weather, other wireless devices or obstructions like walls).

Introduction to AutoCAD

AutoCAD is a software program, created in 1982 for 2D and 3D design and drafting. This program runs on personal computers on Microsoft Windows desktop. AutoCad is available in several different languages and can translate as well.

There are several different versions of AutoCAD. The first version is AutoCAD LT, this is a version of AutoCad with limited capabilities. This version only has 2D capabilities and it is available at most computer stores. AutoCAD LT is perfect for beginners or entry-level users.

Another version of AutoCAD is a student version. This is similar to the full commercial version, but this version cannot be used for commercial use. The reason for this is due to the file format that it is saved in. This version is perfect for students and teachers needing to study and perfect their AutoCad abilities.

The last version of the AutoCad system are vertical programs. This program allows one to draw 3D objects such as walls, doors and windows, and all objects with lines and circles. This is more complex version, but this program is perfect for the construction industry.

Some of the various types of the AutoCad vertical program are as follows: AutoCAD Electrical, AutoCAD Civil 3D, AutoCAD Map 3D, AutoCAD Mechanical, AutoCAD MEP, AutoCAD P&ID, AutoCAD Plant 3D, and AutoCAD Structural Detailing. These programs are perfect for any architectural and construction type projects. These programs give people the tools needed to create their desired designs.

Today, custom application development is not unheard of. There are many applications that have been developed especially for AutoCAD and other CAD programs. These applications make work with the software more efficient and user friendly.

AutoCAD has a few different types of file formats. DWG is their most used file format. Two of the other file formats are DXF and DWF. DXF has become a standard for CAD data and DWF which was developed by Autodesk but is used in the recent versions of AutoCad. Each project is saved based on what is in the design.

Definition

AutoCAD is a 2-D and 3-D computer-aided drafting software application used in architecture, construction and manufacturing to assist in the preparation of blueprints and other engineering plans. Professionals who use AutoCAD are often referred to as drafters. While drafters work in a number of specialties, the six most common specialization areas are mechanical drafting, architectural drafting, civil drafting, electrical drafting, electronics drafting and aeronautical drafting.

Types of drafters

Architectural drafters draw up plans for residential and commercial buildings. Civil drafters draw up plans for use in the design and building of roadways, bridges, sewer systems and other major projects. Mechanical drafters prepare plans for machinery and mechanical devices.

Electrical drafters work with electricians to prepare diagrams of wiring electrical system layouts. Electronics drafters also prepare wiring diagrams for use in the making, installing and repairing of electronic gadgets. Aeronautical drafters create blueprints used in assembling aircraft and other related apparatus.

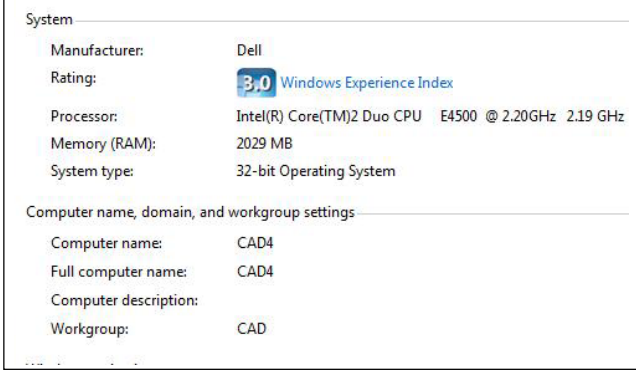
How to use AutoCAD:

1 Decide what project you want to use AutoCAD for. AutoCAD programs cover a broad range of applications. You can find specialized programs for your area of interest, including software focusing on architectural, mechanical, civil, aeronautical or electrical drawing.

2 Ensure that your computer meets the program's system requirements. AutoCAD requires the following:

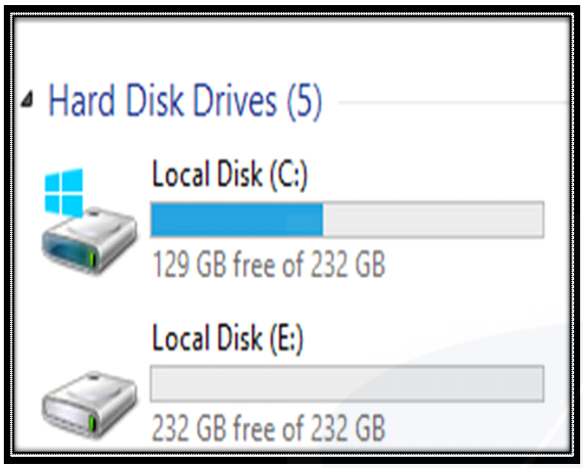
a 2 GB RAM (Fig 8)

Fig 8



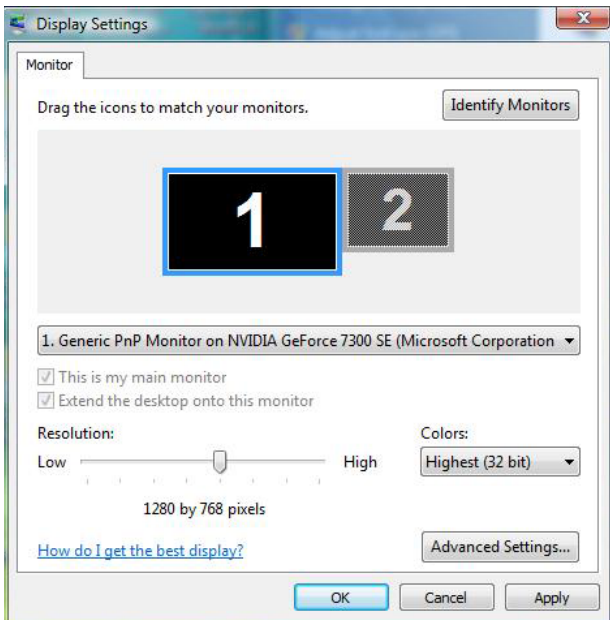
b 2 GB of space for installation (Fig 9)

Fig 9



c Screen resolution of 1.024 x 768 (Fig 10)

Fig 10



d Internet Explorer 7.0 (or) higher (Fig 11)

Fig 11

3 Install the AutoCAD program:

The process is a basic installation with step-by-step instructions from the Installation Wizard. It takes about 30 minutes to complete. After installation the AutoCAD icon will appear on your desktop. Double-click the icon whenever you want to start the program. (Fig 12)

4 Drawing Units:

Before starting to draft, set the parameters of UNITS. In the command bar type in UNITS and then Enter. AutoCAD is used as a measuring parameter UNITS. So in the settings choose inches, (or) millimeters, (or) centimeters, (or) meters, (or) kilometers, etc ... For Architectural use Inches, in mechanical engineering use millimeters, centimeters in construction and surveying meters. So this is important for PLOT (printing on paper) and the SCALE that is placed at the end. (Fig 13)

Fig 13

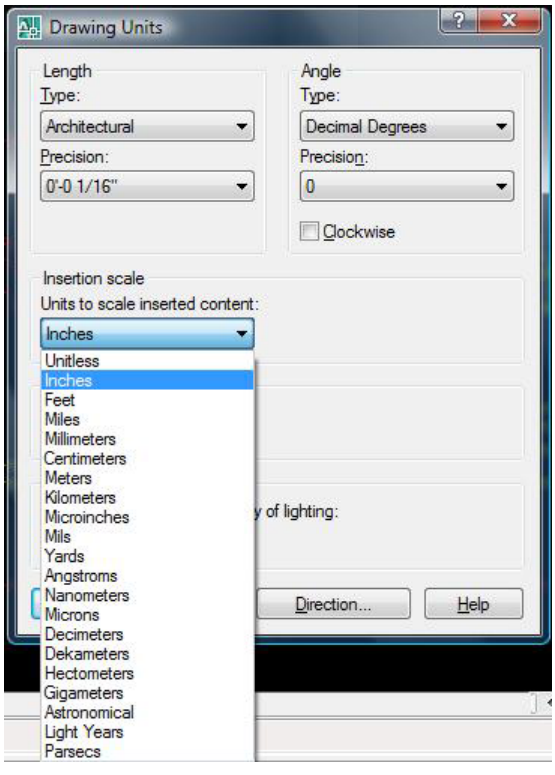
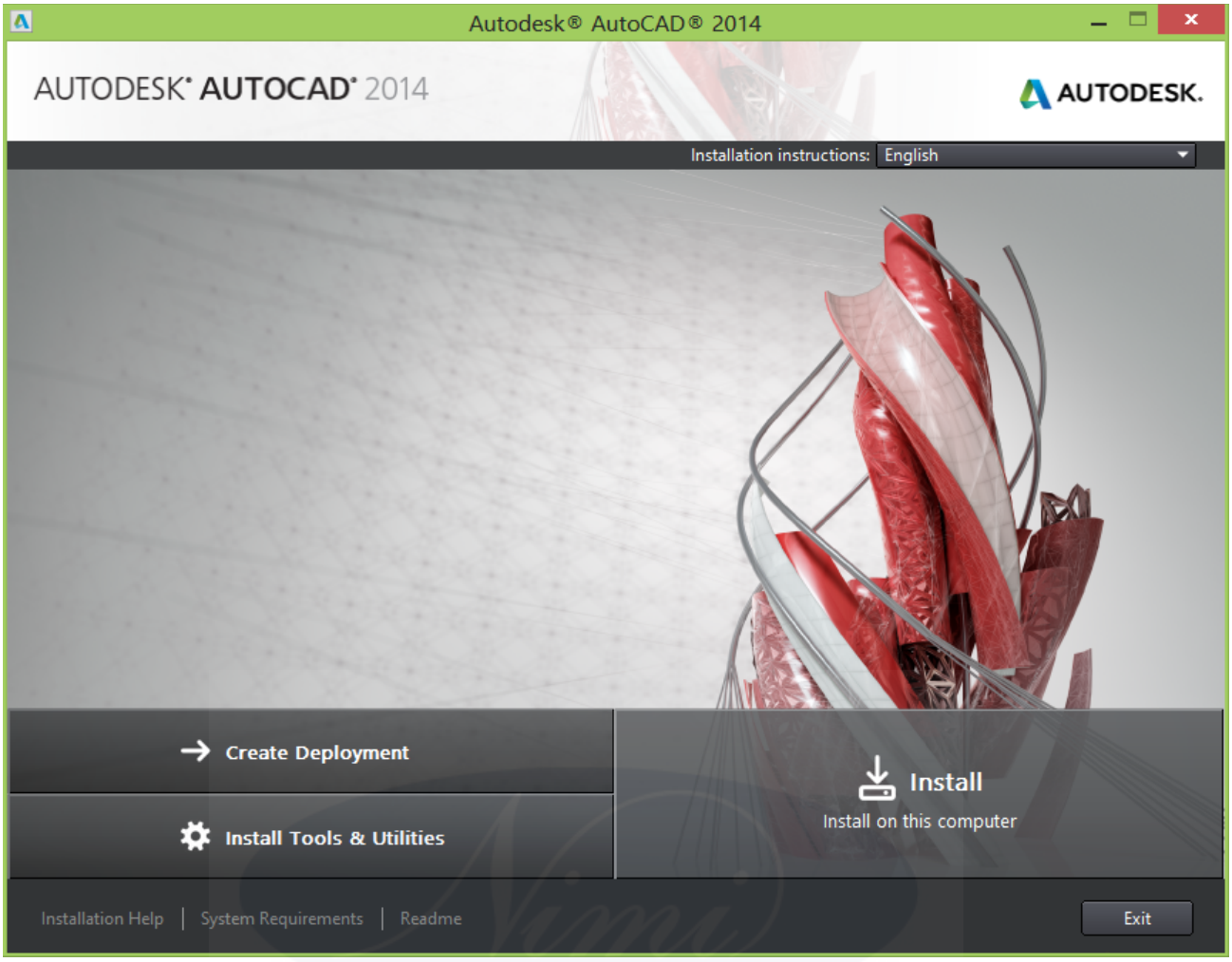
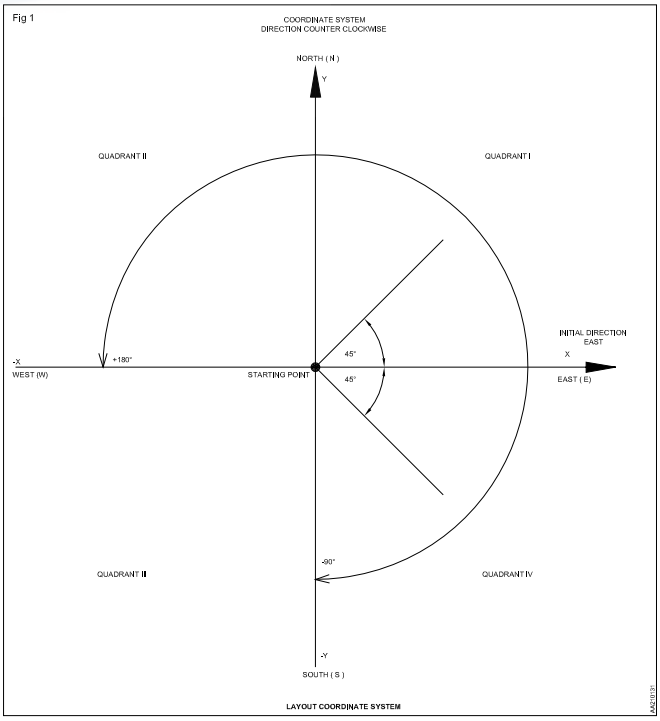


Fig 12



Coordinate system in AutoCAD (Fig 14)



To work in AutoCAD is necessary to know the Coordinate System

When we draw a line or any character or point, the start position will be set in relation to the coordinate system.

Coordinate system understand as a plane that can be in a position if it is a 2D drawing or more positions when it comes to drawing in 3D.

So we start from starting point in relation to the axis X and Y coordinates with the position we are in a certain place (more about that below), but remember the word origins, to the position which is currently located prior to drawing. Each time when we are positioned somewhere; our starting point is the starting point no matter where in the drawing are. The position of the origin depends on the draw in the absolute or polar coordinate system (although we may in the course of combined systems that we want)

Be sure to good learn the coordinate system, if this does not learn then will be almost impossible to design a more complex

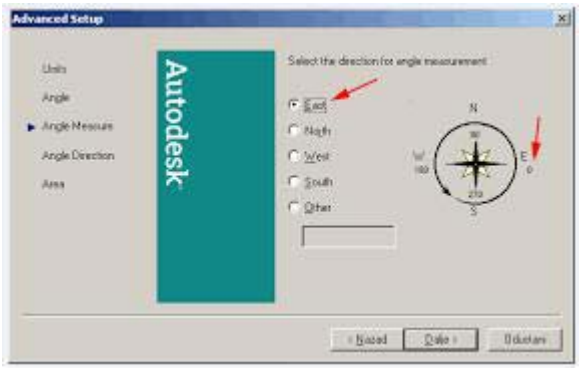
2D drawing about in 3D not to speak of. For 3D drawing, drawing a line in space must review the toolbar UCS and UCS II, because using them will be positioned at a starting point, surface, plane and so forth.

Layout Coordinate System

Short explanation about coordinate system

Our starting point is always in the direction East and to the first X followed by Y coordinates in direction North. (x,y). (Fig 15)

Fig 15



So our starting point is the central starting point. When the Command line write some coordinates, AutoCAD will be based on this starting point (which is currently on the drawing) in relation to his position will be the starting point drawing.

Used as a guide to X axis first coordinate and Y axis for the second coordinate (except in Cartography Geodesy, there are reversed coordinates - replaced, what is the X axis in mechanical engineering and construction to the Y axis in geodesy). It is also important to note that the axis X and Y can be so negative compared to the starting point for some sort of starting point we can enter a drawing and negative coordinates.

These negative coordinates positioned in Quadrant II and III for the X axis, and III and IV quadrant of the Y axis.

Example:

If when you start drawing enter coordinate X = 50 then AutoCAD X axis count by 50 units in the East direction, depending on the value of Y axis, the result will be in quadrant I or IV, but if you write X = -50 then AutoCAD count 50 units in the minus ie. In the direction of West and again depending on the value of Y axis, the result will be in quadrant II or III.

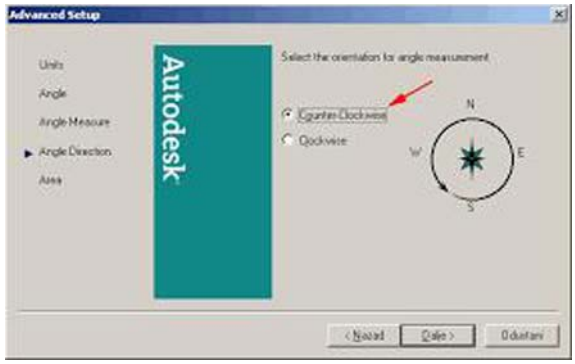
The same is true for the Y axis (Please note the Geodesy is reversed, first write the Y axis and then X (y,x)

All of this applies to enter angles in Command Line.

"COUNTER CLOCKWISE" and "CLOCKWISE" directions are in the drawing coordinate system. (Fig 16)

The engineering and building construction uses direction "Counter Clockwise" and geodesy "Clockwise"

Fig 16



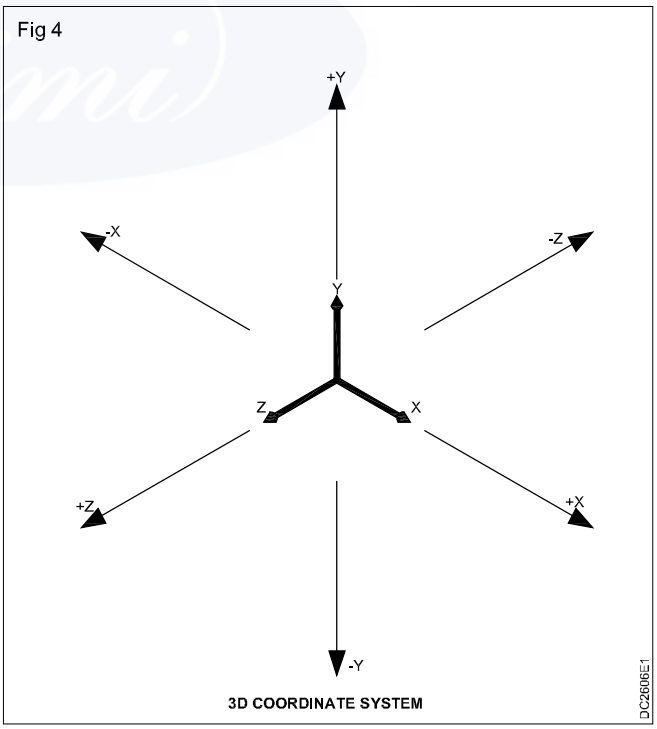
What does it mean?

Means that when we draw circular arcs, and other elements depending on the direction that we will set our direction and drawing, the starting point to the end. By default AutoCAD 2007 in this direction is set in the Counter Clockwise direction, and that means the opposite of clockwise.

If you want to change this direction then the text menu, select Format => Units and select the option Clockwise. Here is set and other parameters related to the units to work in AutoCAD or the same parameters can be set via a dialog window in the STARTUP ADVANCE SETUP window.

3D Coordinate system (Fig 17)

Fig 4



Types of Coordinate system:

There are 2 types of Coordinate system they are as follows:

1 2D Coordinates (Fig 18)

2 3D Coordinates (Fig 19)

Fig 5

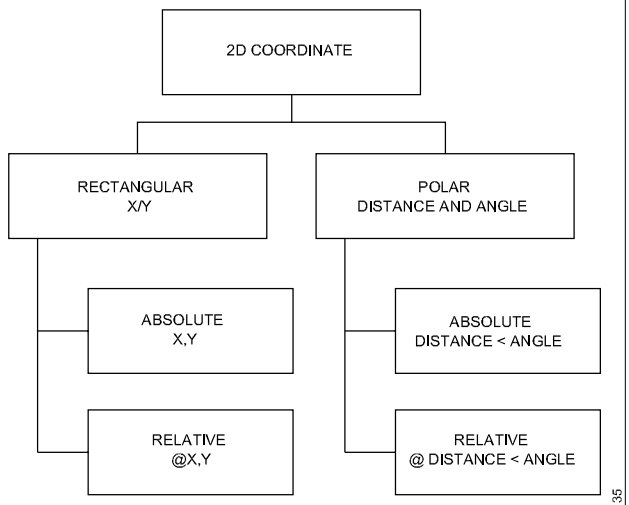
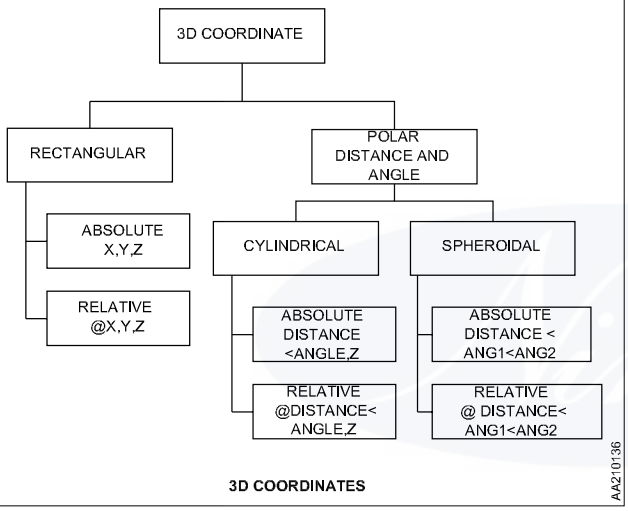


Fig 6



After running AutoCAD You can start to change some settings. Besides STARTUP settings at startup can be defined as follows:

In any respect we draw the line 2D or 3D and can be adjusted accordingly and display the UCS icon on your desktop. View => Display => UCS Icon => Properties (Fig 20 & Fig 21).

Saving drawings

Saves the most recen changes to a drawing. The first time an unnamed drawing is saved the “Save As” dialog box appears. AutoCAD saves its drawings as files with extensions ending in .DWG

1	Choose	File, Save or Saveas
2	Type	Save or Saveas at the command prompt. Command : Save or Saveas
3	Press	Enter
4	Type	A new drawing name or keep the existing drawing.
5.	Click	The OK button.

Fig 20

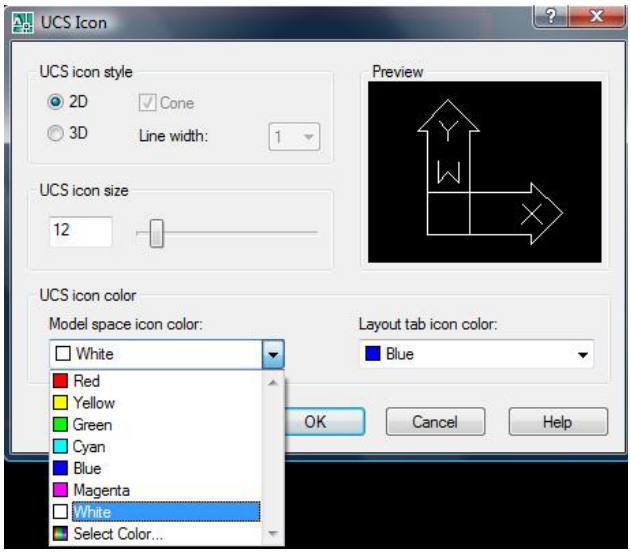
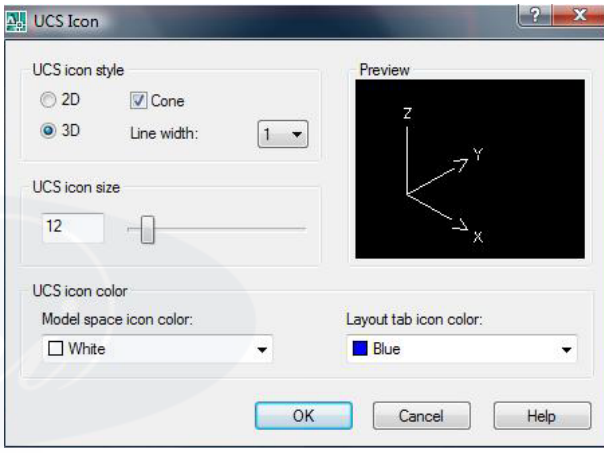


Fig 21



Tip:

Clicking the dropdown list for file type changes the format that the drawing can be saved in. (Fig 22)

File safety precautions

Autosave

AutoCAD automatically saves information in .SV$ files; however, users should save their drainges to .DWG files every 10 minutes. A value of zero(0) disables autosave.

Temporary files

These files have the extensions .ac$ (temporary drawing file).

After a system failure, if you are on a network, you should not delete temporary files until you have verified that they are not part of an active editing session.

Other temporary files may be left in the drawing directory or the temporary file directory. (Fig 23)

Fig 22

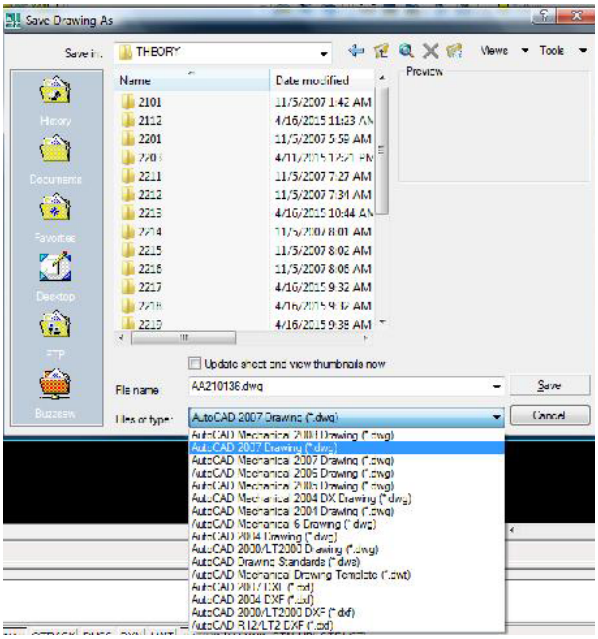
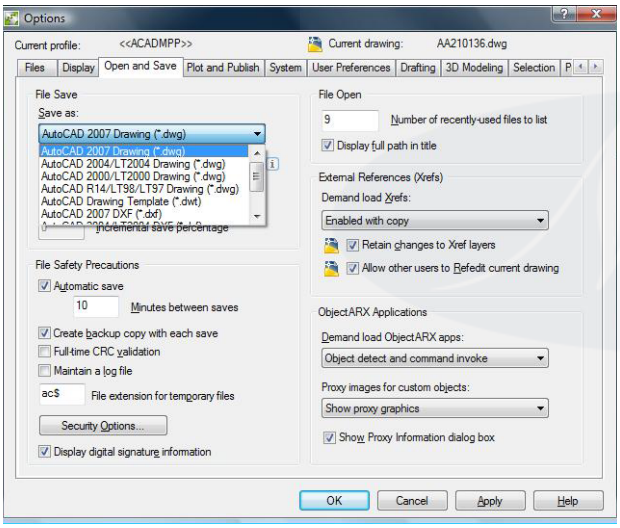


Fig 23



Autosave and SV$ under Tools, options....., Open and save.

Security options

Specifies security settings to be used when your drawing is saved. The password option adds a password to a drawing when it is saved. (Fig 24, Fig 25 & Fig 26)

The size of the line for the mouse pointer(Crosshair size) should not be changed unless you're dealing with surveying, then it is advisable to set it at 100%.

Fig 24

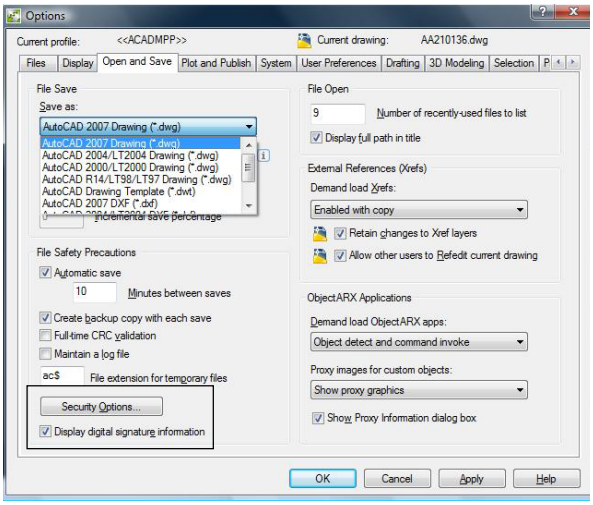


Fig 25

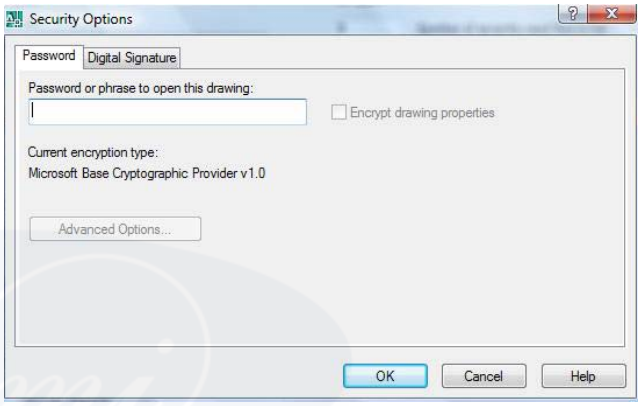
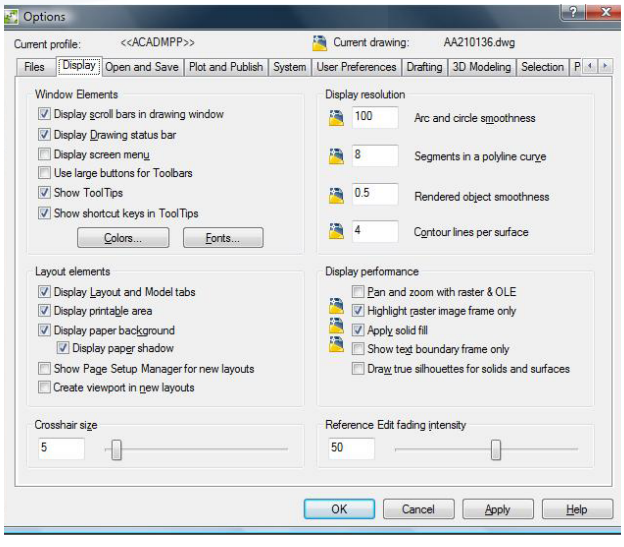


Fig 26



Factors considered in architectural design

Objectives: At the end of this lesson you shall be able to
- **factors considered in architecture design**
- **design principle**
- **elements of design**
- **approach to planning**
- **environmental factor**
- **process of design.**

The meaning of architecture has undergone many changes during the evolution of human civilization. In modern society, architecture is considered with every building task. From public toilets to individual homes, all constructions have become objects of architectural design.

Architecture can be defined as the conscious creation of spaces for utility, constructed from materials in such a way that the whole is both technically and aesthetically satisfying. It is a fusion of art and technology. The theory of architecture involves many technical terms. The definitions of some of the important terms are given below:

1 **Aesthetics :** Aesthetics concerns beauty or the appreciation of beauty. When a building is designed, the aesthetic aspects can be satisfied by using elements such as sloped roofs, decorative columns, roofs for windows, semi circular or segmental arches.

2 **Planning :** Planning a construction means identifying the various steps or activities to be completed in order to carry out the construction in the given amount of time.

3 **Designing :** Designing is the process of procuring of preliminary sketch of an object that is to be physically constructed later. The original idea behind the sketch is called the concept of design.

4 **Creating :** Creating is the actual process of execution, where the design is converted into a physical reality. The process of creating an object involves the processes of

i) Designing

ii) Planning

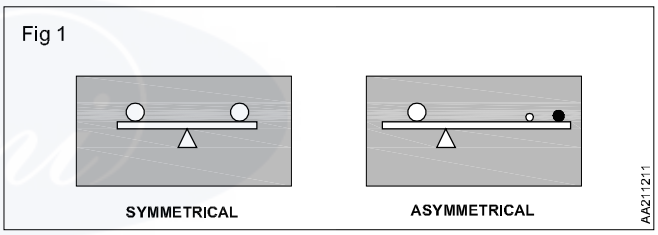
iii) Incorporating the functional and aesthetic aspects

5 **Erecting :** Erecting is the process of assembling or putting into place the completed or fabricated components of building.

Design principles

Balance : Balance is a psychological sense of equilibrium. As a design principle, balance places the parts of a visual in an aesthetically pleasing arrangement. In visual images, balance is formal when both sides are symmetrical in terms of arrangement. Balance is informal when sides are not exactly symmetrical, but the resulting image is still balanced. Informal balance is more dynamic than formal balance and normally keeps the learner's attention focused on the visual message. There are two main types of balance symmetrical balance, asymmetrical balance. (Fig 1)

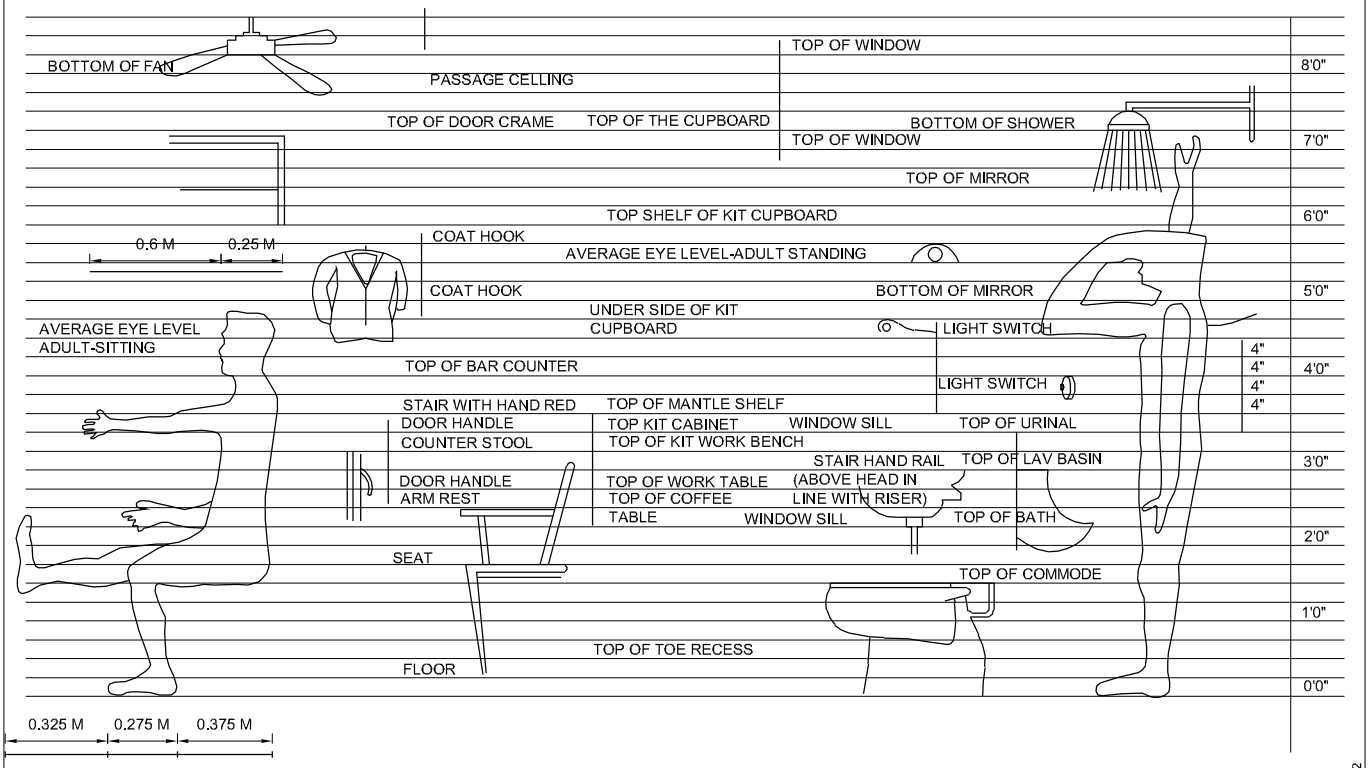
Fig 1



Proportion : Proportion refers to the relative size and scale of the various elements in a design. The issue is the relationship between objects, or parts of a whole. This means that it is necessary discuss proportion in terms of the context or standard used to determine proportions. (Fig 2)

Perspective : Perspective is created through the arrangement of objects in two - dimensional space to look like they appear in real life. Perspective is a learned meaning of the relationship between different objects seen in space. Perspective adds realism to a visual image. Perception can be achieved through the use of relative sizes of objects, overlapping objects and blurring or sharpening objects. (Fig 3)

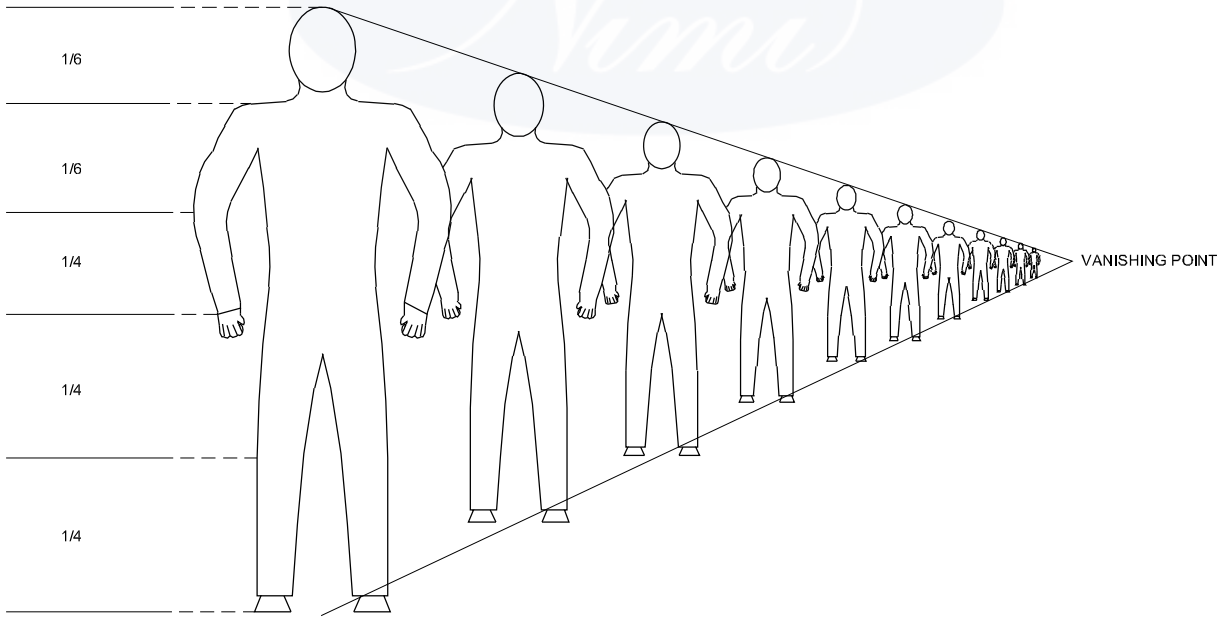
Fig 2



AA211212

COMFORTABLE HORIZONTAL AND VERTICAL DISTANCE FROM EQUIPMENT AND THE HUMAN BODY HELP TO DECIDE THE SIZES OF ROOMS

Fig 3

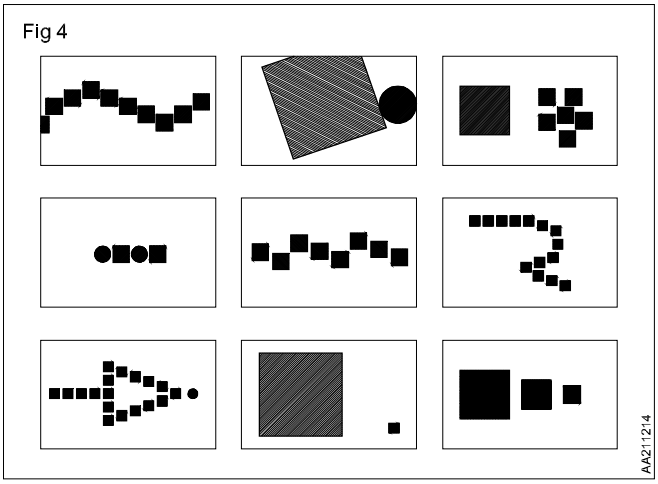


AA211213

Movement - motion or movement in a visual image occurs when objects seems to be moving in a visual image. Movement in a visual image comes from the kinds of shapes, forms, lines and curves that are used. (Fig 4)

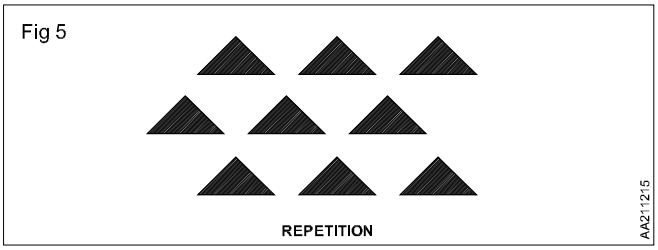
Repetition - Repetition works with pattern to make the artwork seem active. The repetition of elements of design creates unity within the artwork. (Fig 5)

Fig 4



AA211214

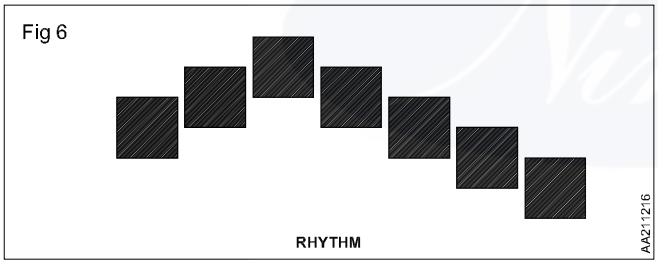
Fig 5



AA211215

Rhythm - Rhythm is the repetition of visual movement of the elements - colors, shapes, lines, values, forms, spaces and texture. Variety is essential to keep rhythms exciting and active and to avoid monotony. Movement and rhythm work together to create the visual equivalent of a musical beat. (Fig 6)

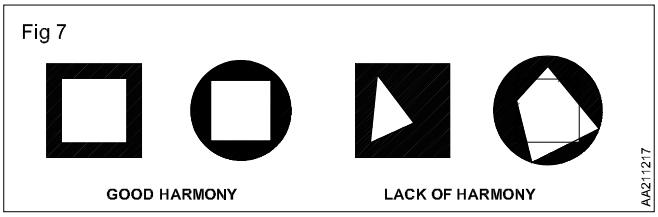
Fig 6



AA211216

Harmony - Harmony in visual design means all parts of the visual image relate to and complement each other. Harmony can be achieved through repetition and rhythm. Rhythm helps direct eye movement. Patterns or shapes can help achieve harmony. By repeating patterns in an interesting arrangement, the overall visual image comes together. (Fig 7)

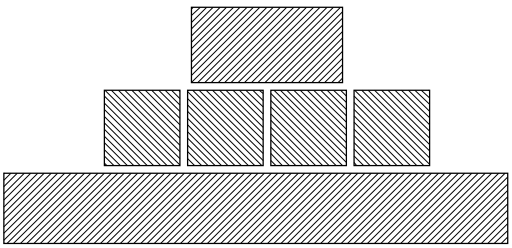
Fig 7



AA211217

Unity - Unity means the harmony of the whole composition. The parts of a composition made to work together as a total visual theme. Unity is the relationship among the elements of a visual that helps all the elements function together. Unity gives a sense of oneness to a visual image. In other words, the words and the images work together to create meaning. (Fig 8)

Fig 8



AA211218

Elements of design

Creating floor plans is a process of allocating interior space to meet funcitonal needs. Designing elevations involves combining the elements of design to create functional and attractive building exteriors. The elements of design like point, line, plane, figure, form and space, color, light, materials and texture are applied to the creation of elevations.

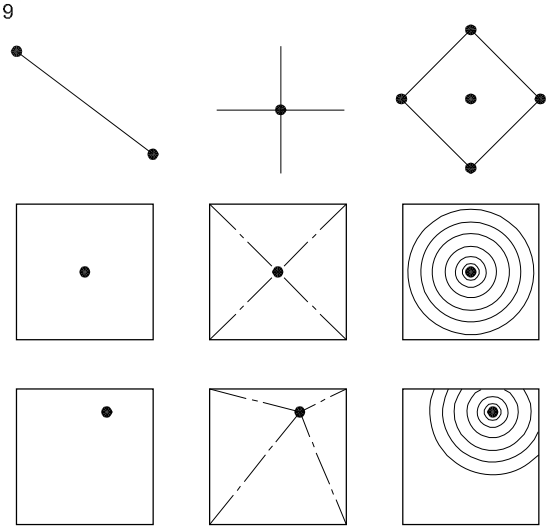
Point

A point has no dimension or magnitude but its importance and denotes its position in space. The size of points makes change with respect to its background. Point may be 'point of attraction' or a focus point in the field of architecture.

As shown in Fig 9 a point can serve to mark

- The two ends of a line.
- The intersection of two lines.
- The meeting of lines at the corner of a plane or volume and the centre of a field or environment.

Fig 9

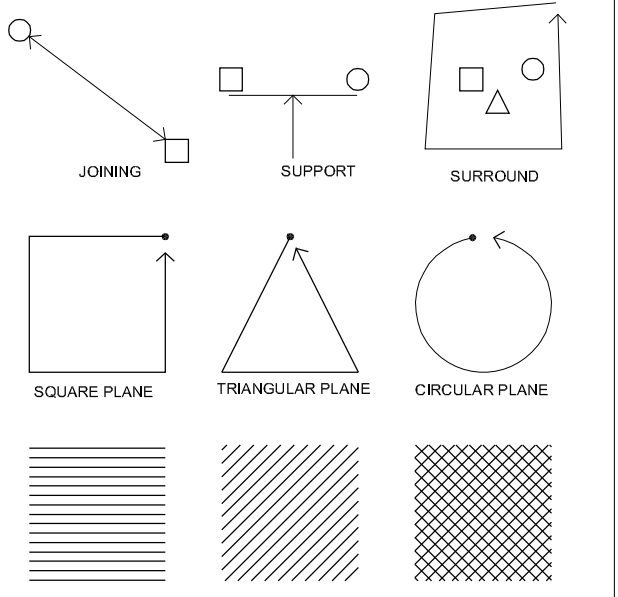


AA211219

Line

The lines of an elevation tend to create either a horizontal or vertical emphasis. The major horizontal lines of an elevation are ground line, eave line and ridge line. (Fig 10)

Fig 10



LINES HELP IN THE FORMATION OF VARIOUS VISUAL ELEMENTS

Lines should be consistent. The lines of an elevation should appear to flow together as one integrated line pattern. The lines of component parts of an elevation should relate each other, and the overall shape should reflect the basic shape of the building.

A line can serve to

1 Join, link, support, surround, or intersect other visual elements,

2 Describe the edges of and give shapes to planes, and

3 Articulate the surfaces of planes.

Plane

Plane is a two dimensional elements composed of numbers of lines adjacent to each other. It has length and breadth but no thickness. It may be straight or curved, horizontal or vertical in appearance of the plane. (Fig 11)

Figure

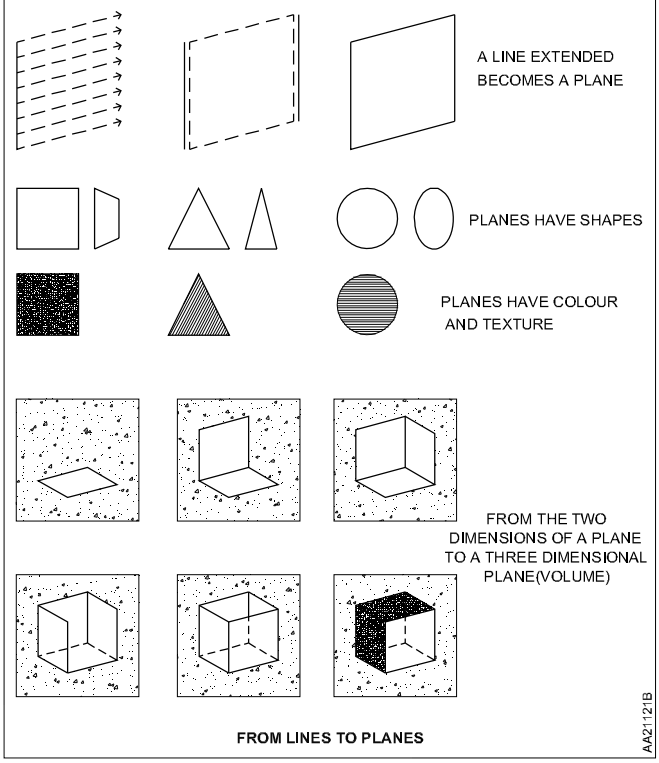
Figure is also a two dimensional elements formed by the enclosure of the space by line or number of lines. It may or may not have depth as a third dimension.

Form and space

Lines combine to produce form and create the geometrical shape of an elevation. Elevation shapes should be balanced. Formal balance is used extensively in colonical and period styles of architecture. Informal balance is more widely used in contemporary residential architecture.

In addition to the elements of design, the basic architectural style of a building needs to be considered when designing elevations. Doors, windows should be part of a continuous pattern of the elevation and should not appear to exist alone. (Fig 12)

Fig 11



FROM LINES TO PLANES

Fig 12

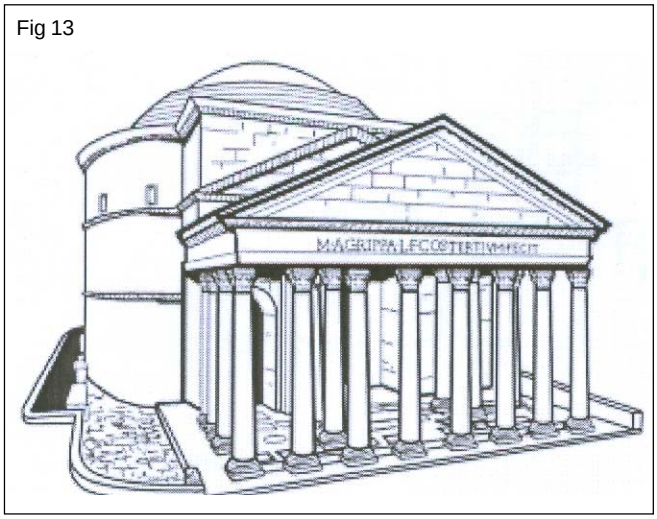
Light and colour

An elevation that is composed of all light areas or all dark areas tends to be uninteresting and neutral. Some balancing of light, shade and color is desirable in most elevation. Shadow patterns can be created by depressing specific areas, using over hangings, texturing and varying colors. Door and window trim, columns, battens and overhangs are used to create most shadows.

Texture

Texture is defined as a feel of the surface of an object. It is everywhere from every material and object, whether it was manmade or natural. Texture gives us a sense of individuality on the material and a design will help emphasize and create a feel. Texture describes emotions and thoughts of a design, rough edges tell as anger or masculinity and smooth surface's is the opposite. (Fig 13)

Fig 13



Textures that could be felt are like sculptures, collage, and embroidery etc. Textures which can't feel by touching are like paintings and drawings etc.

Using textures in architecture creates the feel that all of us need which is to feel belonged and trusted. Using the right material in a design is very important. To create a right feeling of texture, texture can be further classified as regular, irregular and chaoting. Texture also helps us to break the monotony in a composition. Sometimes a color does not look nice individually but looks good in some texture.

Building materials - Building material is very important for the amount of heat gain by the home. It affects the amount of heat transfer through the wall or roof into the house. In hot and cold climates heavy building materials like stone, cavity walls should be used. Roofs must be well insulated. In humid climates lighter materials should be used. The furniture inside the house and those used for partition should be light. (Fig 14)

Fig 14

Approaches to planning

Each part of the cosmos or house has its own relevance; it is at this level of individual rooms, that both comfort and environmental quality are experienced. Hence, they have to be designed carefully during the course of internal planning. The design of the rooms is dependent on the living pattern of the occupants.

All activities that take place in the home are linked to one another and are sequential.

The arrangement of rooms is more important than the amount of space.

There are two basic principles that you should keep in mind while designing:

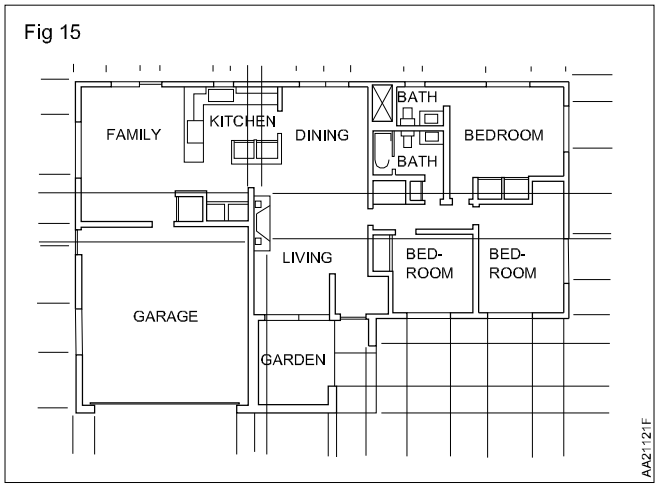
1. The division of the home into public and private areas. The house can be divided into two wings - one that contains facilities for food preparation, entertainment like living, dining and kitchen and the other for renewal and personal like toilets and bedrooms.

2. The logical flow of functions or activities. As our living patterns have become more refined and individualistic, activities which used. As our living patterns have become more refined and individualistic, activities which used to take place in a single room have progressively become subdivided in larger homes. The dimension of each space should be appropriate to its function.

Open planning

In open plan, space continuously flows from one zone to the next. The advantage of open planning is that the house seems more spacious. This is suitable for people desirous of a second home as a cottage typesetting or a place to be given on rent or a home where there are no full time servants. Open planning is especially suited to people who enjoy frequent interaction, but it does have advantages. (Fig 15)

Fig 15

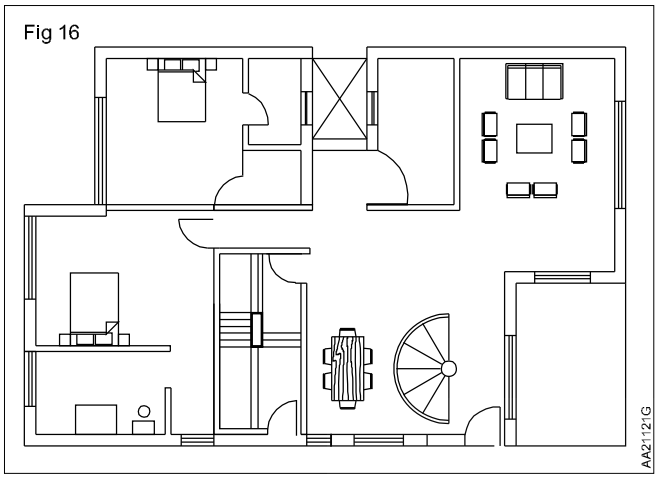


Closed planning

The closed plan is the division of space into separate rooms for specific activities. This plan may be preferred when there are different generations within the same house and the occupants desire privacy. It is also desirable when there is a need to close off certain areas for work, or to control noise.

The choice of a closed plan or an open plan depends upon the family structure and nature of living. (Fig 16)

Fig 16



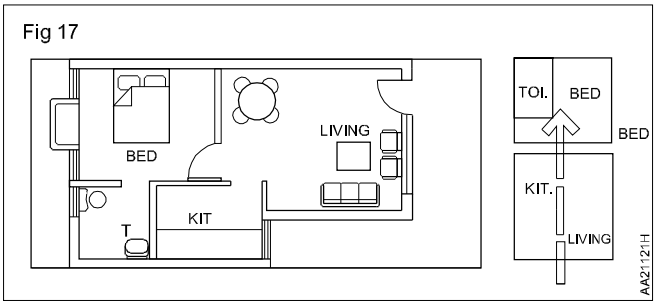
Circulation

Factors that determine the design of your house in a major way is the system of internal circulation.

Horizontal circulation - four models of internal horizontal circulation can be distinguished. These include

Through circulation - this is appropriate in plots, which have very narrow frontage, and entry is possible only from one side. You should place the bedrooms and toilets in the rear portion in such a case. (Fig 17)

Fig 17



Single circulation through living room - this is the most common type. Here all rooms are accessible from the main living room, which is designed as a multi purpose room. You can go into the back garden through the living room or through the kitchen. (Fig 18)

By-pass circulation - in plots, which have larger frontages, you can reach the rear portion of the plot through outside the house but within the property line. (Fig 19)

Fig 18

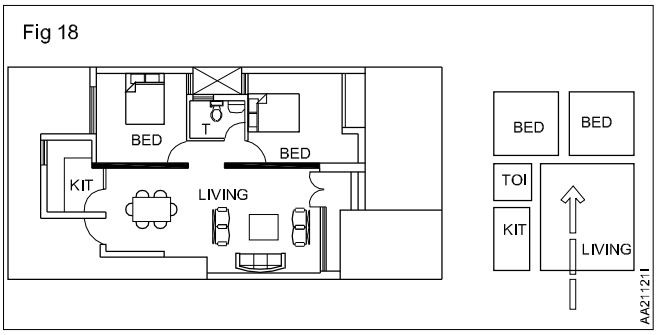
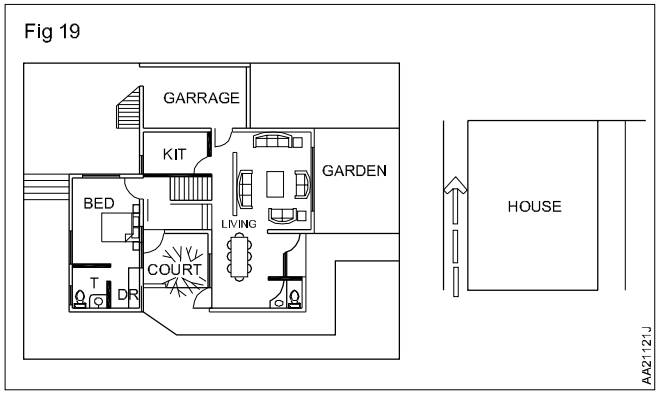
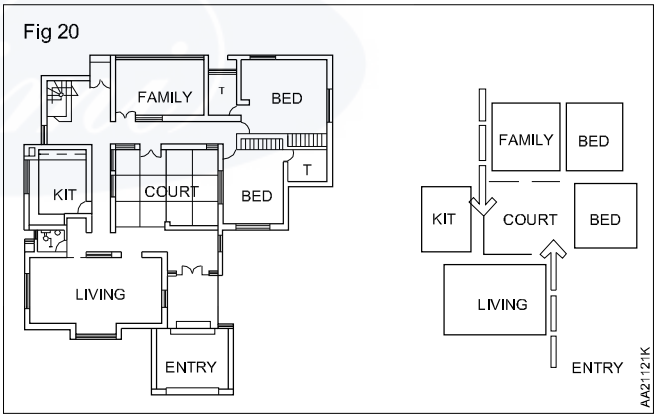


Fig 19



Atruium or open court circulation - this is a good system of circulation in detached houses. This system of movement was used in most of the older houses. This type of house also has climatologically benefits, besides having a private, oepen, internal space for living. (Fig 20)

Fig 20

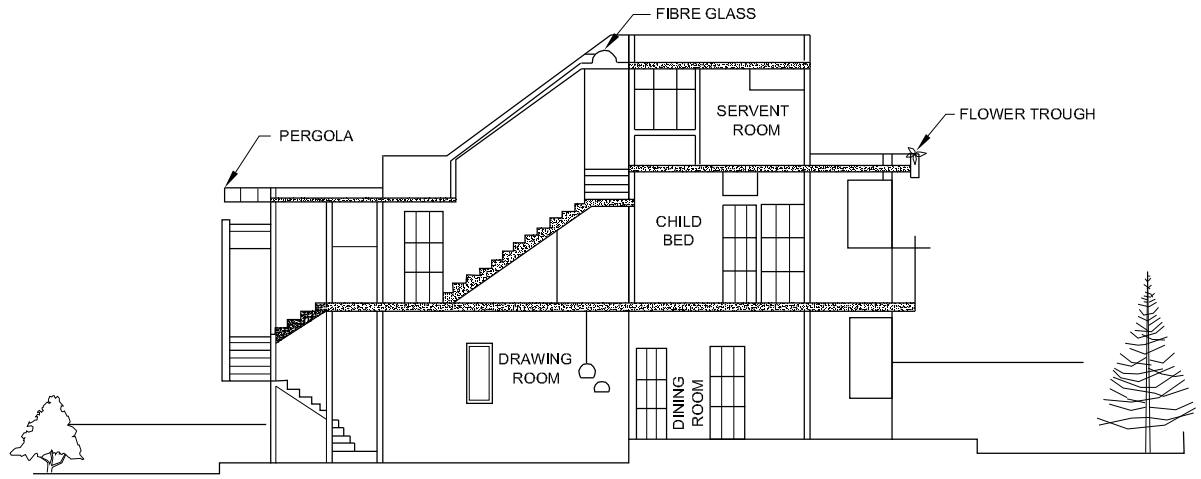


Vertical circulation - the form of your house is also dependent on the number of storey's you build. If you choose to build more than one storey, new determining factors are introduced like the position of the staircase balancing the lower and upper storey accomodation so that the house is structurally possible. (Fig 21)

Environmental factors

Environmental study for architectural design involves the collection of data, survey, creative ability and imagination, and the design of solutions to solve building problems. When an architect is give a design assignment, there are many environmental factors that are to be considered. The site is the major factor that has to be considered.

Fig 21

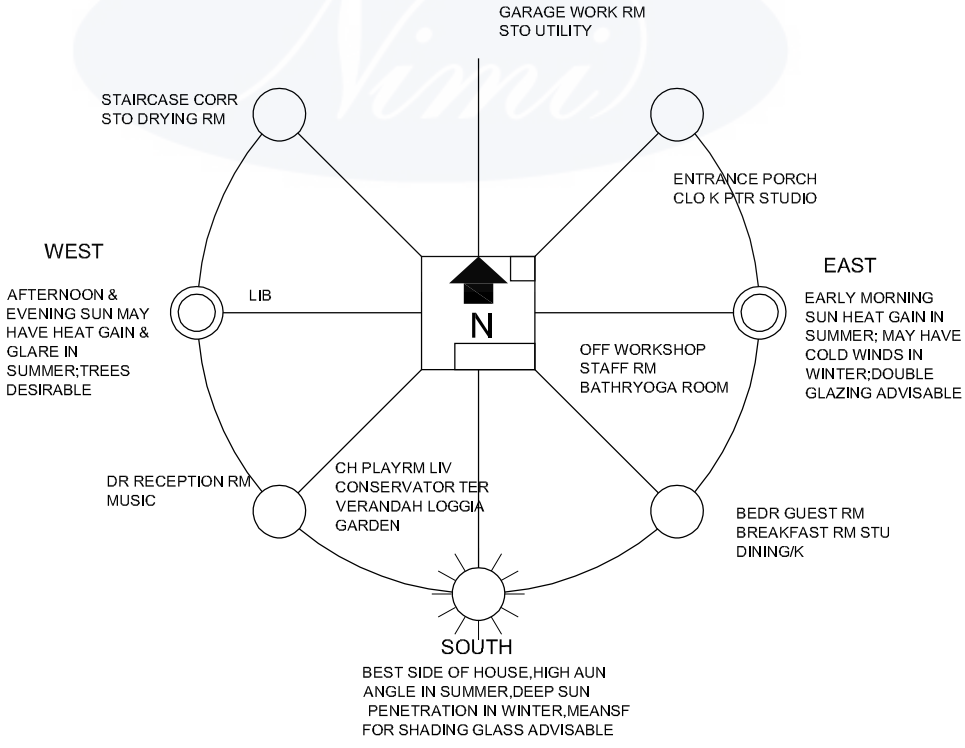


Orientation

As far as possible each room should receive sunlight druing some part of the day throughout the year. The building orientation determines the natural amount of radiation. The summer sun is from the north and shading is required in the northern face of the building and not in the southern side. In india, there are places, which receive the sun only from southern side, and other places, which receive the sun from the northern and southern side. Here shading for both the sides is important, especially in those areas below 23" north.

In hot climate, go for a plot that has narrow streen in front. This will help also in mutual shading. In colder climates, the street in front of the house to receive south sun. In warm humid climates, the street needs to be in the direction of prevailing wind patterns in monsoons. (Fig 22)

Fig 22

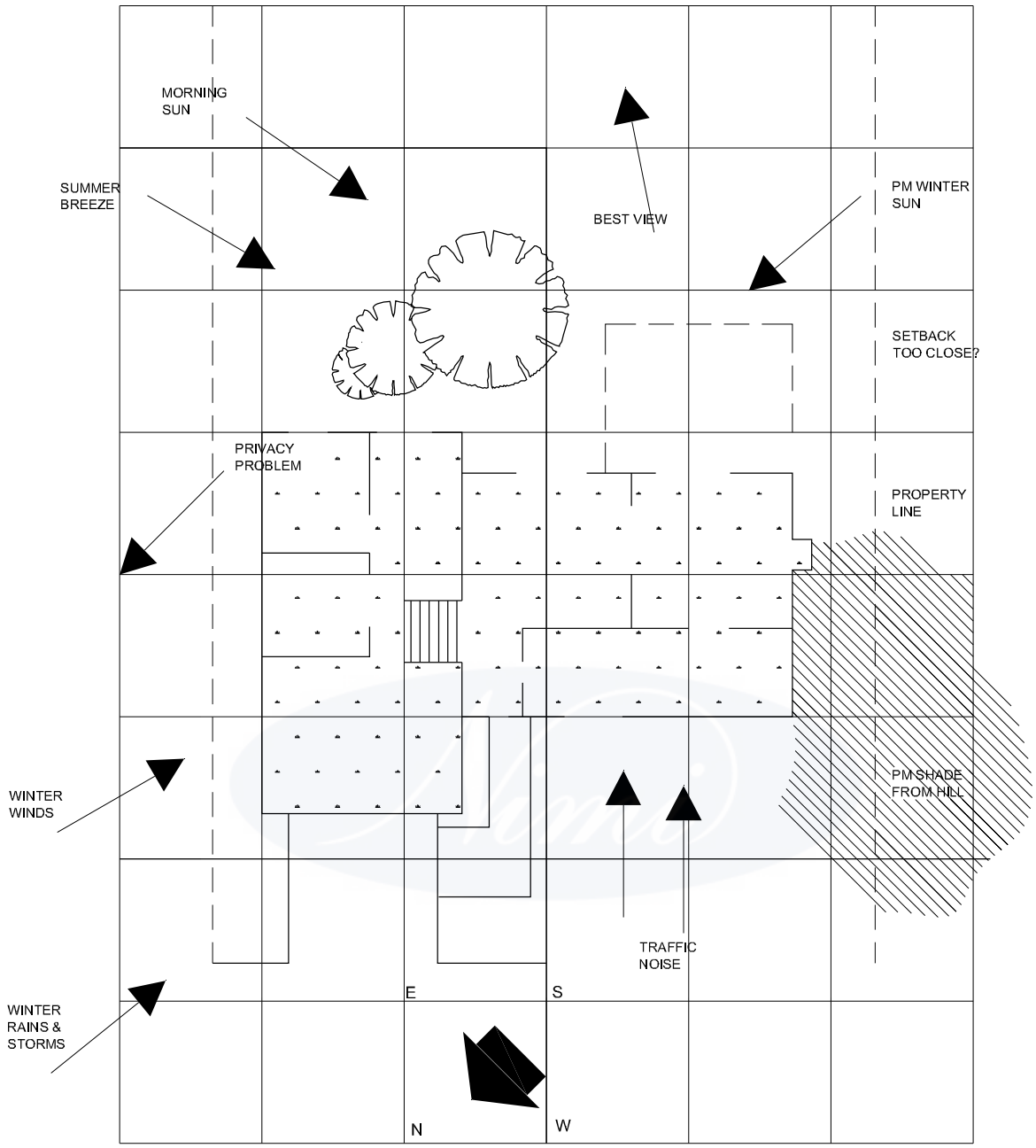


FAVOURABLE ORIENTATION OF HOUSES AND ROOMS

Effects of wind

Cross ventilation is one of the most desired features in any house. The velocity of the wind will increase if a little turbulence is created. Ideal orientation to do this would be to turn the house, so that the winds enter the house at an oblique angle. You can keep the sill height in bedrooms at the matress level. ie., at one and half feet above ground level. (Fig 23)

Fig 23



FACTORS AFFECTING THE POSITIONING OF YOUR HOUSE IN THE PLOT

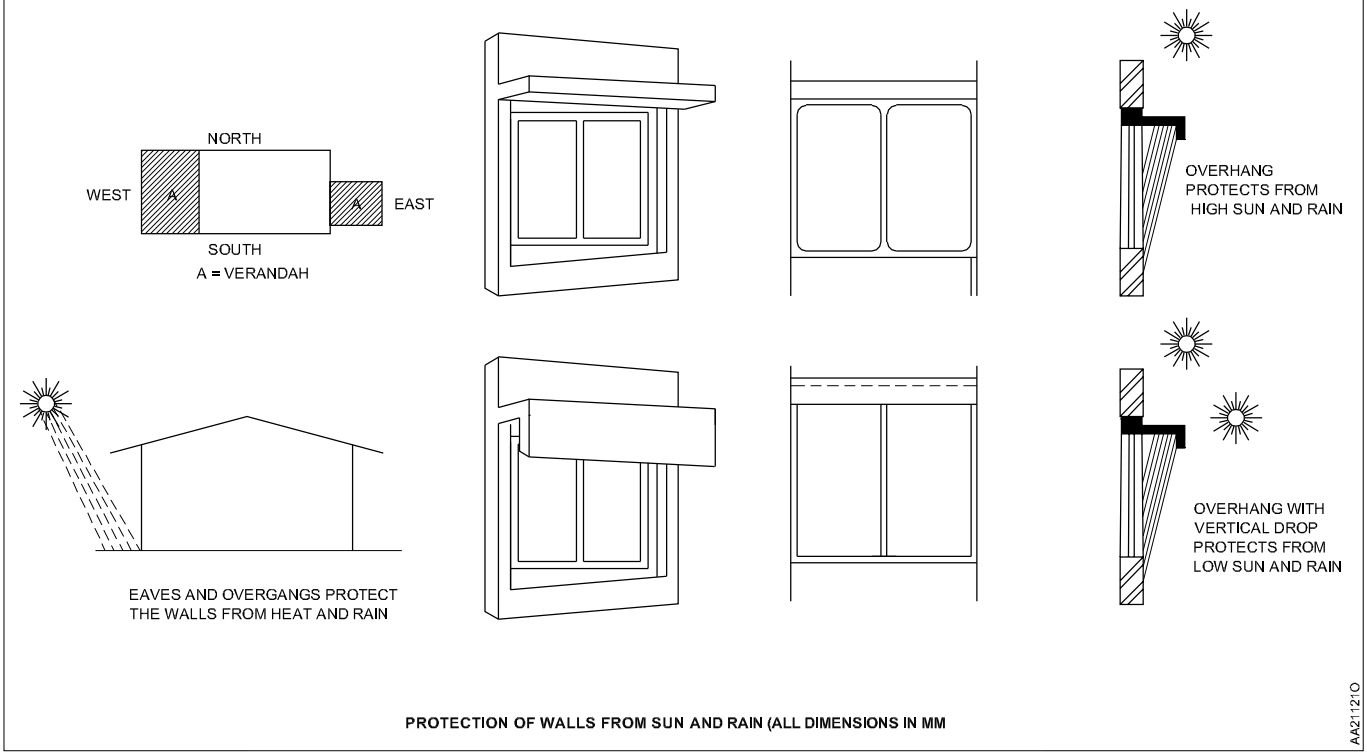
AA21121N

Factors at the building level

Certain elements like verandahs, courtyards and locally created water bodies and vegitation have very useful climatic implications. Water bodies and vegetation cool a vegitation by evaporation and absorption of heat. Coutyards aid in heat loss enhancing ventilation. In hot climates, roof gardens, gardens and planters on windows and chajjas or shades can reduce heat gain. (Fig 24)

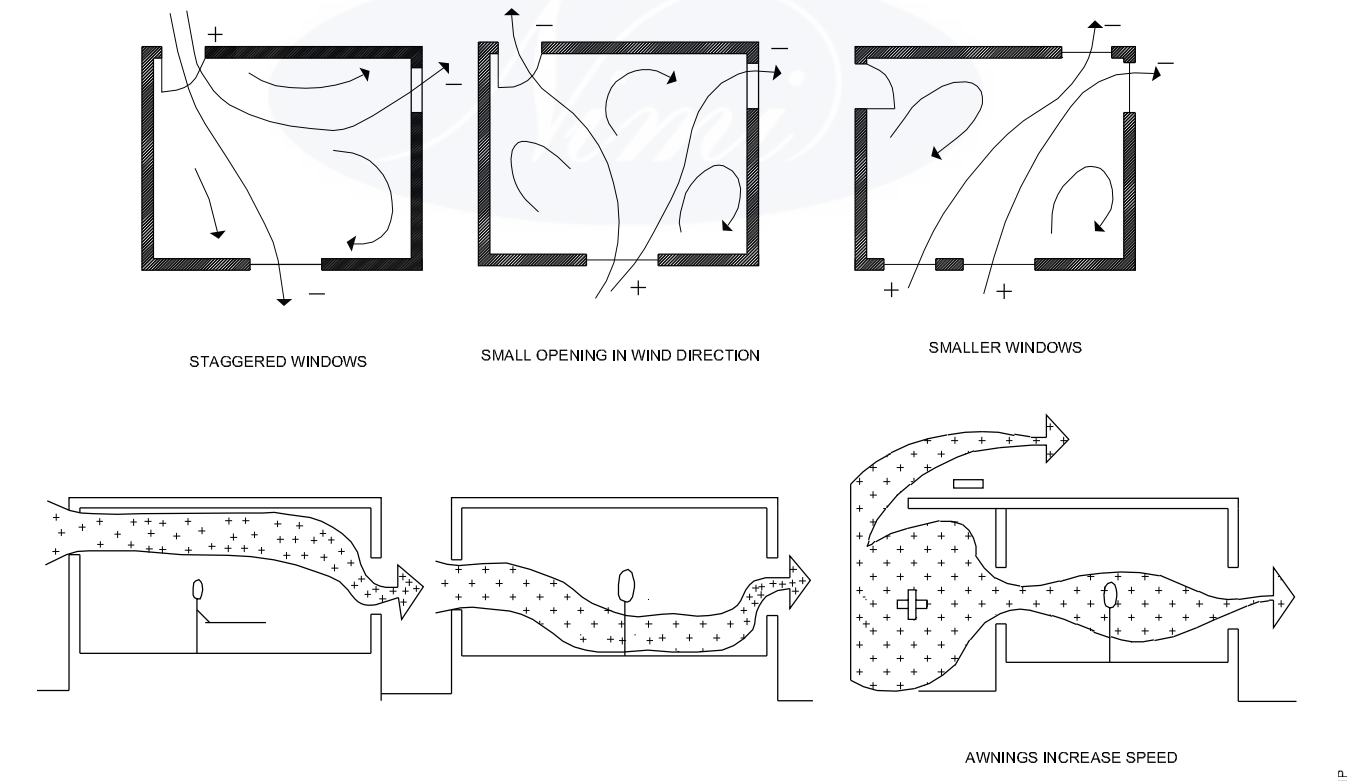
Window positioning - Windows should be staggered than aligned. Indoor wind speeds are greater if the outlet is greater if the outlet is greater than the inlet. It is desirable to provide every wall with windows on two walls. Windows are possible only on the third wall. If the windows are possible only on one external wall, two similar windows are preferable to a single larger one. (Fig 25)

Fig 24



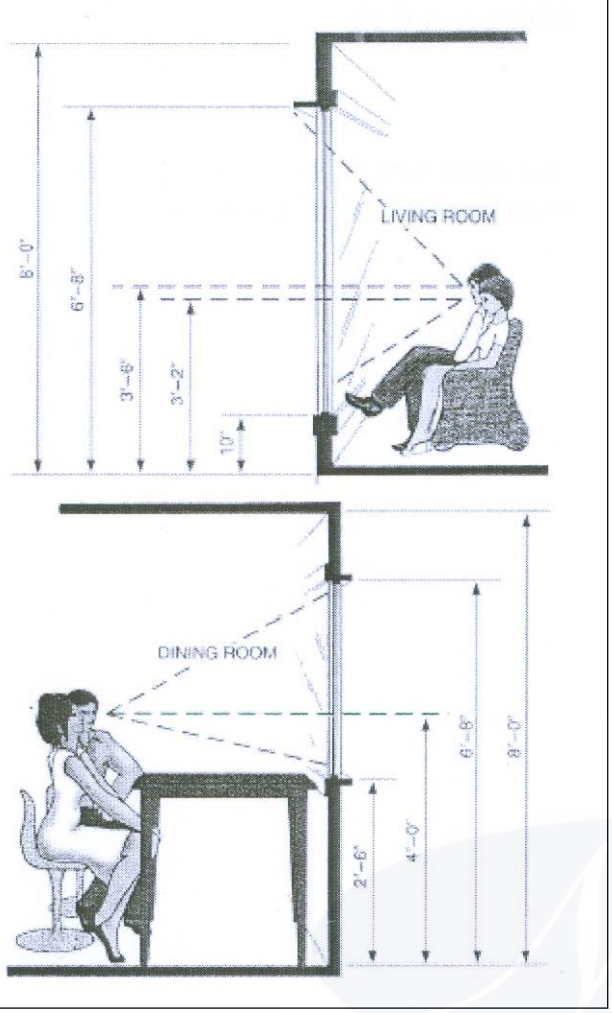
PROTECTION OF WALLS FROM SUN AND RAIN (ALL DIMENSIONS IN MM

Fig 25



THUMB RULES FOR AIR FLOW PATTERNS

Fig 26



The diagrammatic representation

Achieving the characteristics in a home that relate to a person's / family needs is the challenge of designing. A step by step design procedure can be followed to complete the design.

Process of design

Step 1 : Site analysis

Step 2 : Site planning

Step 3 : Requirements

Step 4 : Space designation

Step 5 : Proportionately defined rooms

Step 6 : Single line diagram

Step 7 : Floor layout analysis

Step 8 : Functional planning

Conceptual design ideas

Conceptual design starts with good ideas and thougtful planning. To begin, focus on the proposed building site and note all its characteristics. Intend to take full advantage of anything affecting your lot which may enhance your design. (Fig 27)

Step 1 : Site analysis

Each site is characterized by various factors that create a unique environment. These influences are called elements. Natural elements include hill and trees, direction of wind, sun and views. Man made elements would include neighbouring buildings, roadways and sources of noises, etc. It may be necessary to visit the site several times to determine the daily effects of the elements.

Step 2 : Site planning

Every site has the potential for residential development. Many factors determine the suitability of a site for an individual use. A good site analysis as described in step one should indicate whether the setting is appropriate.

With the approximate location of the natural and manmade elements shown, we can then begin planning the living layout by first establishing the general positioning of the building.

The three basic components of a home are : Living area(L), Working area(W), and Sleeping area (S). Layout these three areas on a plot plan. Be sure to locate them in relation to any features you can take advantage of (ie., solar orientation, view, wind sheltering etc.,) planning a house on a city lot may differ, as compatibility with neighbouring buildings also becomes a factor. (Fig 28)

Step 3 : Requirements

Designing or planning a building in architecture means planning the spaces provided by the building. The kinds of spaces to be designed are decided based on the kind of activities to be performed in the building. The set of spaces that is required for a particular building forms he design requirements for that particular building. For example in considering the design of a residence, the set of activities generally performed within a residence must be identified. The corresponding spaces required to perform these activities are the following:

Fig 1

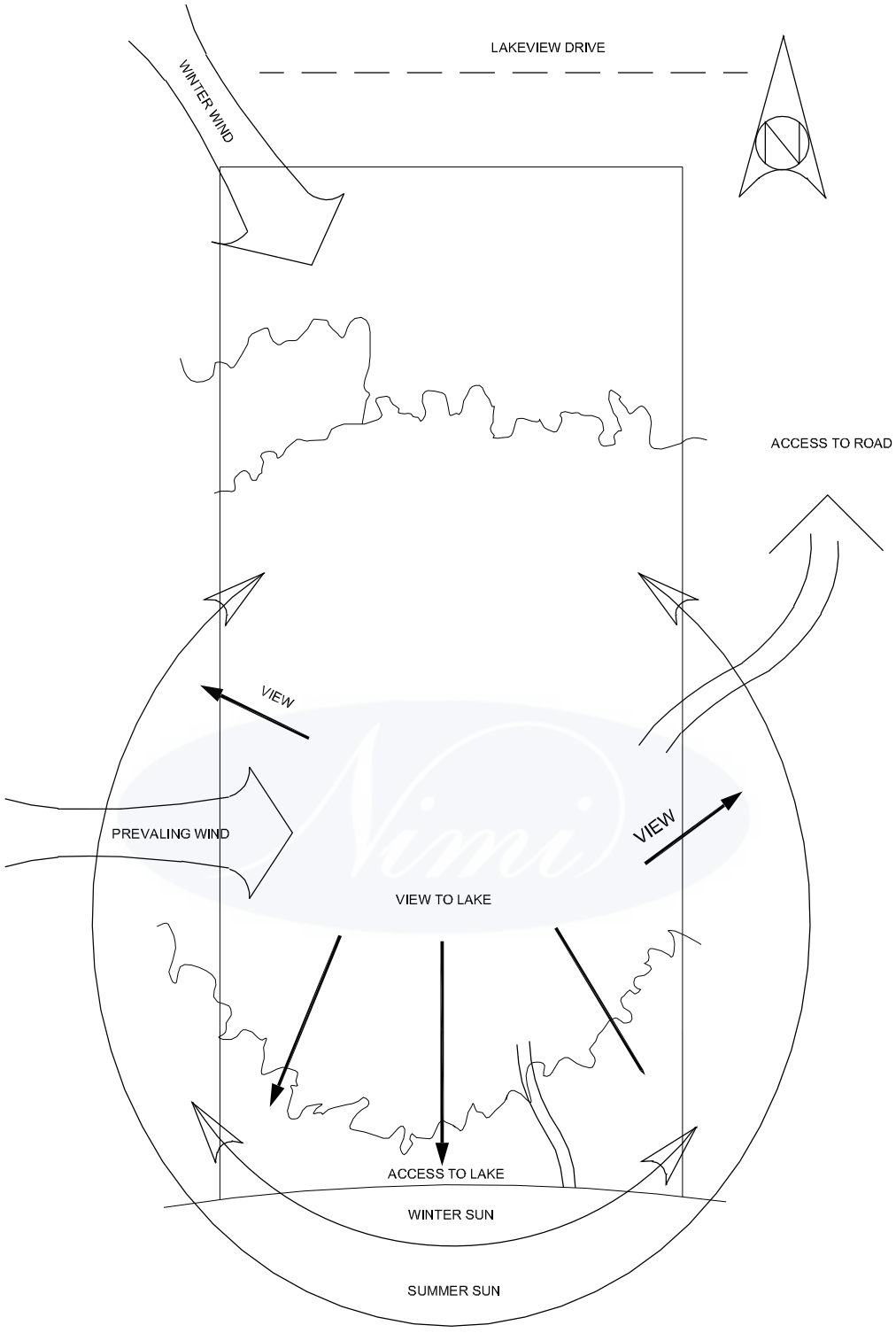
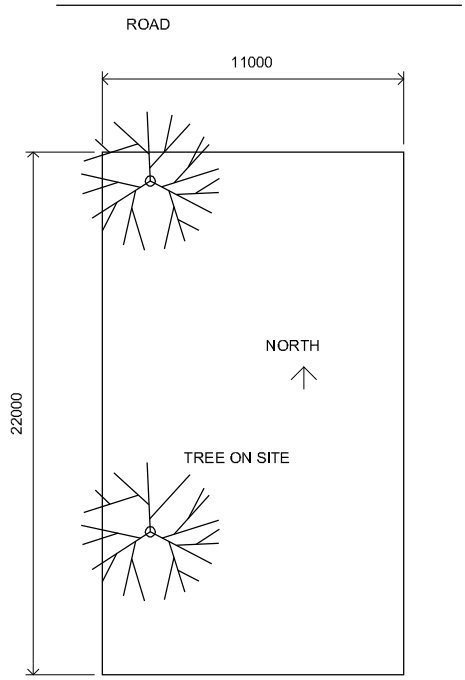

LAKEVIEW DRIVE
WINTER WIND
ACCESS TO ROAD
VIEW
PREVALING WIND
VIEW
VIEW TO LAKE
ACCESS TO LAKE
WINTER SUN
SUMMER SUN
AA211221

Fig 2



STEP 3 PLOT THE BOUNTARY

MARK ALL SPECIAL FEATURES,ROAD AND THE NORTH POINT

AA211222

	Activities	Space required
1	Sitting / Entertaining guest's	Living space
2	Eating	Dining space .
3	Cooking	Kitchen space
4	Sleeping	Bed space
5	Reading / Learning	Study space
6	Family get together / Entertainment	Family space
7	Bathing	Bathroom
8	Sitting outside	Verandah / Sitout

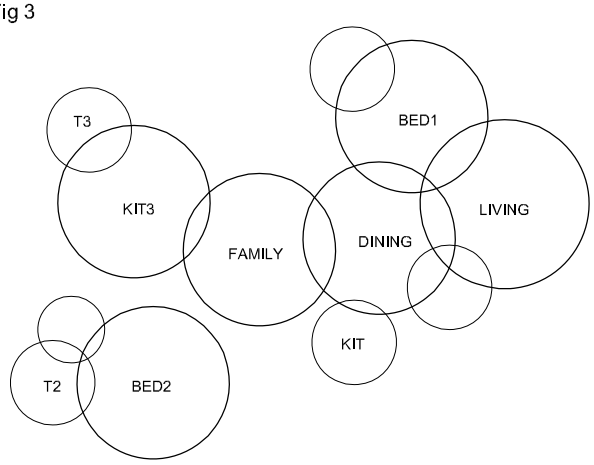
Step 4 : Space designation

Once you have completed your needs requirement list, assign specific rooms to the working, living and sleeping general areas. Keep the activity of a room consistent with that area - living, working and sleeping. It is important to think about and visualize the relationship of each indoor space and the adjacent external environment. (Fig 29)

Step 5 : Proportionately defined rooms

With specific rooms accounted for a layout of these areas can be formed. Sketch each space in a loose arrangement with regard to the general relationship of rooms established in step four. Illustrate room sizes in proportion to each

Fig 3

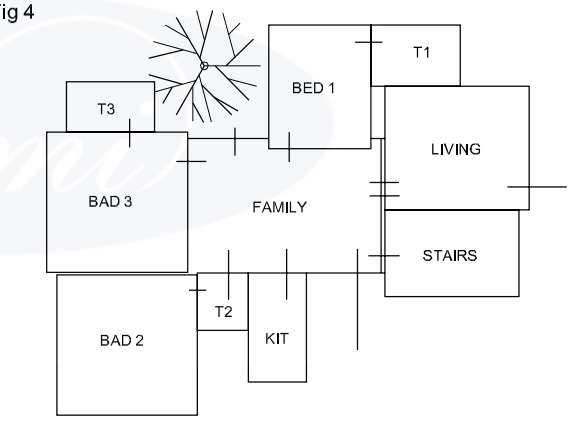


AA211223

other, forming a casual floor layout. Outdoor living areas should be included as an integral development of the plan. Utilize exterior spaces adjacent to each indoor area to extend the use of that area.

For example, a living room use for entertaining may be extended to include a sit out for summer enjoyment. Outdoor living areas that are visually accessible to indoor areas can complement each other by adding theme, character and a feeling of spaciousness. (Fig 30)

Fig 4



AA211224

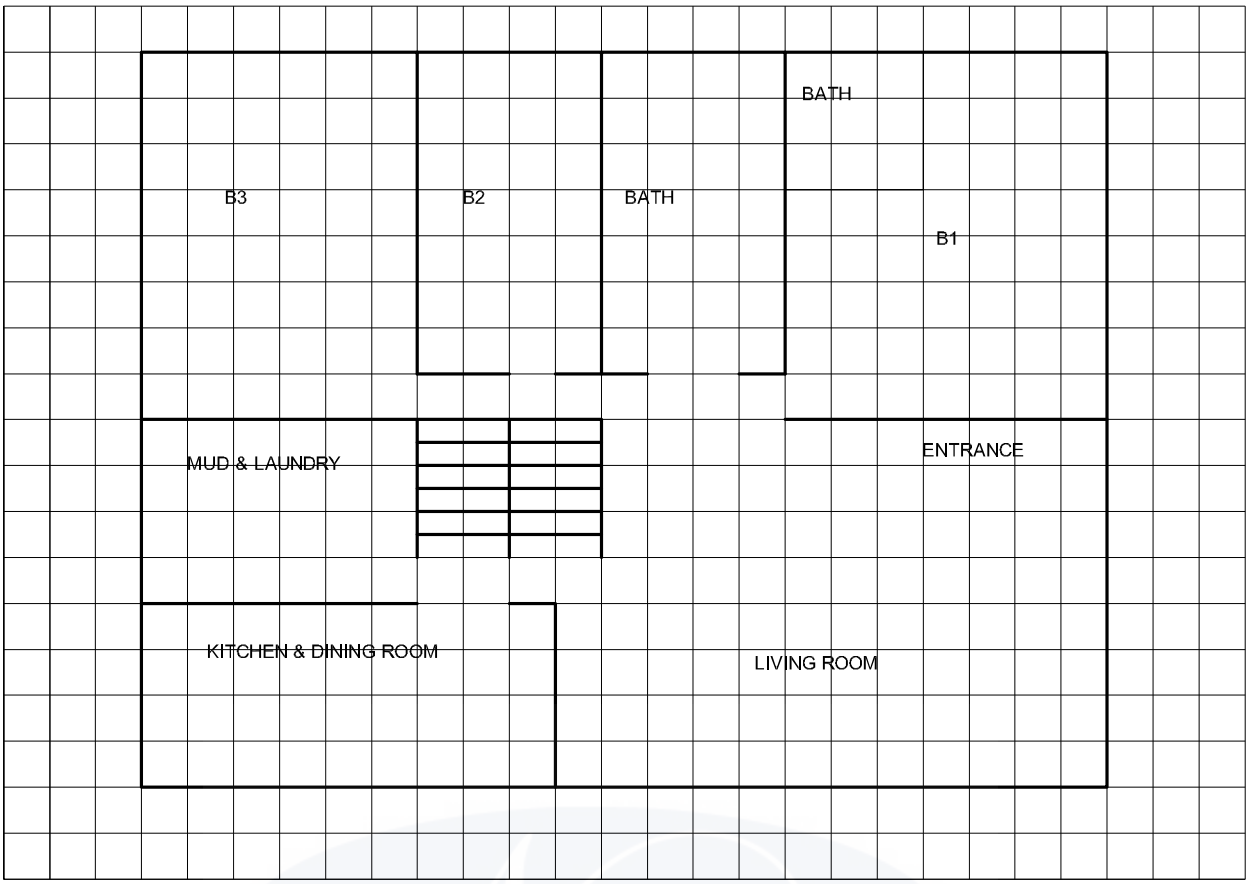
Step 6 : Single line diagram

To realie the usefulness of a plan, the preliminary layout must be converted to a 'single line sketch', with rooms drawn to accurate proportions. A workable sized sketch can be achieved at a scale of one quarter inch equals one foot. (Fig 31)

Step 7 : Floor layout analysis

A successful floor plan has no wastage space. The three major components (living, working and sleeping areas) create divisions for each activity. These areas are connected by communicating elements such as halls, stairs, and doorways. These communicating elements are areas where wasted space is often overlooked. A centrally located main entrance should lead to each area without going through another.

Fig 5

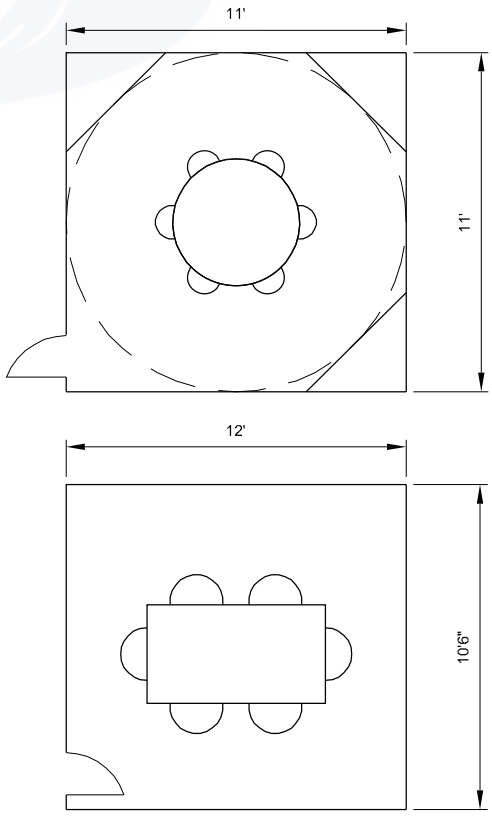


Preplan the placement of furnishings to ensure that each room arrangement is suitable. Precise sketches or cutouts of furniture sizes are necessary to layout an accurate living plan of your home. House designs at this stage should remain flexible, allowing for alternations to improve and assist the function of each room. Work areas and bathrooms require permanent furniture which make preplanning essential. Of any area, the kitchen is probably the most used. If not the most useful room in a house.

Living room - In a house of 800 square feet built up, the living room must be at least of 12'x18' or 14'x20'. In this you will need these basics - a seating area along with a table or two to place things on, a dining space with chairs and some extra storage. You could also choose to have a separate drawing and dining room. The living room should be in front portion of the house directly accessible from the entrance lobby or the outside. Too many doors should not open into the living room since it decreases the functionality and increases the risk to security. (Fig 32)

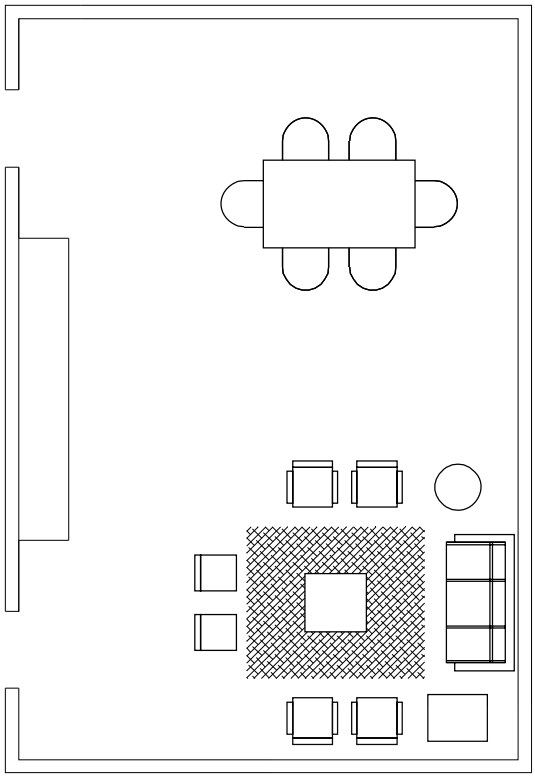
Dining room - The most important furniture of the dining room is the dining table and chairs. Depending upon the size of your family, the frequency of entertaining and space available, you can decide on the size of your dining table. In the dining area, there should be atleast two feet between the backs of chairs and nearby walls for passage. The table could be circular or rectangular. Round tables are more suitable if the space is less as it takes up less space than a squarish table. However if the dining table has to

Fig 7

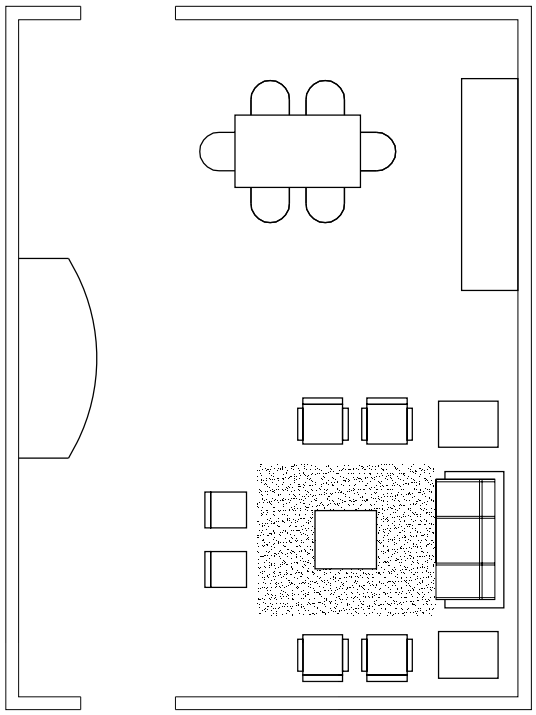


SMALLEST POSSIBLE DINING SIZE REQUIRED FOR SIX PERSONS.

Fig 6



TYPICAL LAYOUT FOR A 12' X 18' LIVING - ROOM



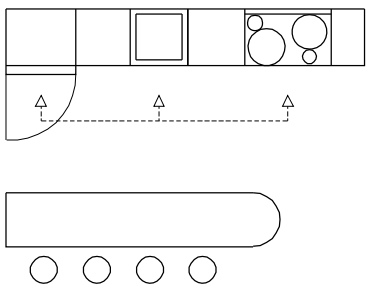
TYPICAL LAYOUT FOR A 14' X 20' LIVING - ROOM

AA211226

accomodate more than eight people, circular tables are not recommended as they take up too much space. (Fig 33)

Kitchen - They should be logically arranged according to their use. The work triangle is the area enclosed by an imaginary line connecting the refrigerator, the cooking area, and the sink. Ideally the minimum distance between the various activities should not be less than three feet. The perimeter of the triangle should not exceed 25 feet to prevent wasted motion. There are different types of kitchen layout as shown below.(Fig 34 & Fig 35)

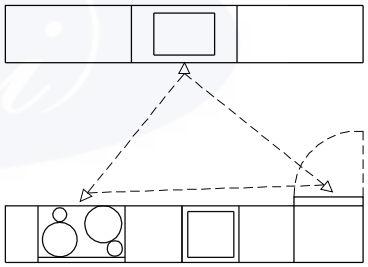
Fig 8



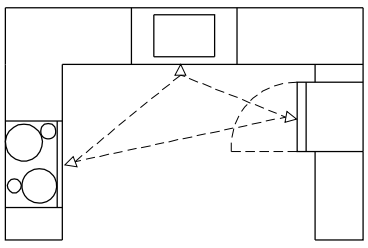
THE ONE WALL KITCHEN

AA211228

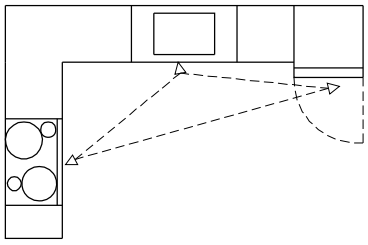
Fig 9



CORRIDOR TYPE KITCHEN



U- SHAPED KITCHEN



L- SHAPED KITCHEN

AA211229

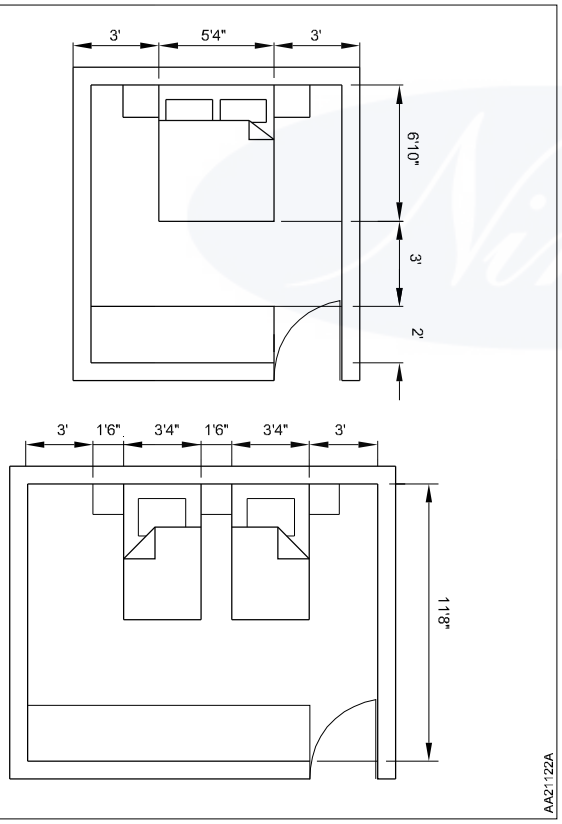
Bed rooms - The bedroom should be planned according to the age, marital status of the occupants. The number of bedroom depends on the size of the house. Since bedrooms are private spaces, you should place them at the rear of the house.

If the bedroom is in the front part of the house, it should have only one entrance from the inside portion. You should not access one bedroom through another bedroom. You can put guest bedroom in the front portion of the house.

The minimum size of a functional bedroom is 100 square feet with a minimum dimension of 9 feet. However, in such a room only the bare essentials like a bed and a small cupboard can fit. For fitting a study table, two chairs and a dressing table a bedroom must be atleast 150 square feet. How big your bedroom is should depend on the furniture you are planning to fit in here.

The window should be parallel to the bed position. The window should not be over the bed. When two people sleep in the same room, then the relative position of the two beds in the room depends upon the relationship of the people occupying them. (Fig 36)

Fig 10

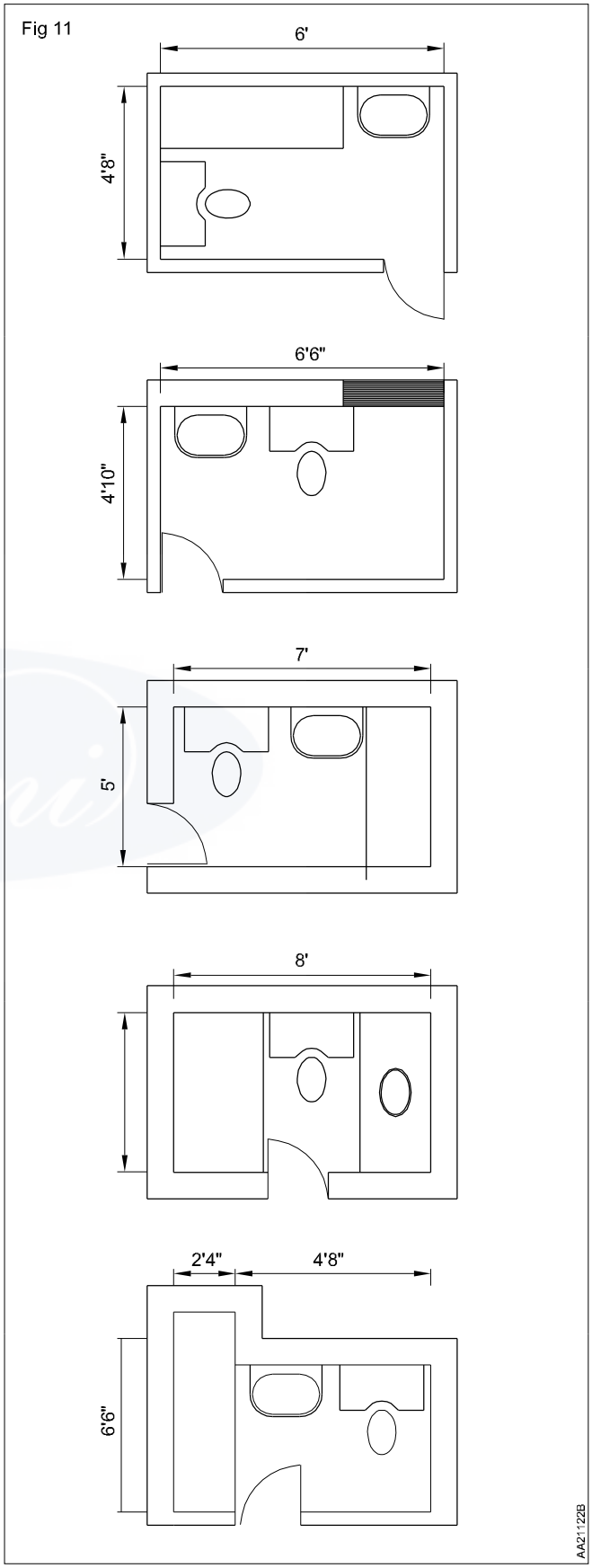


Toilets - The bathroom arrangement is less critical but specific family requirements should be incorporated (e.g. Large vanity, multiple sinks, separate bathing area etc.) proper placement of multiple plumbing fixtures can take advantage of common piping. Placing one above the other is the most efficient and economical arrangement.

The minimum size for a full bathroom is 35 square feet. It could be 5 feet by 7 feet or 6 feet by 6 feet. It includes the sink, toilet seat with cistern and a bathing area. The door to the toilet should preferably open on the longer side.

The toilet can be divided into two types of areas - the dry area including sink and the toilet and a wet area, which includes the bathing area. In well planned toilets, you must separate these two area. (Fig 37)

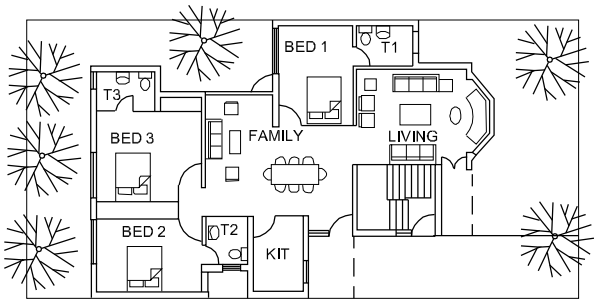
Fig 11



Step 8 : Functional planning

The final plan will emerge from this process. You can then start thinking in the third dimension in terms of height, number of floors and volume. The subsequent sketches illustrate how a final plan is derived. (Fig 38)

Fig 12



Living Room	= 16'9" x 12'4"
Family/Dining RM	= 15'8" x 19'6"
Bed room 1	= 13' x10'
Bed room 2	= 11'6" x14'
Bed room 3	= 11'6" x14'
Kitchen	= 6'8" x 9'6"
Toilet 1	= 5'6" x 7'6"
Toilet 2	= 6' x 5'6"
Toilet 3	= 5' x 7'6"

Step 5 The final plan

The final floorplan indicating the arrangement of furniture, the placement od doors and windows and so on.

Designing elevation

Elevation shows the vertical surfaces of a structure. Designing the elevations of a structure is only one part of the total design process. However, the elevation design reflects the part of the building that people see. The entire structure may be judged by the elevations. (Fig 39)

Design sequence for creating elevations

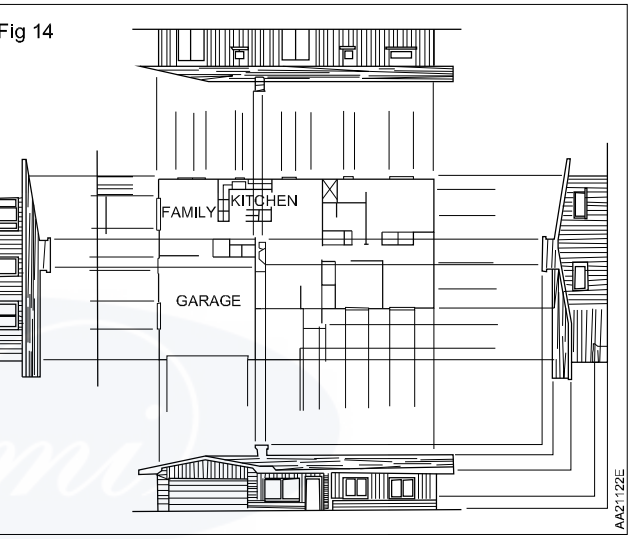
The first step in elevation design is to choose an architectural style. Then sketch the outline of an exterior wall showning the roof shape and the position of doors, windows and other key features.

Next create a series of progressive sketches to develop an elevation design. Experiment with different roof styles, door and window designs, siding materials for exterior walls,

Fig 13

overhangs, roof materials, etc., Sketches can also show architectural styles derived from the same floor plan. (Fig 40)

Fig 14



Roof style and type

To design elevations, a designer needs to know roof styles and which style best matches the buildings overall style. There are many styles of roofs. The gable, hip, flat and shed styles are the most popular. Other features which affect the appearance of the roof must also be considered. In addition to style, the overhang size nad teh roof pitch must be determined during the design process. (Fig 41)

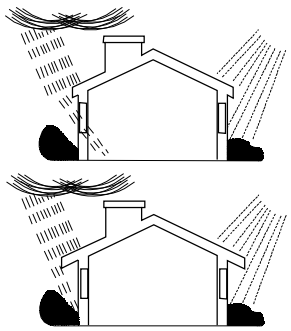
Roof overhang

The overhang is the portion of the roof that projects past the outside walls. Sufficient roof overhang should be provided to afford protection from the sun, rain and snow. The length and angle of the overhang greatly affects a roof's appearance and ability to provide protection. The amount is also determined by architectural style. (Fig 42 & Fig 43).

Fig 15

AA21122F

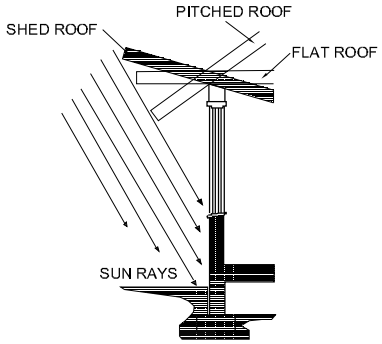
Fig 16



EFFECT OF LONG AND SHORT OVERHANG ON SUN AND RAIN PROTECTION

AA21122G

Fig 17



AA21122H

Drawing of different types of arches

Objectives: At the end of this lesson you shall be able to
- **state the arch**
- **state the technical terms regarding arch**
- **state the types of arches according to shape, number of centres workmanship & materials of construction.**

Arches

An arch is a structure which is constructed to span across an opening. Usually wedge shaped units are joined together with mortar to form an arch. Sometimes, an arch is formed as a single unit by using R.C.C. or steel.

Technical terms

The technical term used in connection with Arches are given below

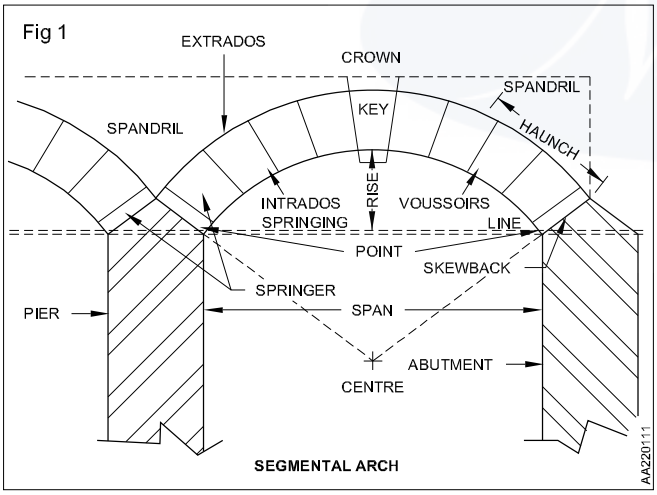
Intrados or soffit or bottom

It is the inner curve or surface of an arch (Fig 1)

Extrados or back

It is the external or upper curve of an arch (Fig 1)

Fig 1



Voussoirs

These are the tapered or wedge shaped units which form the courses of an arch (Fig 1)

Key

Key is the uppermost or central voussoir of an arch. (Fig1) in other words. It is the wedge shaped unit at the crown. Sometimes, it is made projected below and above the outlines of an arch to improve the appearances of an arch.

Crown

The heighest point of extrados is called as crown (Fig 1)

Abutment

The end support of an arcade is known as pier (Fig 1)

Pier

The intermediate support of an arcade is known as pier (Fig 1)

Skew back

The inclined or splayed surface of an abutment or pier which receives the arch is known as skew back in other words, an arch springs from skew back (Fig 1)

Springer

This is the first voussoir on either side of an arch at springing level (Fig 1) It is laid on the skewback.

Springing points

These are the points from which the curve of an arch commences or springs.

Springing line

It is the imaginary horizontal line joining the two springing point of an arch (Fig 1)

Rise

It is the vertical measurement or distance between highest point on intrados and the springing line (Fig 1).

Centre

This is the geometrical centre point of the curve of an arch from which the arc of intrados or extrados is described (Fig 1)

Ring or Ring rim or Ring course

It is the circular course which forms the arch.

Depth or height: The perpendicular distance between intrados and extrados is known as depth or height.

Spandril: It is the irregular triangular portion between the extrados of two consecutive arches and the horizontal line drawn tangent to the crown (Fig 1)

Haunch: The lower half portion of the arch between the crown and the skewback is known as haunch (Fig 1)

Arcade: A series of arches which support the wall above and arc being supported by piers is known as arcade.

Thickness or breadth of soffit: It is the horizontal distance measured perpendicular between front and back faces of an arch. It is actually the thickness or breadth of masonry used to form an arch.

Impost: The projecting course at top of an abutment or pier is known as impost.

Types of arches

The various type of arches can be classified as follows

- According to shape
- According to number of centres
- According to workmanship
- According to materials used for construction.

Construction

Arches

According to shape

1 Flat arch
2 Segmental arch
3 Semi-circular arch
4 Semi-Elliptical arch
5 Inverted arch.
6 Pointed arch.
7 Reliveing arch
8 Horse-shoe arch
9 Stilled arch
10 Venetian arch
11 Florentine arch.

According to number of centres

1 One-centred
2 Two centred
3 Three centred
4 Four centred
5 Five centred

According to workmanship

1 Rough arch
2 Axed or rough cut arch
3 Gauged arch
4 Purpose made brick arch.

According to materials of construction

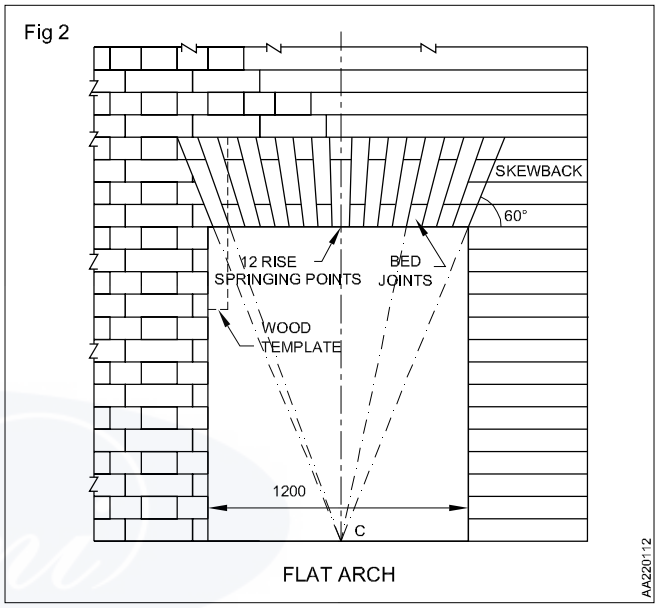
1 Stone arches
2 Brick arches
3 Concrete arches.

Classification of arches according to shape

Flat arch

- The shape of the arch is flat and the skew back forms an angle of 60^0 as shown in Fig 2.
- Although the arch is flat, to allow the settlement of arch masonry, the following slight rise (camber) is provided inthe arch.

Fig 2



FLAT ARCH

a 10mm to 15mm per meter width of opening in intra dos and

b Half the camber of intrados in extrados.

- The flat arches are comparatively weak and they can be used for light loads and for spans upto 1.50m

Segmental arch:

- The centre of the arch lies between the springing line as shown in Fig 1
- The thrust due to loads is transferred to the support (pier or abutment) in an inclined direction
- This is the common type of arch provided in buildings.

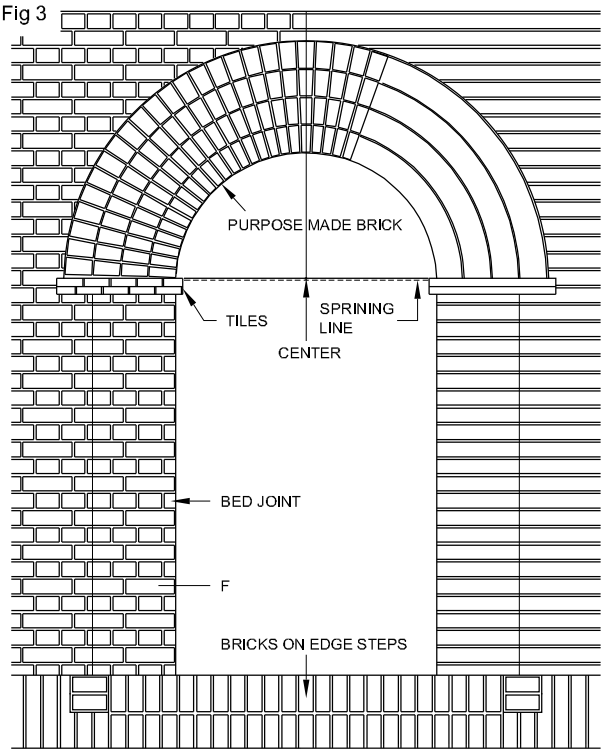
Semicircular arch:

- The arch centre lies at the midpoint of springing line and the shape of the arch is a semicircle as shown in Fig 3.
- The skewback is horizontal. Hence, the thrust acts in the vertical direction.

Inverted arch:

- The arch is constructed in inverted position so that, the crown of the arch is below the springing line and the centre of the arch above the springing line.

Fig 3



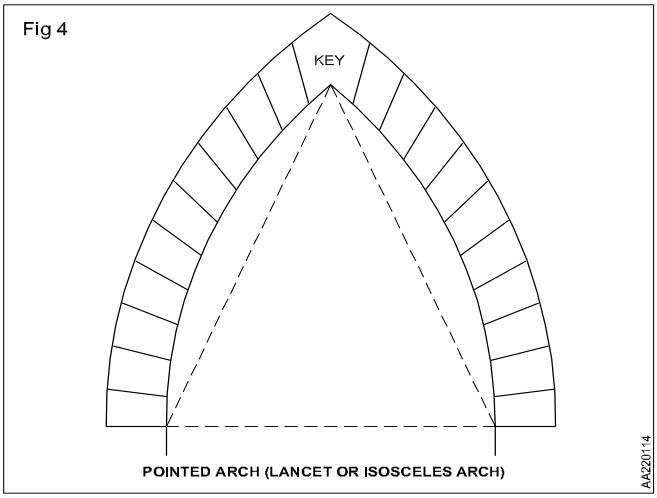
SEMI CIRCULAR ARCH

- The inclination of skewback is 60^0
- The inverted arches are used to distribute the loads of the piers uniformly over the entire length of foundation.
- Other details of this type of arch is already discussed in Inverted arch foundations. (Theory for Ex. No: 3.10)

Pointed arch:

- Two curves of same radius form this type of arch. The curves meet at the apex of a triangle.
- The triangle formed may be an equilateral triangle as shown in Fig 4.

Fig 4



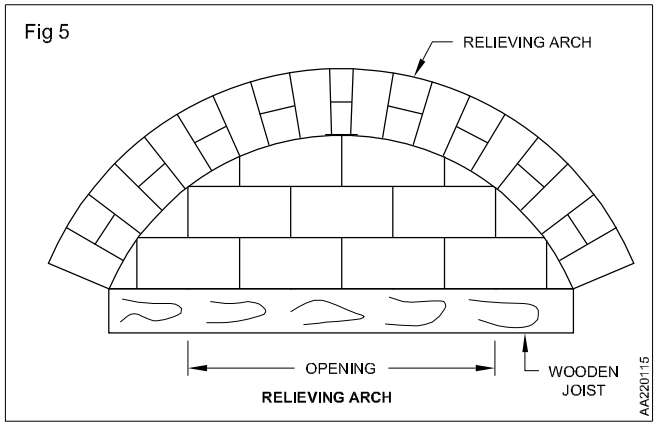
POINTED ARCH (LANCET OR ISOSCELES ARCH)

- The triangle formed may be an isosceles trianle shown in Fig 5. It is known as Lancet arch.

Releiving arch:

- Releiving arch is constructed over a wooden Lintel (Fig 6) or flat arch (Fig 7) to carry the load above the opening. Therefore, the wooden Lintel or flat arch is relieved from carrying the load.

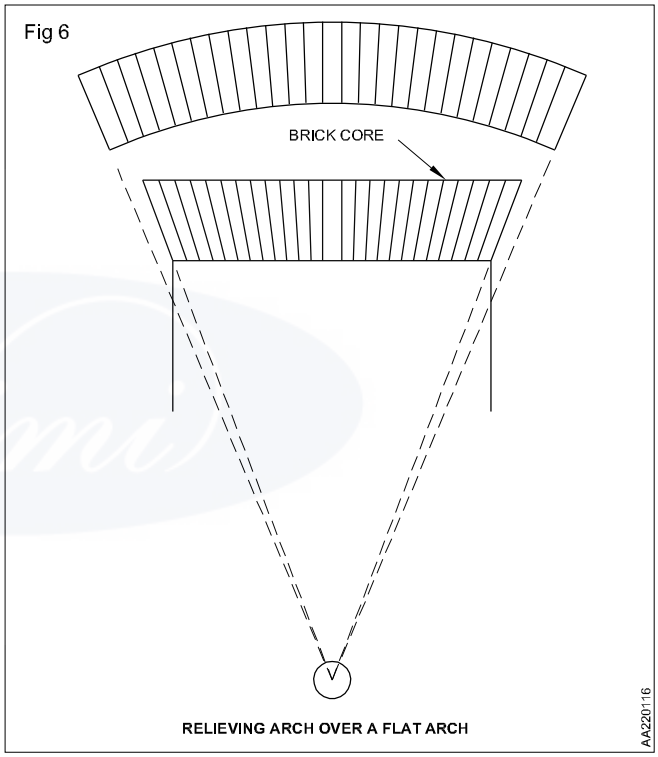
Fig 5



RELIEVING ARCH

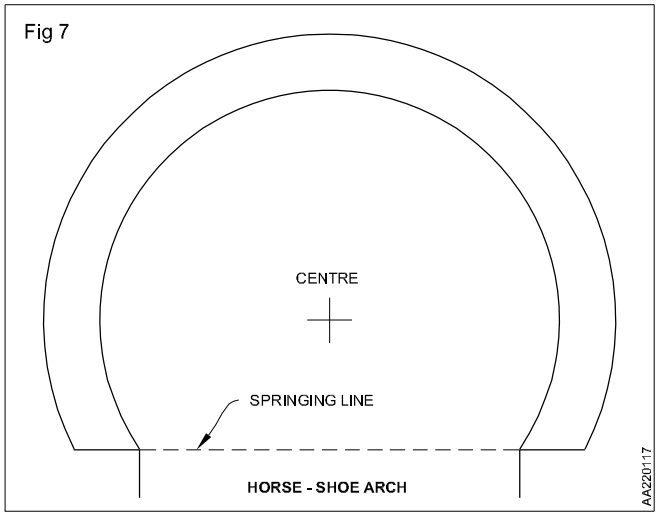
- Sufficient bearing on bothsides are given to the relieving arch as shown in Fig 6 and Fig 7

Fig 6



RELIEVING ARCH OVER A FLAT ARCH

Fig 7



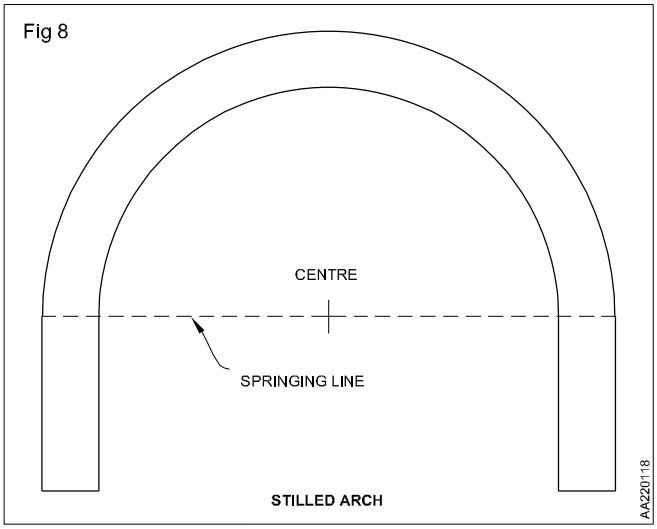
HORSE - SHOE ARCH

- This type of arch is also known as discharging arch.

Horse-shoe arch

- This arch is in the shape of horse -shoe as shown in Fig 8
- The arch is more than a semi circle and the centre of the arch lies above the springing line.

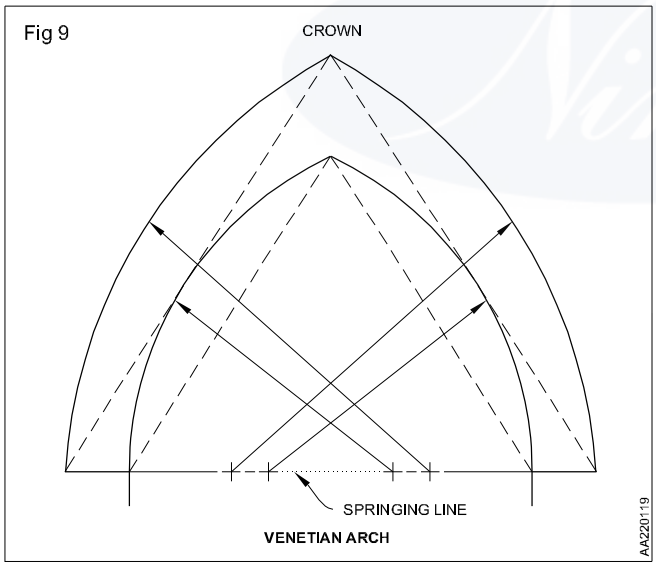
Fig 8



Stilled arch:

- In this type of arch, a semi circular portion is placed on top of two vertical portions as shown in Fig 9.

Fig 9



- The springing line of the arch passes above the vertical portions and centre of the arch.

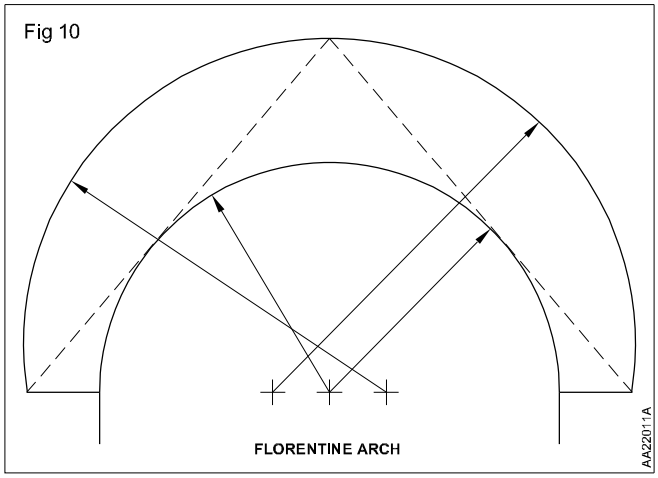
Venetian arch:

- The venetian arch has four centres which are all located on springing line.
- The depth of arch at crown is more than that at support.
- The shape of arch is as shown in Fig 10.

Florentine arch:

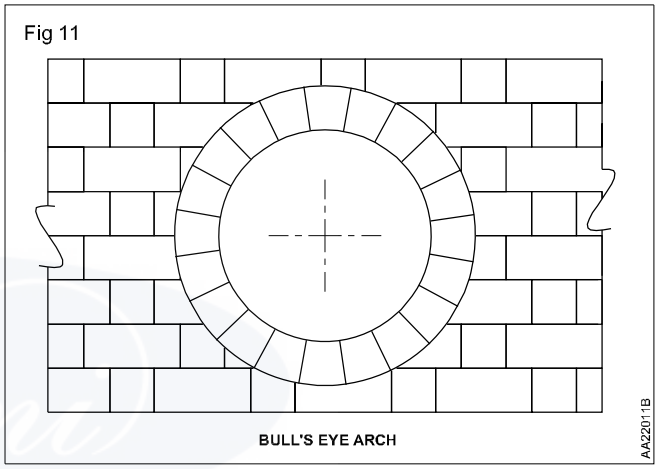
- Florentine arch has three centres, all located on springing line.

Fig 10



- The depth at crown is similar to venetian arch but, the intrados has the shape of semicircle as shown in Fig 11.

Fig 11



Classification of arches according to number of centres:

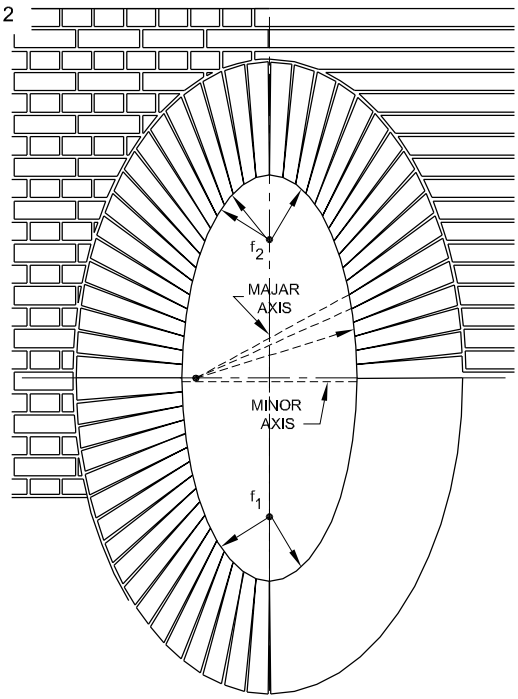
One-centred arch:

- The curve of this arch is formed from one centre only
- The flat, segmental, semi circular, horse-shoe and stilled arched (Shown as in Fig 2,1,3,8 and 9 respectively) are examples of one centred arches.
- Sometime, to improve the appearance of the building, circular windows are provided. In such case, a Bull's eye arch or circular arch is constructed as shown in Fig 12.

Two centred arch:

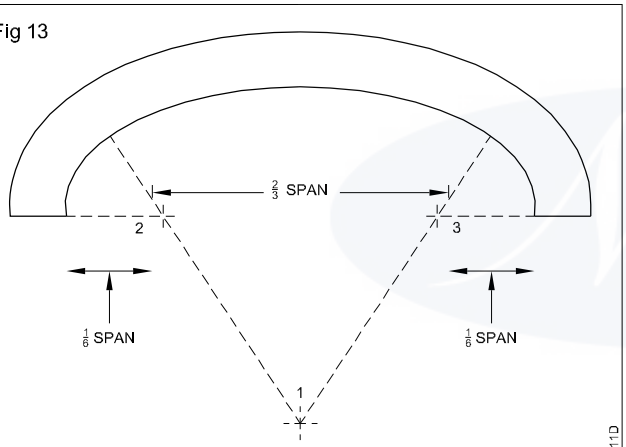
- The arch has two centres. The pointed arches shown in Fig 4 and 5 are examples of two-centred arches
- The Elliptical arch shown in Fig 13 has two centres (Foci f1 & f2) which is used to improve the architectural elegance of a building.

Fig 12



ELLIPTICAL ARCH OR TWO CENTRED ARCH

Fig 13

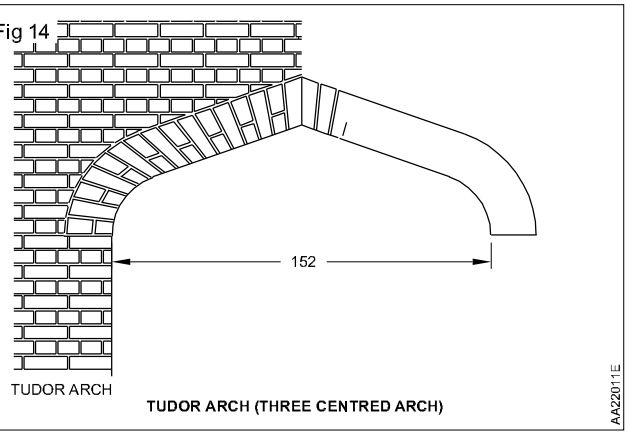


THREE CENTRED ARCH

Three centred arch:

- As this type of arch has three centres, it is in the shape of a semiellipse as shown in (Fig 14)
- The florentine arch is also a three-centred arch (Fig 11)

Fig 14



TUDOR ARCH (THREE CENTRED ARCH)

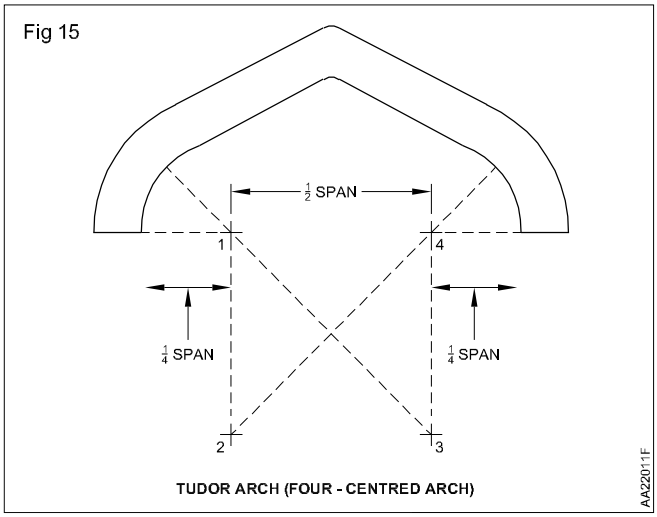
Four centred arch:

- This type of arch has four centres

  (example: Venetian arch in Fig 10)

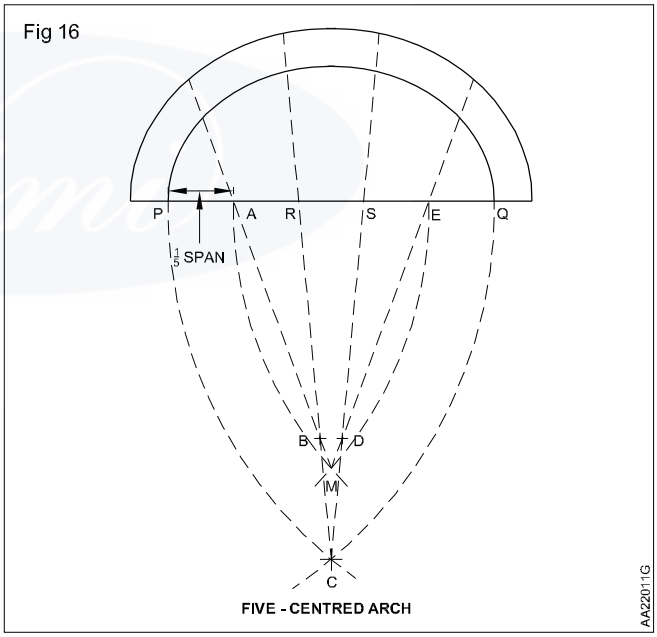
- Fig 16 shows a four centred pointed arch which was developed in Tudor arch
- The curve formation of Tudor arch is illustrated in Fig (15&16)

Fig 15



TUDOR ARCH (FOUR - CENTRED ARCH)

Fig 16



FIVE - CENTRED ARCH

Five -centred arch:

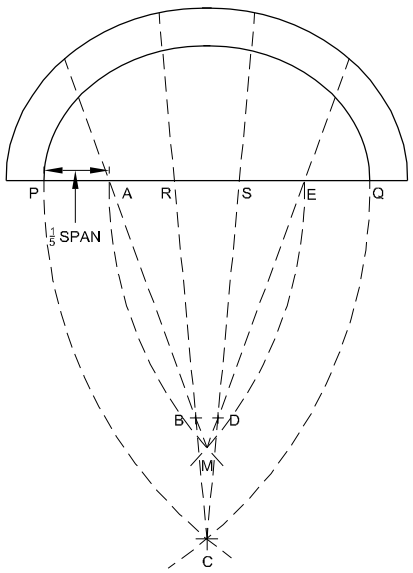
- This arch as five centres and the shape of the arch looks like an exact ellipse (Fig 17)
- The construction method of this arch is already explained in Ex no: 3.17.3

Classification of arches according to workmanship:

Rough arch:

- This type of arch is constructed with normal size of bricks. The stretcher is not visible in elevation. Only the headers appear in elevation. Therefore the height of arch consist of several rays as shown in (Fig 18.)

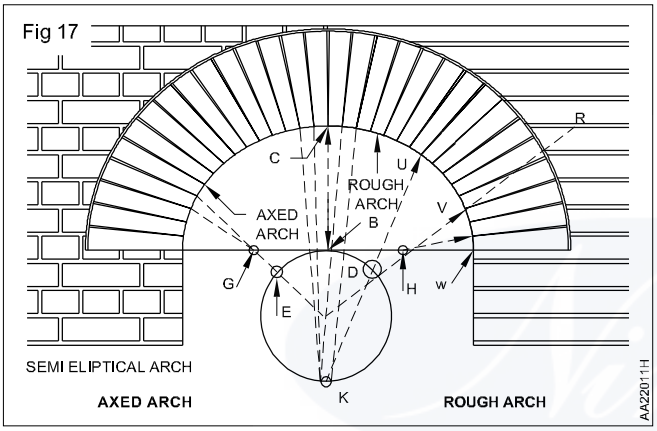
Fig 16



FIVE - CENTRED ARCH

AA22011G

Fig 17



AA22011H

- The mortar joints are in wedge shape.
- The thickness of mortar joint is more at extrados than at intrados.
- This type of arch will not carry heavy load.
- Moreover, this type of arch is used where the appearance is not important.

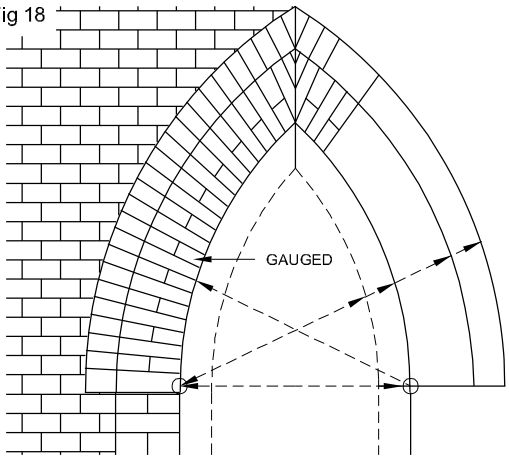
Axed or rough cut arch:

- The ordinary or standard bricks are roughly cut to wedge shape units by means of bricklayer's axe
- The bricks may be rough axed or fine-axed
- The thickness of mortar joints varies from 3 to 6mm (Fig 18)
- These arches are stronger than rough arch.

Gauged arch:

- Gauge means measure, the arch is constructed with bricks which are finely cut by means of a wiresaw.
- Thus the joist of a gauged arch are very fine, thin and truly radial. The mortar joints are as thin as 1.5mm to 0.75mm (Fig 19)
- For a high class work. special bricks are used, which can be cut and worked to the required forms.

Fig 18



GAUGED ARCH OR POINTED ARCHES

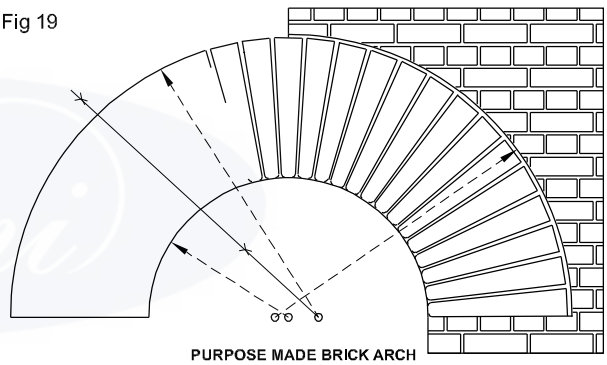
AA22011I

Purpose made brick arches:

- Purpose made bricks are used to construct these arches.
- The mortar joints are fine and thin

  This type of arch isused where the elevation is important (Fig 20)

Fig 19



PURPOSE MADE BRICK ARCH

AA22011J

Classification of arches acccording to materials of construction

Stone arches:

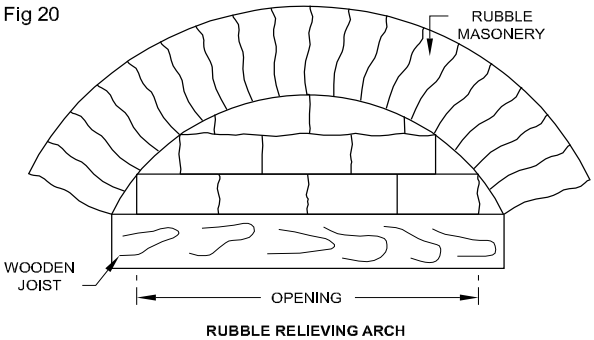
The two kinds of stone arches are

a. Rubble arches

b. Ashlar arches

a. Rubble arches: They consist of rubble stones which are roughly hammer dressed to the required size and shape and laid in cement mortar (Fig 21)

Fig 20



RUBBLE RELIEVING ARCH

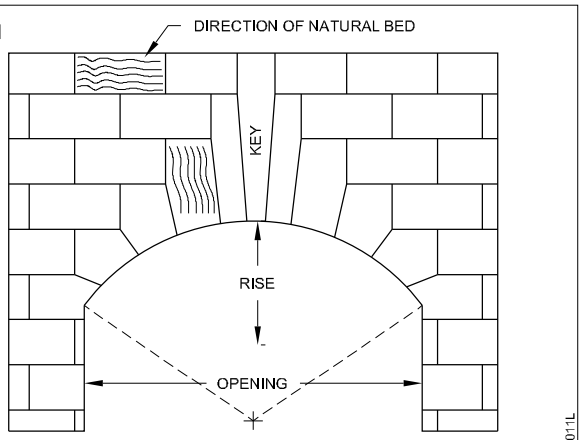
AA22011K

In this type of arch. all the stone need not be of the same size. This type can be used upto a span of 1.00m

It is used only for interior work.

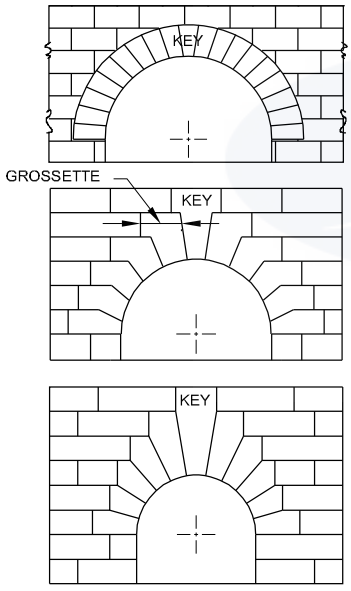
b. Ashlar arches: Properly dressed wedge shaped stone are used to form this arch. A stone arch may be constructed as a segmental arch. Semi circular arch and Flat arch as shown in Fig 22, Fig 23 and Fig 24 repectively.

Fig 21



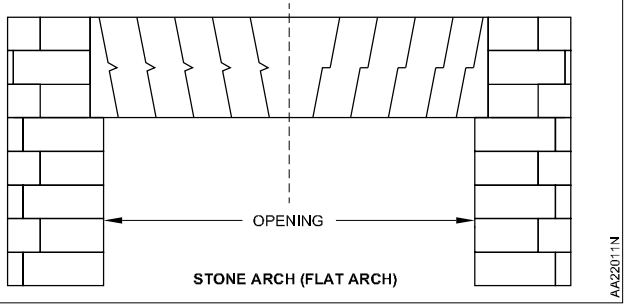
STONE ARCH (SEGMENTAL ARCH)

Fig 22



THREE DIFFERENT TYPES OF SEMI CIRCULAR STONE ARCHES

Fig 23



STONE ARCH (FLAT ARCH)

Ashlar arches have a good appearance and are used for superior work.

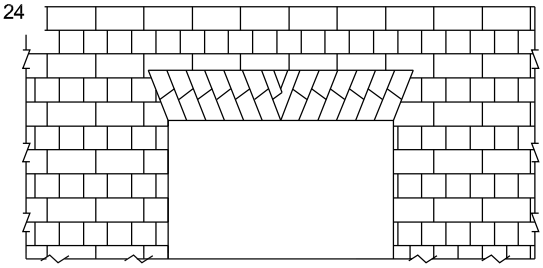
In both Rubble and Ashlar arches, care should be taken to lay the stones with their bedding planes normal to the direction.

Brick arches:

Brick arches are classified into four forms according to the quality of workmanship and the bricks used. They are a) Rough brick arches, b) Axed brick arches, c) Gauged brick arches and d) Purpose - made brick arches.

They are already discussed above and details are given in Fig 18, Fig 19 and Fig 20. A brick arch may also be constructed as Dutch or French arch (Flat arch) as shown in Fig 25.

Fig 24



DUTCH OR FRENCH ARCH

Concrete arches:

Concrete arches are classified into

a) concrete block arches and

b) Monolithic concrete arches

a) Concrete block arches:

- In this type pre-cast concrete blocks are laid in cement mortar.
- The block are pre-cast and water cured for 15 days. The mix used is 1:2:4 Generally, reinforcement is not used.
- The method of construction of block arches are similar to stone or brick arches.

b) Monolithic concrete arches:

- These are cast in situ type which are generally used for culverts and bridges.
- Generally they are constructed in PCC. If the span is large R.C.C is used to construct these arches.
- Necessary form work is provided to support fresh concrete until it hardens sufficiently to support its own weight and the load above. Curing is carried out for 15 days.

Drawing of different types of lintels

Objectives: At the end of this lesson you shall be able to
- **state lintel**
- **state classification of lintel**
- **state timber lintel**
- **state stone lintel**
- **state brick lintel**
- **state steel lintel**
- **state R.C.C. lintel.**

Lintel

Lintel is a horizontal member which is placed across the opening to support the portion of structure above it.

Classification of Lintels

Lintels are classified into the following types, according to the materials of their construction

1 Timber Lintel

2 Stone Lintels

3 Brick Lintels

4 Steel Lintel

5 Reinforced cement concrete Lintel

1 Timber Lintels

Timber lintels are oldest types of lintels, though they are not commonly used now a-days, except in hilly areas. Timber lintels are relatively costiler, structurally weak and vulnerable to fire. They are also liable to decay if not properly ventilate.

Fig. shows a wooden lintel provided. Over the full width of the wall, by jointing together three timber pieces with the help of steel bolts. Figure shows wooden lintel for a wider wall. The lintel is composed of two wooden pieces kept at a distance with the help of wooden distance pieces. Sometimes, timber lintels are strengthened by the provision of mild steel plates at their top and bottom, such lintels are called fletched lintels (Fig 1)

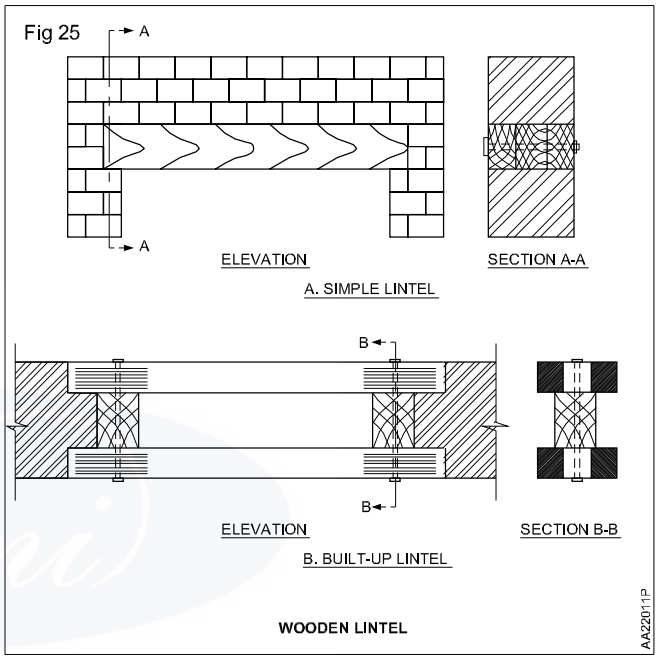
2 Stone Lintels

Stone Lintels are the most common types. Specially where stone is abundantly available. A stone lintel consists of a simple stone slab of greater thickness. Stone lintel can also be provided over openings in brick walls. Dressed stone lintels give good architectural appearance.

Stone lintels may be used in the form of either one piece in the form of either one piece or more than one piece along the width of the wall.

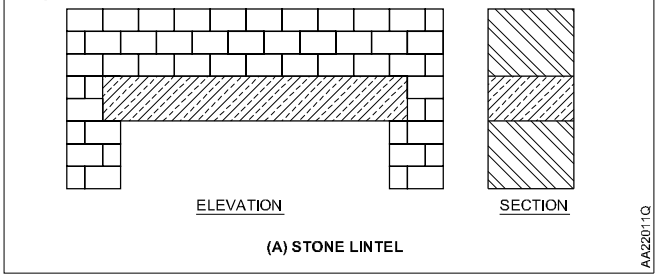
The depth of stone lintel is kept equal to 10cm. per metre of span, with a minimum of 15cm. They are used upto span of 2m. For wider spans, stone slabs are kept on edge. Stone is very weak in tension. Also, it cracks if

Fig 25



subjected to vibratory loads. Hence stone lintels should be used with caution where shock waves are quite common (Fig 2).

Fig 25



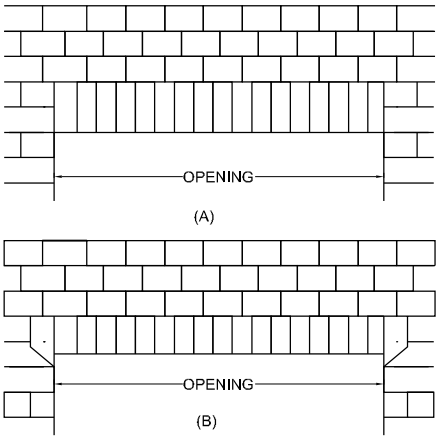
3 Brick Lintel

Brick Lintels are not structurally strong, and they are used only when the opening is small (less than 1m.) and loads are light. A brick lintel consists of bricks placed on end or edge, as shown in figure. A better way of forming brick lintel is shown in fig.

The depth of brick lintel varies from 10 to 20cm, depending upon the span. It is constructed over temporary wooden cantering. The bricks with frogs are more suitable for the construction of lintel since the frogs,

when filed with mortar, form joggles which increase the shear resistance of end joints. Such lintel is known as joggled brick lintel (Fig 4).

Fig 27



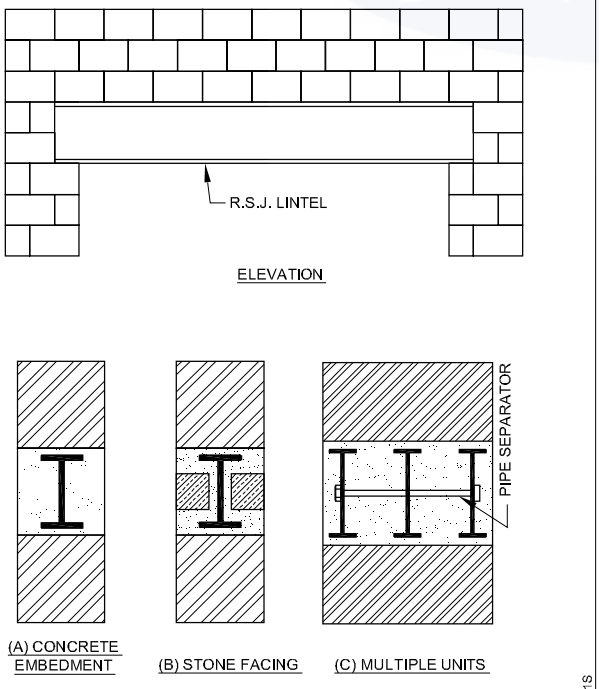
BRICK LINTELS

AA22011R

4 Steel Lintels

Steel Lintels are provided where the opening is large and where the super-imposed loads are also heavy. It consists of rolled steel joints or channel sections either used singly or in combination of two or three units. When used singly, the steel joint is either embedded in concrete, or cladded with stone facing, so as to increase its width to match with the width of the wall. When more than one units are placed side by side, they are kept in position by tube separators. (Fig 4)

Fig 28



STEEL LINTELS

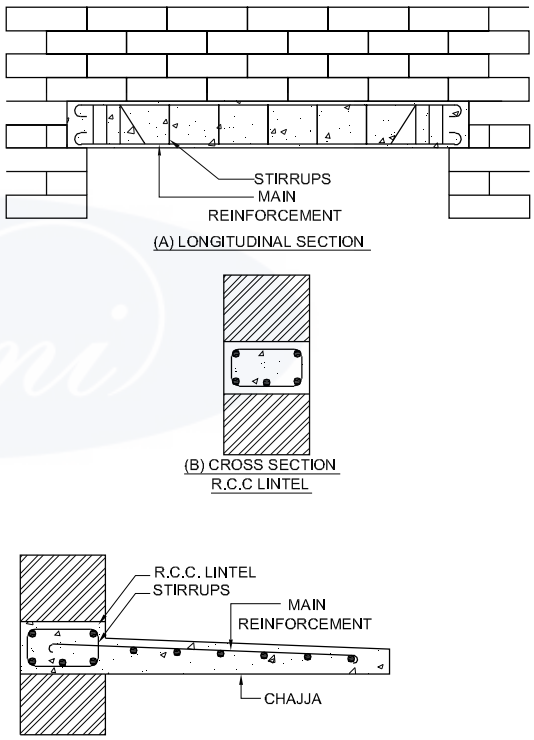
AA22011S

5 Reinforced cement concrete Lintels

Reinforced cement concrete lintels have replaced practically all other types of lintels because of their strength, rigidity, fire resistance, economy and ease in construction. These can be used on any span. Its width is kept equal to the width of the wall. The depth of R.C.C. lintel and the reinforcement depends upon the spa tnd the magnitude of loading. Longitudinal reinforcement, consisting of mild steel bar, are provided near the bottom of lintel to take up tensile stresses. Half these bars are however cranked up near the ends. Shear stirrups are provided to resist transverse shear.

Fig. shows a typical R.C.C. lintel. Fig. shows a R.C.C. lintel over a window, along with the chajjas projection, R.C.C. lintels are also available as precast units. For cast-in-situ units, which are quite common, form work is required for construction.(Fig 5)

Fig 29



R.C.C. LINTEL WITH CHAJJAPROJECTION

AA22011T

Draw plan and elevation of straight stairs

Objectives: At the end of this lesson you shall be able to
- **technical terms**
- **materials used for different types of stairs**
- **details of construction of various stairs**
- **planning and design of a stair.**

Stairs

Stairs are provided in a building as a means of communication between the various floors. A building may have a number of staircases between various floors depending on the number of people using the building. As much as stairs are very functional, stairs are can be very decorative and an impressive part of a building. Especially at the entrance of a large building stairs play an important role in the first impression of a building. The stairs of public entertainment places such as theatres require special treatment for finish. Usually the decorative carpets are spread over the steps to create the desired effects and the artistic balustrade is provided to give comfort to the uses of stair.

A stair is defined as a sequence of steps and it serves as a means of ascent and descent between the floors or landings. The width of the stair depends on the situation and the purpose for which it is provided. The space occupied by the stair is known as stairway.

Technical terms

The definitions of technical terms that are used in connection with the stair are as follows.

Tread : The flat or horizontal member which forms the upper surface of a step on which the foot is placed for ascending or descending.

Rise : This is the vertical distance between two successive treads.

Going : This is the horizontal distance between the faces of two consecutive risers.

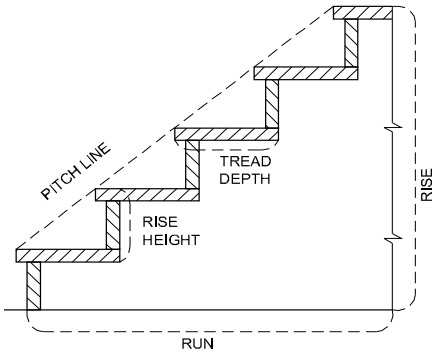
Riser : The vertical or front member of the step which is connected to the treads is known as a riser.

Run : The total length of a stair in a horizontal plane is known as run and it includes the length of the landings also. (Fig 1)

Baluster : This is the vertical member which is fixed between string and handrail to give support to the handrail.

Balustrade : The combined frame work of handrail and baluster is known as the balustrade or barrister.

Fig 1



Flight : An unbroken series of steps without an intermediate platform extending from floor to floor, floor to landing, or landing to landing.

Staircase : Stairs together with the part of the building accomodating them.

Headroom : The vertical distance between the nosing of one flight and the bottom of flight immediately above is known as the heeadroom. It should be of sufficient value so as not to cause any difficulty to the persons using the stair.

Landing : The horizontal platform between two flights of stair is known as the landing. A landing facilitates changes of direction and provides an opportunity for taking rest during the use of a stair. A half landing is where a 180^{o} change in direction is made, and a quarter landing is where a 90^{o} change in direction is made (on an intermediate landing).

Handrail : The inclined rail over the string is known as handrail. It is generally moulded. The handrail serves as

the guard rail and it should be provided at a convenient height so as to give grasp to the hand during ascent and descent. Height of the handrail is typically between 34 to 38 inches (864 and 965 mm), measured to the nose of the tread. The minimum height of the handrail for landings may be different.

Newel post : This is the vertical member which is placed at the ends of flights to connect the end of strings and handrails.

Final

A decorative cap to the top of a newel post, particularly at the end of the balustrade is called final.

Nosing : The projecting part of the tread beyond the faces of riser is known as a nosing. The term line of nosing is used to denote an imaginary line parallel to the strings and tangential to the nosing. It is used full in the construction of the handrail. The undersurface of the handrail should coincide with the line of nosings. Maximum nosing protrusion is typically 1.25 inches (32 mm) to prevent people from tripping on the nosing.

Pitch : The angle of inclination of the stair with the floor is known as a pitch. It also indicates the angle which the line of nosings makes with the horizontal.

Scotia : This is an additional finish or moulding provided to the nosing or tread to improve the elevation of the step and to provide strength to the nosing.

Soffit : The under surface of a stair is known as soffit. It is generally covered with ceiling or finished with plaster.

Waist : The thickness of the structural slab in case of an R.C.C. stair is known as waist.

Walking line : The approximate line of movement of people on a stair during ascending or descending is known as a walking line and it is situated at a distance of about 450 mm from the center of handrail.

String : The inclined member of a stair which supports the ends of steps is known as a string.

Step : A combination of tread and riser is known as a step.

i) **Bullnose step :** This is generally provided at the bottom of flight. It projects in front of the newel post and its end forms a circular quadrant in plan.

ii) **Commode step :** This step has a curved riser and step.

iii) **Dancing or balancing step :** These steps do not radiate from a common center.

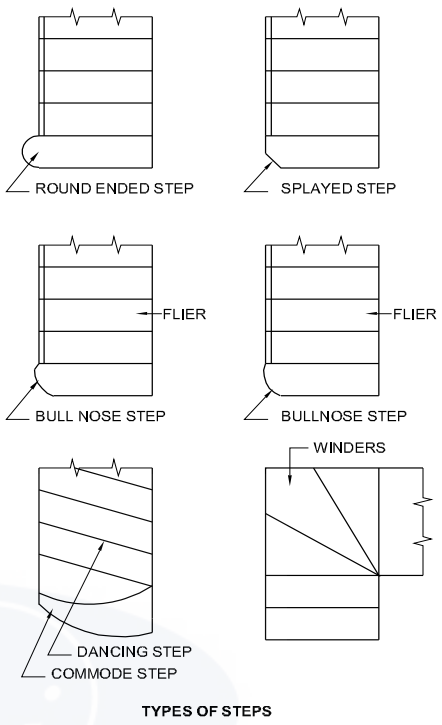
iv) **Flier :** This is an ordinary step of rectangular shape in plan.

v) **Round-ended step :** This step is similar to a bullnose step except that its end or ends are semi-circular in plan.

vi) **Splayed step :** This step has one end or both ends splayed in plan.

vii) **Winder :** This is a tapering step and it is used to change the direction of a flight. The winders radiate from a common center. A series of winders form a circular or spiral stairway. When three steps are used to turn a 90° corner, the middle step is called kite winder.

Fig 3



TYPES OF STEPS

Requirements of a good stair

A well designed stair should fulfill the following requirements for providing an easy, quick and safe mode of communication between the floors.

1) Location

The stairs should be so located that they are well-lighted and well-ventilated and have convenient and spacious approaches. In case of public buildings, the stair should be located near the main entrance and incase of residential buildings, the stair should be centrally located so as to have easy access from all the rooms without distributing the privacy of rooms. In case of big buildings, there may be more than one stair.

2) Width of the stair

The width of the stair should be sufficient for two persons to pass on it simultaneously and for furniture, etc to be carried up and down the stair. The minimum width of a stair is taken as about 800 mm. If the width of stair exceeds 1.80 m, it is desirable to provide a central handrail.

3) Pitch of the stair

The inclination of a stair to the horizontal should be limited to 30° to 45°.

4) Headroom

The provision of adequate headroom is a necessity in a good stair. It should preferably be not less than 2.1 to 2.3 m. So that even a tall person can use the stair with the luggage.

5) Length of flight

It is not desirable to provide a flight with more than 12 or at the most 15 steps and not less than 3 steps. Suitable landings should be provided to give comfort and safety to the users of the stair.

6) Winders

There are to be avoided as far as possible. However, if winders are unavoidable, they should be placed at the bottom rather than aat the top flight.

7) Handrail

When a flight consists of more than three steps, a handrail at least on one side is considered to be a necessity. The wide stairs should be provided with handrails on both the sides. Very wide stairs, as required for public buildings, should be provided with a central handrail. The height of handrail above the riser should be approximately 800 mm.

8) Materials and workmanship

The stair should be constructed of sound materials and good workmanship so as to impart durability and strength to the stair. The stairway provides a path by which fire can spread from one floor to another and hence the fire protection of the staircases is extremely important. The materials used for the linings of walls and ceiling of staircase should be non-combustible and of low flame spread.

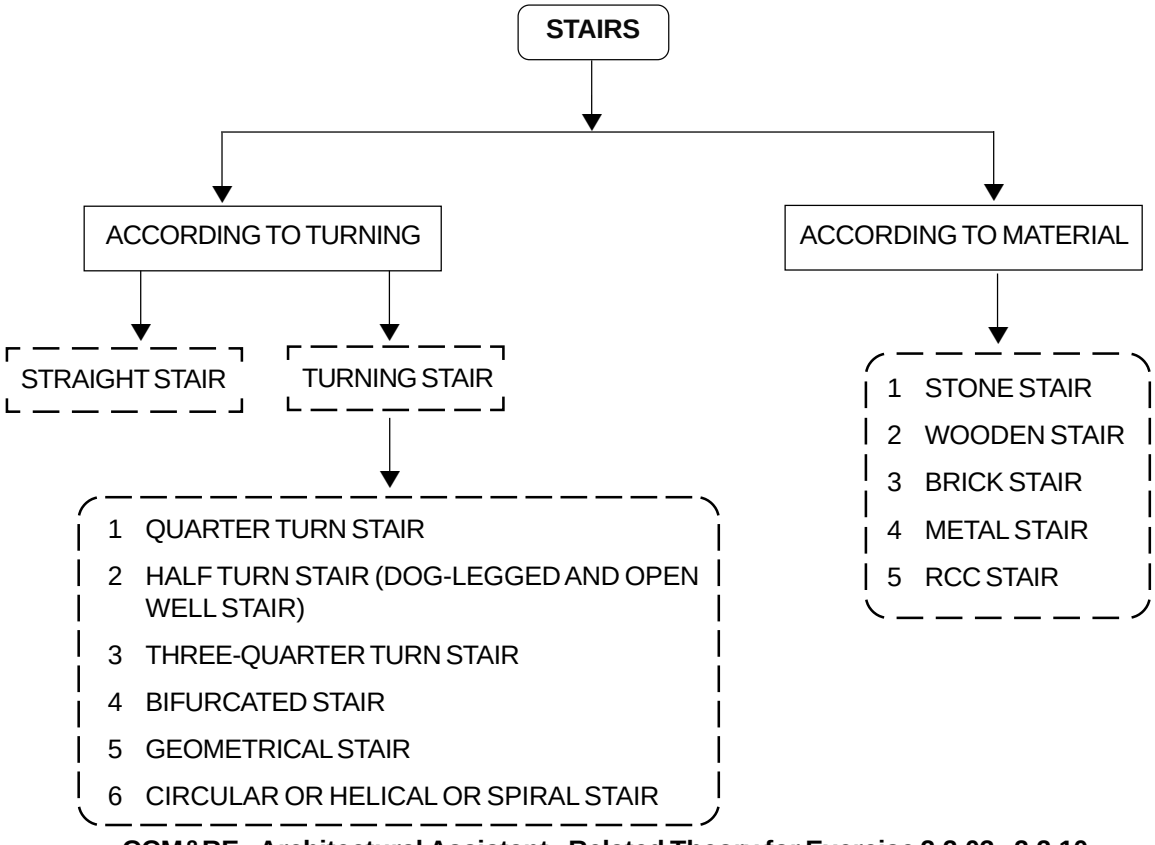
9) Treads and risers

In order to make the ascent and descent easy, the treads and risers of a stair should be suitably proportioned. The staircase in a residential building should not have a rise of more than 15c and a going of less than 25 cm. For public buildings, it is desirable to have a rise of not more than 180 cm and a going of not less than 27 cm. Whatever may be teh values of the rise and going, they should be kept constant throughout the stair or atleast throughout each flight.

Materials used for different types of stairs

The selection of materials for the construction of stairs depends upon the availability of the materials, funds available, desired life of the building, quality of finishes, aesthetical importance and fire resisting quality expected. Following are the materials which are commonly used int he construction of the stair. The various materials used for the construction of stairs are timber, bricks, stones, steel, plain or reinforced cement concrete or a combination of different materials. The selection of material to be used for the construction depending upon the fund available, availability of materials, life, expectancy of building, aesthetics and fire resistance qualtiy expected. Marble stairs are to be designed only indoors and are resistant to dampness. Granitic stairs are also resistant to dampness. That's why these stairs can be constructed pretty much anywhere. Stone is quite a sliding material; therefore, these stairs should be covered with non-sliding surface. Combined-type stairs is the type of stairs when different materials are being used, eg., the wooden coat for the stairs, concrete stringer, metal railings and bollards.

Classification of stairs



Details of construction of various stairs

Stairs according to the materials of construction

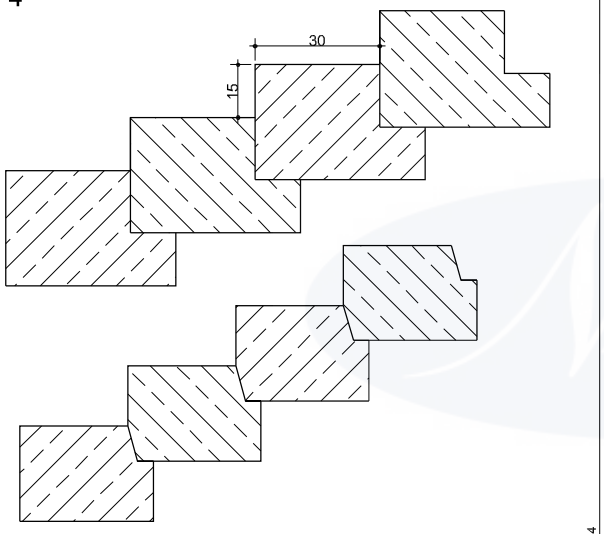
1 Stone stairs

The stone to be used for the construction of stair should be hard and non-absorbent and they should possess enough resistance to the action of fire. These stairs are used for warehouse, workshops etc. They are widely used at the places where the ashlars stones are readily available. A stone step may be constructed in any one of the following ways.

a Rectangular step with rebated joint

In case of a rectangular step, the arrangement is made. The overlap is about 25 mm to 40 mm. This arrangement results in considerable saving in labour of cutting and dressing stones. (Fig 4)

Fig 4



RECTANGULAR STEP WITH REBATED JOINT

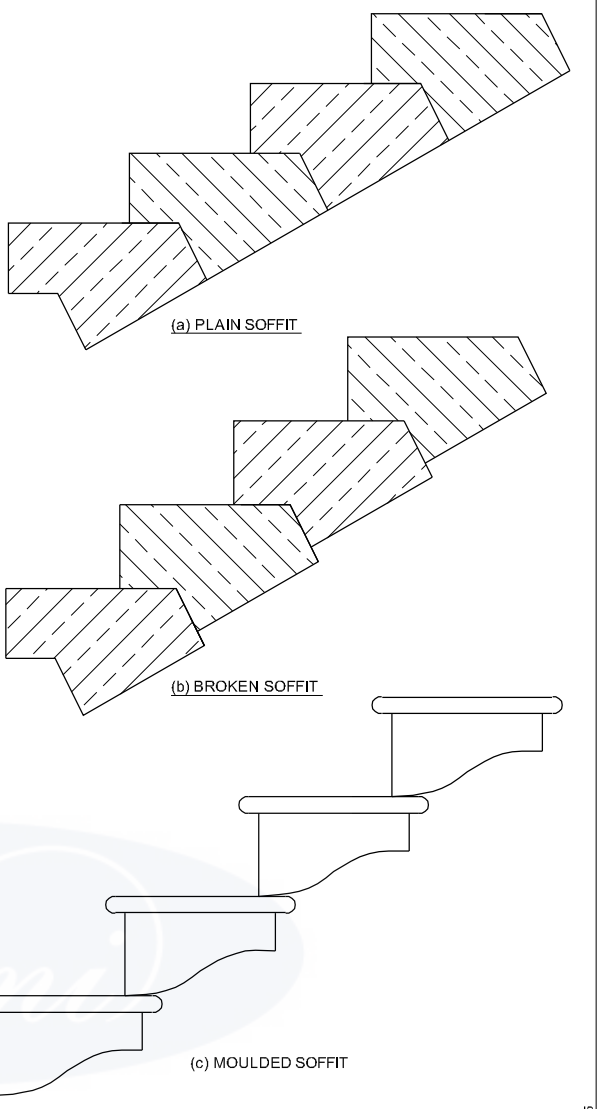
b Spandrill step

In this arrangement, the steps are triangular in shape and they are cut in such a way so as to obtain plain soffit. This arrangement is used where the head room is desired. The soffit affords a nice appearance and the weight of steps is also reduced. The ends of of spandril steps which are built into the wall should be square so as to provide a horizontal seating or bearing. The soffit can also be made broken or moulded. (Fig 5)

c Tread and riser step

In this arrangement the treads and riser of stones are provided as in case of timber step. The stone slab treads and risers are connected by dowels.

Fig 5



SPANDRIL STEP

d Cantilever tread slab steps

In this arrangement the steps are formed of treads only. For this purpose, only thick stone slabs are used without any riser. The steps may be either be rectangular or triangular in shape.

e Build-up step

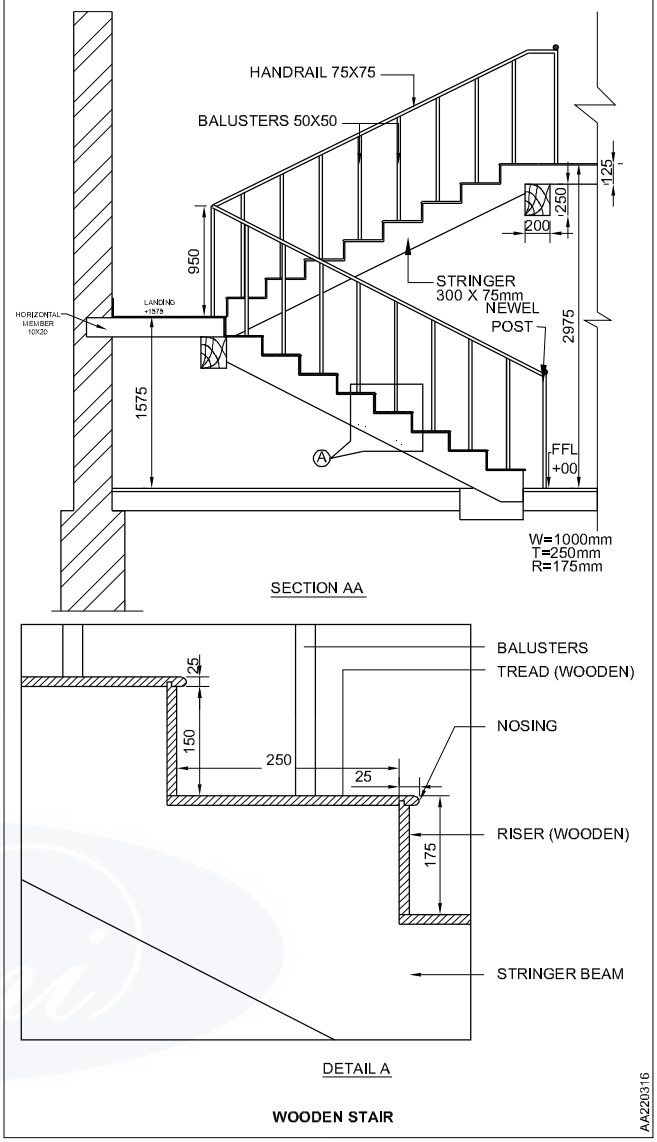
These steps are in the form of a treads and risers of thin swan of stone slabs, they are placed over brick or concrete steps. The thickness of stone slabs may vary from 20 mm to 50 mm. This arrangement is generally adopted for marble steps to give an ornamental covering to the step.

2 Wooden or timber stairs

As a wooden stairs are light in weight, they are mostly used for residential buildings. The main objection to the provision to a wooden stair is that it is easily attacked by fire and thus, in case of a fire, the occupants of upper

floors cannot escape. But if a wooden stair is constructed from good quality timber such as teak and if its thickness is about 45 mm, it becomes sufficiently fire proof and it allows enough time for the occupants of upper floors to escape. The string supporting the ends of wooden steps may be a cut string or a close string. The scotia blocks may be provided to giva an additional finish to a wooden step. The small triangular wooden blocks, known as the glue blocks, may be provided at the inner angle formed between a tread and a riser, to give additional strength to a wooden step. These blocks are glued and placed at about 80 mm distance. A metal strip may be provided on the nosing of a wooden step to increase its resistance against wear and tear. The landing, in case of wooden stair, may be formed by providing wooden bearers or beams of suitable sizes. In some cases, the risers may be totally omitted. The treads are housed in the strings and the soffit is covered with wooden battens or metal sheets. The timber used in the preparation of wooden stair should be free from fungal decay, insect attack and the other defects. The edges of timber should be finished smooth and the pieces of timber having abnormal lightweight should not be used. (Fig 6)

Fig 6

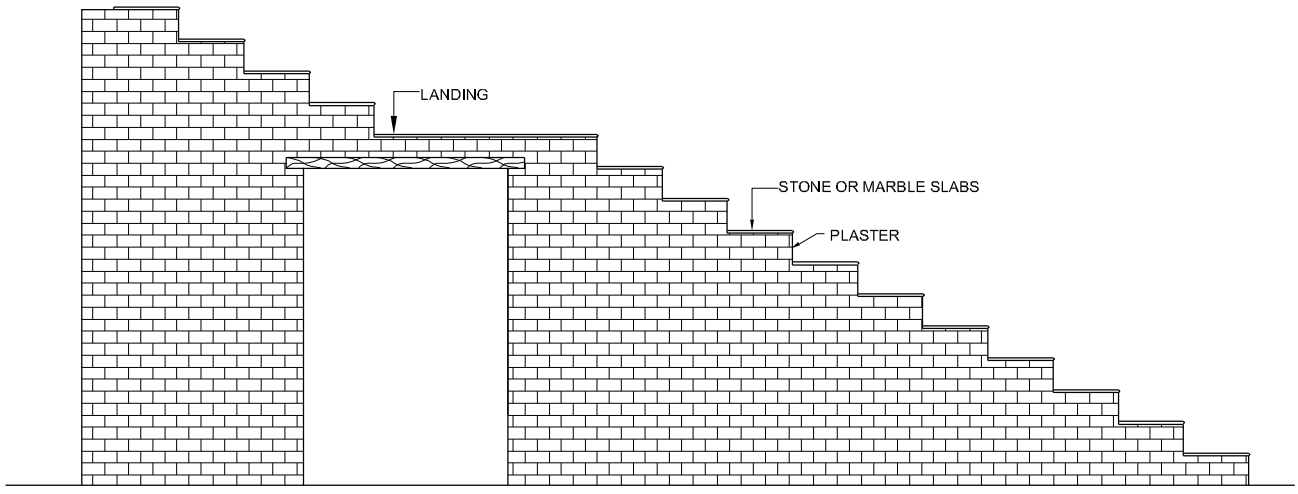


WOODEN STAIR

3 Brick stairs

These stairs are now not frequently used. The entrance steps form a typical brick stair. A brick stair may be made of solid construction or arches may be provided. The latter arrangement reduces the total quantity of brick work and gives some additional space which can be used for making cupboards, etc., In case of a brick stair, the treads and risers are generally made equal to length of 11/2 brick and height of two layers of bricks respectively. The treads and risers of a brick stair are finished with suitable flooring material. (Fig 7)

Fig 7



BRICK STAIR

4 Metal stairs:

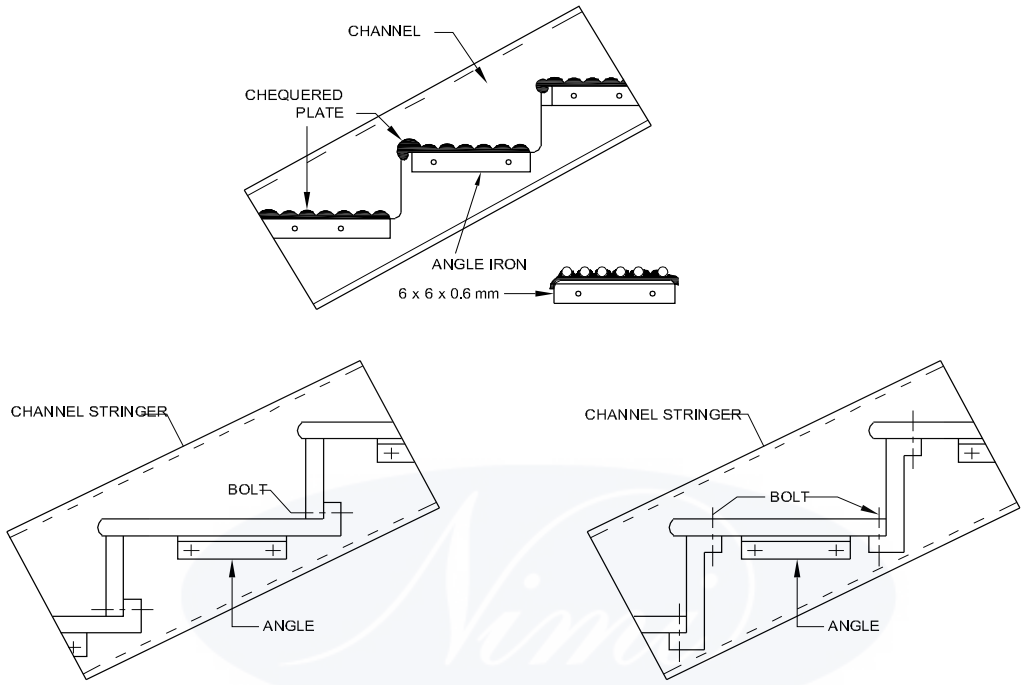
The external fire-escape stairs are generally made of metal. The common metals, used for the construction of stairs, are cast-iron, bronze and mild steel. Thus the metal stairs are widely used in factories, workshops, godowns, etc. The stringers are usually of channel section. The tread and riser of step may be of one unit. The treads and risers

are supported on the angles which are connected to the stringers. The spiral stairs of cast-iron consist of cast-iron newel fixed in the center around which the cast-iron steps are fixe. For metal stairs, the metal balusters with handrail of pipe are used. (Fig 8)

5 R.C.C. Stairs

These stairs are now commonly used in all types of construction and incase of a framed structure of reinforced concrete, the R.C.C. stair is perhaps the only choice. They are found to resist wear and fire better than any other material and can be moulded to the desired shape. The steps can be provided with suitable finishing material such as marble, terrazzo, tile, etc. These stairs can be easily maintained clean and they are strong, durable and pleasing in appearance. They can also be easily rendered non-slippery and can be designed for greater widths and longer spans. (Fig 9)

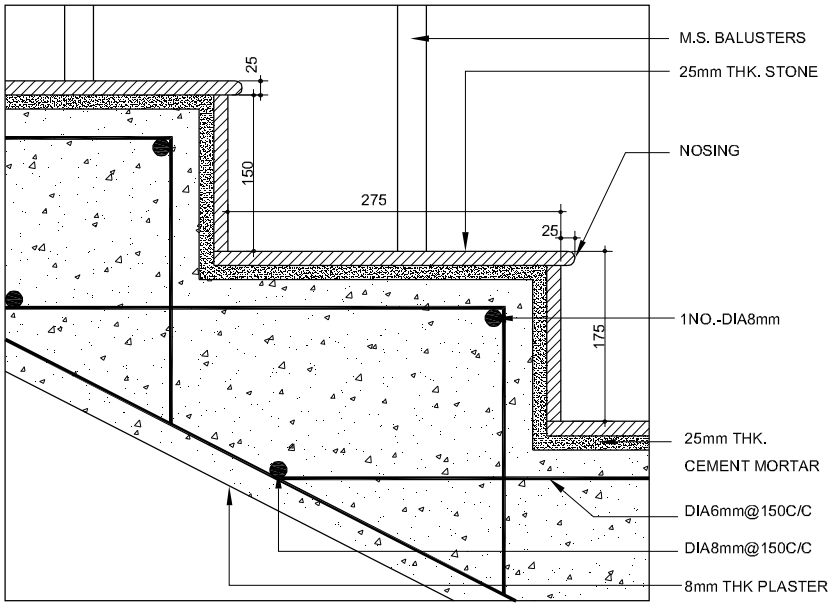
Fig 8



STEEL STAIRS

AA220318

Fig 9



R.C.C. STAIR

AA220319

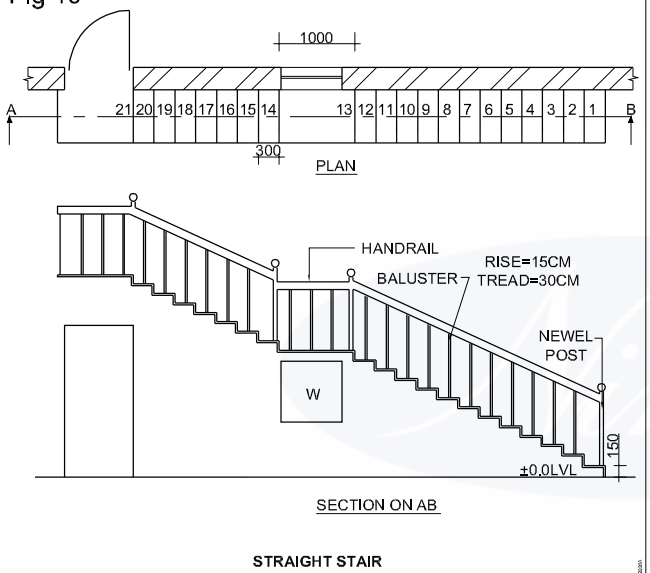
The details and placing of reinforcement will naturally depend on the design of R.C.C. stair. These steps may be cast-in-situ or pre-cast. In the latter case, it is also possible to pre-cast a flight and then placed it in position with the help of suitable equipment.

Stairs according to the materials of construction

The stairs are classified as follows with reference to the shape of construction.

1 Straight stairs : In case of a straight stair, all steps lead in one direction only. This type os stair may consist of one or more flights and they are used. When the space available for staircase is long but narrow in width. These stairs are not as expensive to construct as other types of stairs. The design of straight run staircase is most simple. (Fig 10)

Fig 10



STRAIGHT STAIR

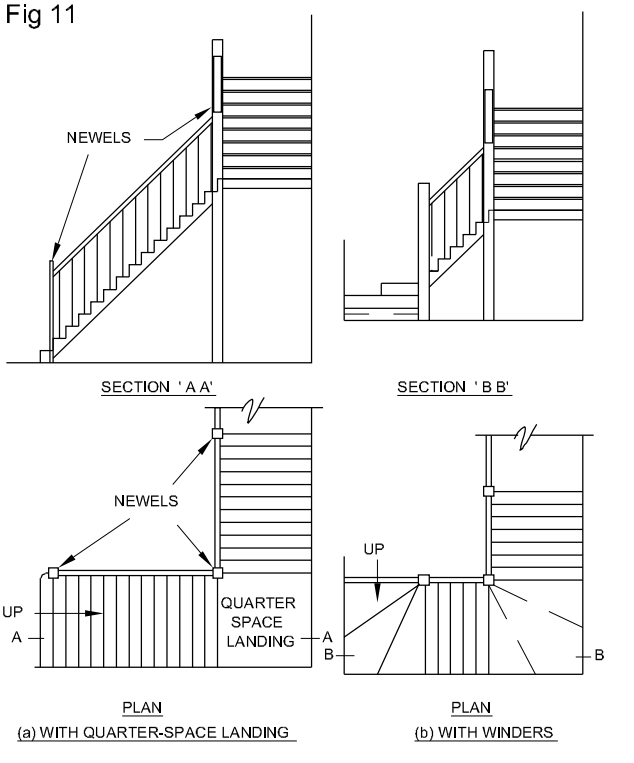
2 Turning stairs : In case of turning stairs, the flight take turn. The usual types of turning stairs are explained below.

i) Quarter-turn stairs : A stair turning through one right angle is known as quarter turn stair. A quarter turn stair changes its direction to the left or right turn being affected either by introducing a quarter space landing or by providing winders. (Fig 11)

ii) Half-turn stairs : A stair which changes its direction reversed or changed for 180° is known as a half-turn stair. A half-turn stair may be of dog-legged type or open newel type.

In case of a dog-legged stair, the flights run in opposite directions and there is no space between them in plan. These stairs are useful where total width of space available for the staircase is equal to twice the width of steps. Its name is derived from its appearance in the sectional elevation. (Fig 12)

Fig 11



QUARTER TURN STAIR

In case of an open newel stair, there is a well or hole or opening between the flights in plan. Thus well may be rectangular or of any geometrical shape and it can be used for fixing lift. These stairs are useful where available space for staircase as a width greater than twice the width of steps. (Fig 13)

iii) Three-quarter-turn stairs : A stair turning through three right angles is known as three-quarter-turn stair. In this case, an open well is formed. This type of stair is used when the length of the staircase is limited and when the vertical distance between the two floors is quite large. (Fig 14)

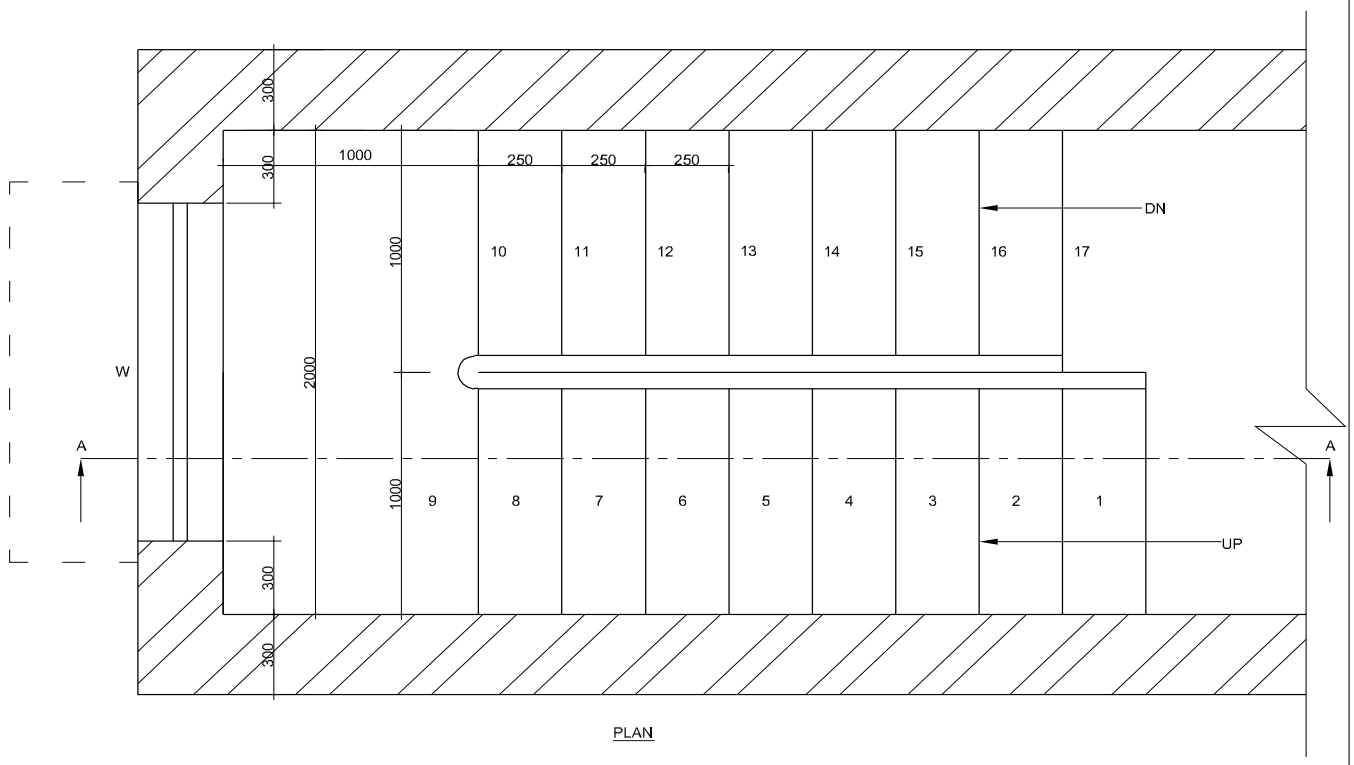
Quarter turn or "Wide U"

iv) Bifurcated stair : If a quarter turn stair is branched into two flights at a landing it is termed as a bifurcated stair. This type of stair is used in the public buildings near their entrance hall. The stair has a wider flight at the bottom which bifurcated into two narrower flights at the landing - one turning to the left the other to the right.

3 Geometrical stairs

These stairs have any geometrical shape and they require no newel posts. The handrail of a geometrical stair continues without interruption and without any angular turns. The construction of a geometrical stair requires considerable skill and it is found that a geometrical stair is a weaker than a corresponding open newel stair. (Fig 15)

Fig 12

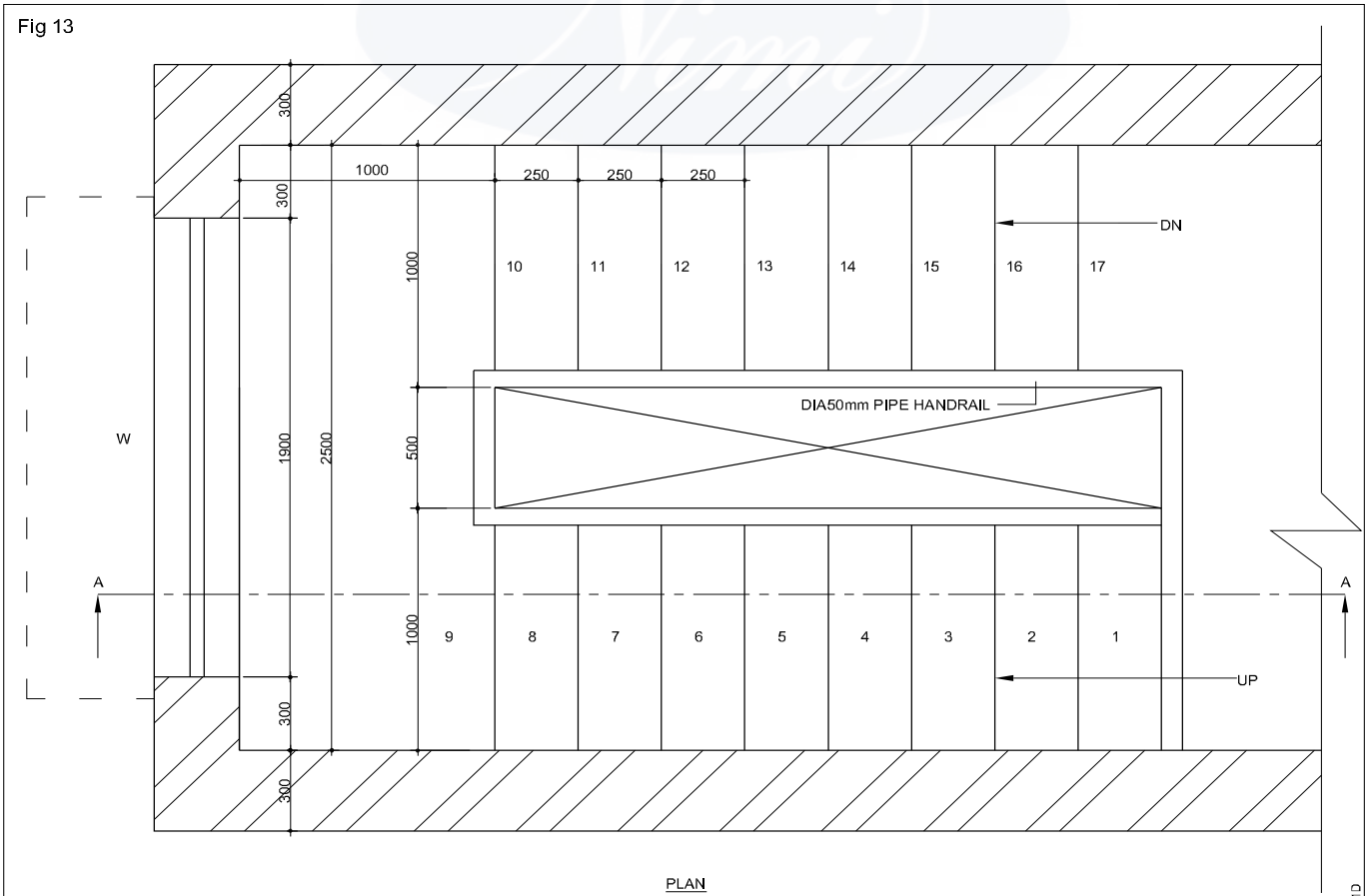


PLAN

DOG LEGGED STAIR

AA22031B

Fig 13



PLAN

OPEN WELL STAIR

AA220331D

Fig 1

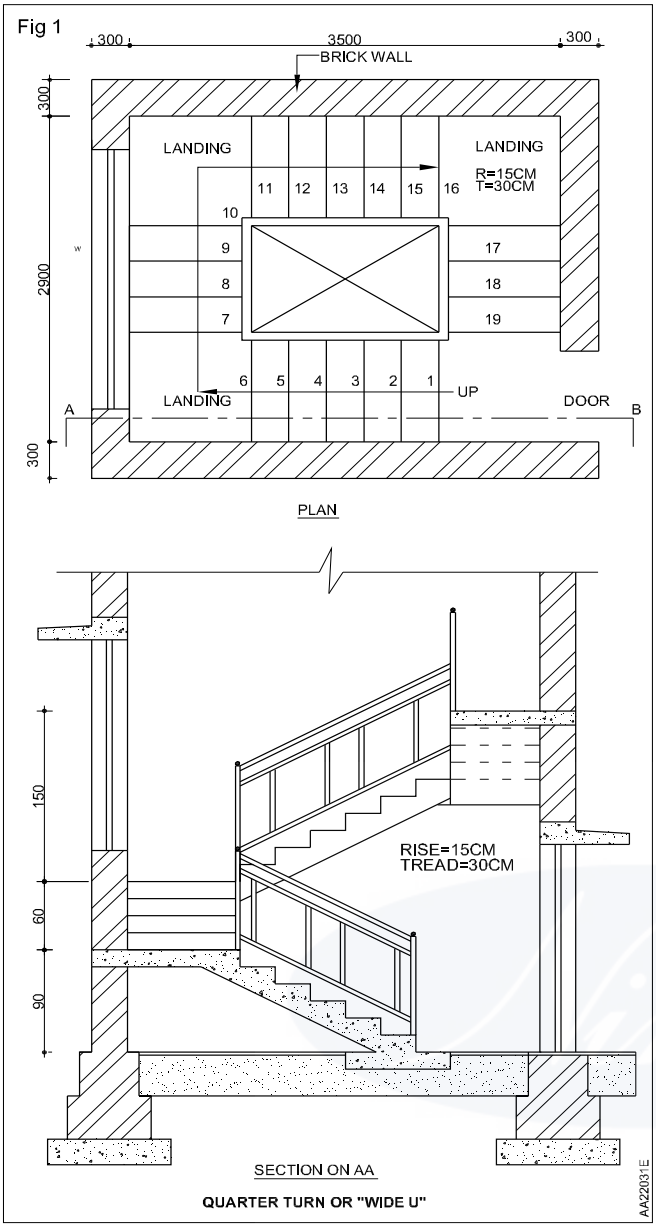
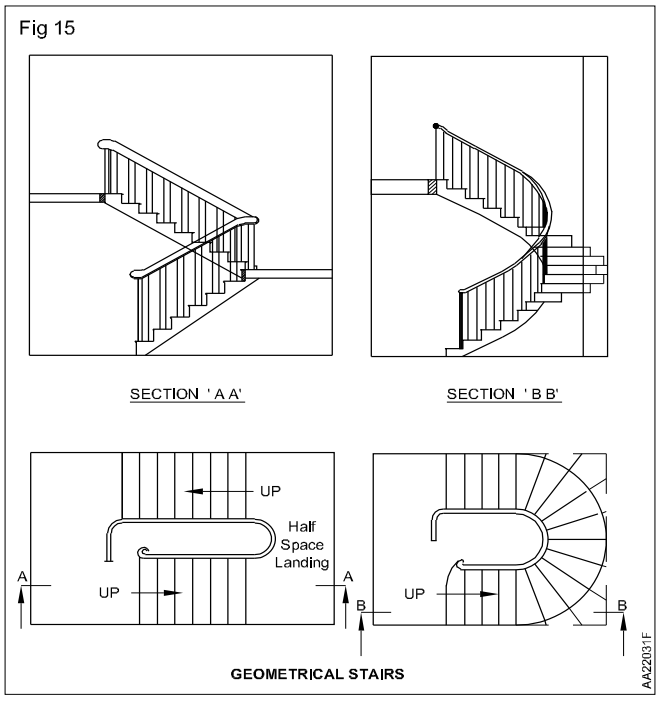


Fig 15



4 Circular or helical or spiral stairs

In this type of stair, the steps radiate from the center and they do not have either any landing or any intermediate newel post.

In circular stairs the flights consists of winders only and they may be continued through any desired number of turns. The construction of circular staircase will require a great amount of space it is employed in places where there are space limitations. (Fig 16)

A spiral stair may be constructed of cast-iron, mild steel or concrete. Usually the structural design and construction of a spiral stair are complicated in nature. For concrete spiral stair, the steel reinforcement is heavy and formwork is complicated. These facts make the concrete spiral stairs expensive. The core of spiral stair may be solid or hollow. The spiral stairs are useful where the space available is limited and where the traffic is less. Spiral stairs have a closed circular form and a central supporting column. The spiral-type staircase has a nice looking design, but a little bit risky for safety reasons as generally these have winder steps. (Fig 17)

A helical stair looks very fine but its structural design and construction is very complicated. It is made of RCC in which a large position of steel is required to resist bending, shear and torsion.

Planning and design of a stair

Design of layout:

The height of the floor is generally known. The procedure for determining the number of treads and risers is as follows:

i) The positions of first and last risers are determined with regard to the positions of doors, windows, verandahs, etc.

ii) A convenient height of the riser is assumed.

iii) A number of risers = Total height of floor / Height of riser.

iv) Number of treads in a flight = Number of risers - 1

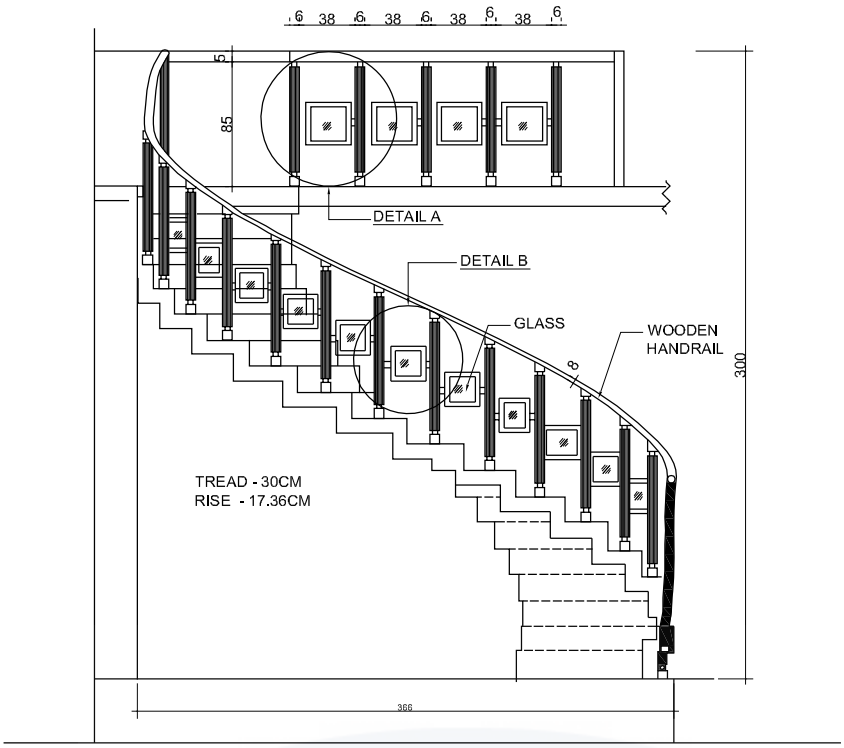
The surface of the upper floor forms the tread for the top step. Depending up on the spce available for stair case, the type of stair is selected. Do not allow doors to swing over steps; the arc of doors must be completely on the landing/floor.

Following rule-of-thumb are commonly used for obtaining a statisfactory proportion of the tread and riser of a step:

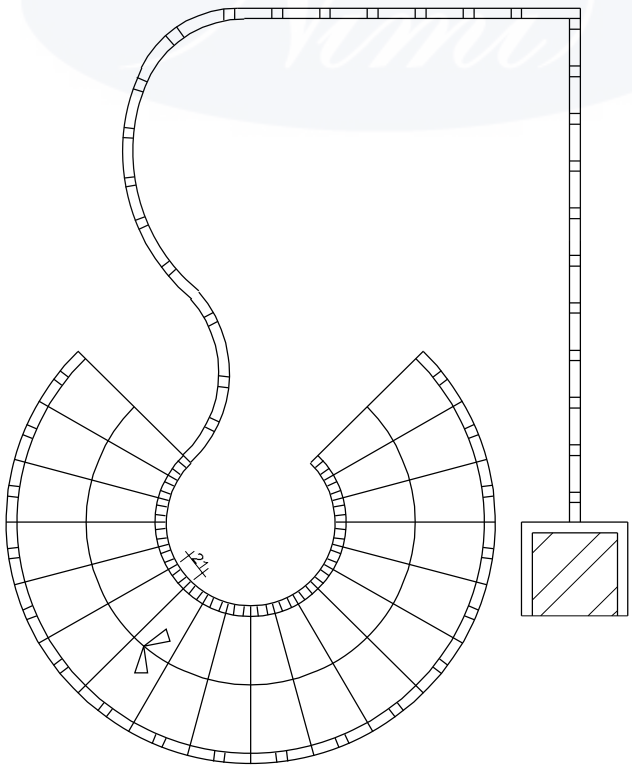
i) (Rise in cm) + (going in cm) = 40 to 45

ii) (Rise in cm) + (going in cm) = 410 to 450 approximately.

Fig 16



ELEVATION

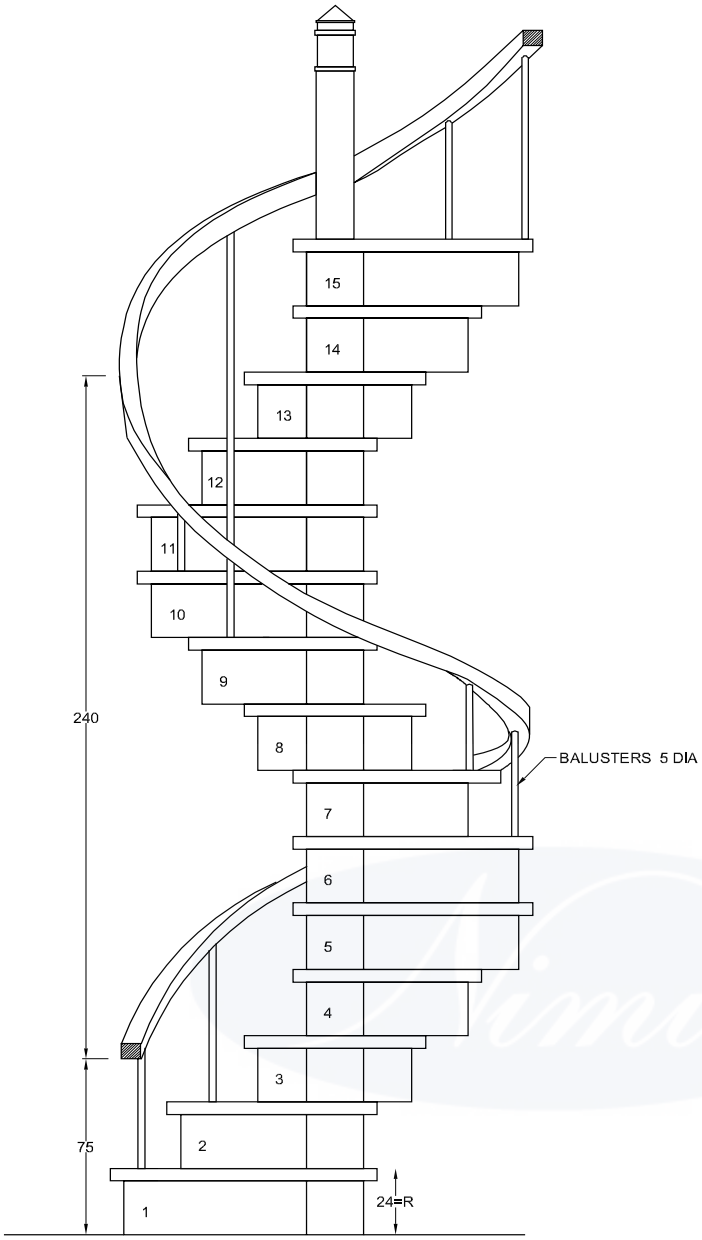


PLAN

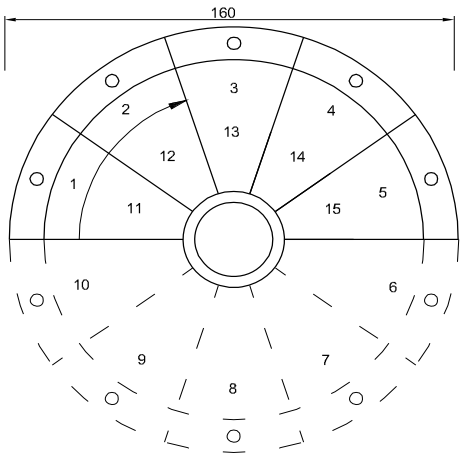
CIRCULAR OR HELICAL OR SPIRAL STAIRS

AA22031G

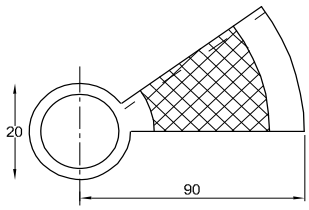
Fig 17



ELEVATION



PLAN



STEPS DETAIL

STEEL SPIRAL STAIR

AA220311H

iii) (2 x Rise in cm) + (going in cm) = 60 approximately.

iv) Take rise = 140 mm and going = 300 mm as standard.

Design of stairs

1 Plan a dog legged stair for a building in which the vertical distance between the floors is 3.6 m. The stair hall measures 2.5 m x 5 m.

Solution:

Let the rise be 15 cm and tread be 25 cm.
Let as keep width of each flight = 1.2 m

Width of landing = width of stairs = 1.2 m

Height of each flight = 3.6/2 = 1.8 m

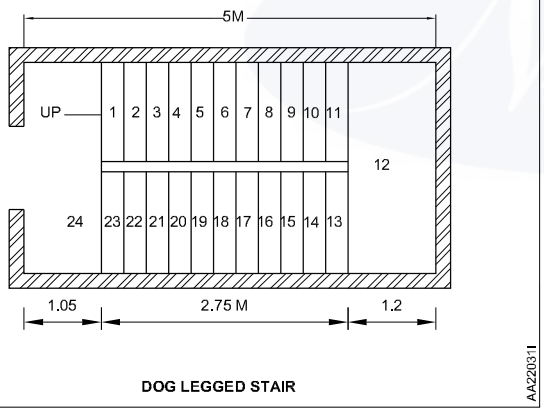
There for. no of risers required = 180/15 = 12" each flight.

No. of treads in each flight = 12-1 = 11

There for space occupied by treads = 11x25= 275 cm.

There for space left for passage = 5-1.2-2.75= 1.05 m (Fig 18)

Fig 18



DOG LEGGED STAIR

2 The stair hall of a public building, which measures 4.25 m x 5.25 m. The vertical distance between the floors is 3.9 m. Design a suitable stair for the building.

Solution:

Since it is a public building, let as fix the width of stairs = 1.5 m. Since the width of room is 4.25 m, space left between the two flights = 4.25-2x1.5 = 1.25 m. This suggests that we can provide an open well-type stairs.

Let the height of risers be 15 cm, keeping two flights, No. of riser in each flight = 1/2 x 3.9 x 100/15 = 13.

There for no of treads in each flight = 13-1 = 12.

Keeping width of tread = 25 cm, and width of landing = 1.5, horizontal distance required to accomodate these = (25x12) + 150 = 450 cm = 4.5 m. This will leave width of passage = 5.25 - 4.5 = 0.75 m only which is not sufficient. Also, in public buildings, maximum no. of treads in each flight is limited to 9.

Hence let us provide 6 treads in the landing portion, which can be easily accomodated in a width = 5x25 = 125 cm, which is equal to the width of well.

Provide 9 treads in each flight. Thus there will be a total a 9+9+5 = 23 treads in three flights will be = 23+3 = 26.

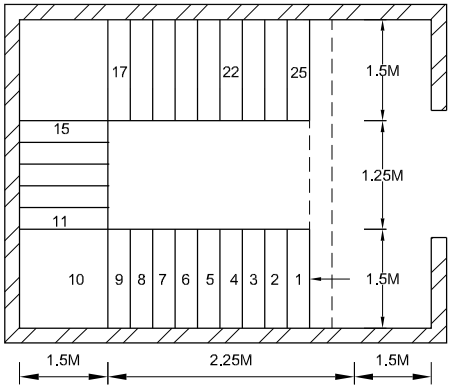
Height of riser = 3.9 x 100/26 = 15 cm.

Thus the steps will have risers of 15 cm and treads of 25 cm. Horizontal space required for 9 treads = 25x9 = 225 cm = 2.25 m. (Fig 19)

Therefore, width of passage left = 5.25 - (1.5+2.25)

= 1.50 m

Fig 19



PUBLIC BUILDING STAIR

Draw the different components of floor

Objectives: At the end of this lesson you shall be able to
- **state the definition of floor**
- **explain the components of floor**
- **identify types of floors**
- **state the selection of floors**
- **explain the construction methods of different types of floors.**

1 Floors are provides to divide a building into different lurely for creating more accomdation one above the other with in certain limited space and provide support for the occupants, furnitur and equipment of a building.

2 The bottom floor near the ground level is known a ground floor and the other floors above it are termed as upper floors ie. 1st floor, 2nd floor, etc.

3 If there is any accomadation constructed below the natural ground level. It is known as basement and the floor provided in it is known as basement floor.

4 An additional intermediate floor between two floors above ground level and the area restricted to 1/3 of the are of floor area and with minimum height of 2.2 m is known as mezzanine floor.

This floor may act as a gallery or balcony between the floor and ceiling of any storey. A floor consists of the following two components.

1 A sub-floor (or base course or sub-grade)

The purpose of this component is to impart strength and stability to support floor covering and all other superimposed loads. Live loads to be considered for design of floors.

A sub floor, which provides proper support to floor covering and the superimposed loads which are carried by it. Sub floor consist of lean concrete 75 mm to 100 mm thick in the ration (1:4:8 or 1:5:10) and 100 mm to 150 mm thick layer of fine sand as a cushion and the remaining portion is filled with locally available soil on ground floor. The roof also serve as a sub floor for upper floor.

Floor covering (or paving or flooring)

This is the covering over the sub-floor and is meant to provide a hard, clean, smooth, imperious, durable and attractive surface to the floor.

Construction of ground floors

Since the ground floors directly rest on the ground, hence they do not require the construction of a sub-floor. But, to ensure proper drainage, a floor may consist of a system of drains constructed below it, such that the whole water leads outside the building. However, in normal construction of ground floors, the space above the ground, upto a height about 25 to 30 cm below the plinth level, is first filled with some inert material to prevent the rise of water into the floor. This porous layer of inert material may be made of materials, such as sand, gravel, crushed stone, cinder, etc. In some cases, the asphalt layers also help in the general drainage of the surface. Over this uniform and even surface or layers, a floor covering or wearing surface or finish is provided.

Generally, the following materials are used for ground floor construction.

i) Bricks

ii) Stones

iii) Wooden blocks and

iv) Concrete

The materials usually employed for floor finishes or coverings are as follows:

i) Mud and muram

ii) Stones

iii) Bricks

iv) Wood or timber

v) Concrete

vi) Mosaic

vii) Terrazzo

viii)Asphalt

ix) Tiles

x) Rubber

xi) Linoleum

xii) Cork

xiii)Magnesite

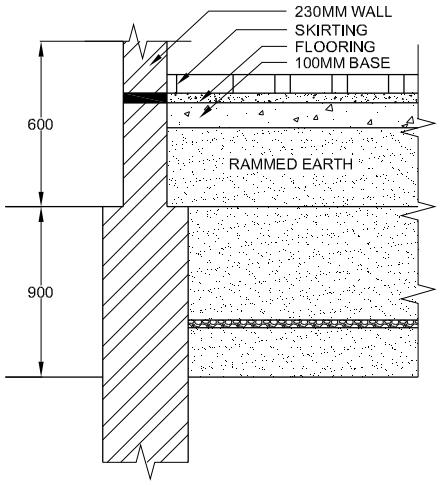
xiv)Marble and

xv)Plastic or P.V.C

Selection of floorings or wearing surfaces for ground floors:

Each type of floor has its own merits and there is not even a single type which can be suitably provided under all circumstances and more so when floors have to serve different purposes in different types of buildings, such as residential, institutional, industrial, assembly etc. However,

Fig 1



COMPONENTS OF GROUND FLOOR

the selection of flooring, ie., floor covering should be made considering the following factors.

Ground and upper floors

1 Initial cost

2 Appearance

3 Cleanliness

4 Durability

5 Damp-resistance (or damp-proofing)

6 Sound insulation (or noiselessness)

7 Thermal insulation

8 Smoothness

9 Hardness

10 Comfort criteria

11 Fire-resistance

12 Maintenance considerations

1 Initial cost

The floor coverings, of marble, rubber tiles and special clay tiles are considered to be most expensive whereas the floorings, viz., Terrazzo, linoleum, cork, asphalt, tile, vinyl tile, slate, etc. are moderately expensive. The floors made of concrete and brick, offer the cheapest type of floor construction.

2 Appearance

Generally, floorings of terrazzo, tiles, marble and cement mortar, provide a good appearance whereas the asphalt covering gives an ugly appearance.

3 Cleanliness

Being the sanitation property, a floor should be non-absorbent and capable of being easily and effectively cleaned. All joints in flooring should be such as to offer a water tight surface. Floorings of terrazzo, marble, tiles and slates are generally used.

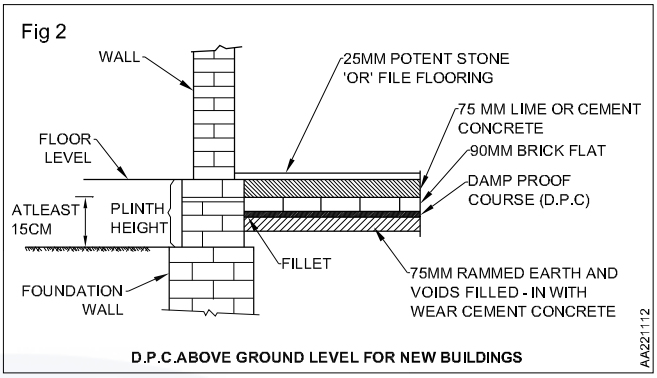
4 Durability

The flooring material should offer sufficient resistance to wear and tear, temperature, chemical action etc., so as to provide long life to the floors. The floorings of marble, terrazzo, tiles and concrete are considered to be of best type.

5 Damp-resistance (or Damp-proofing)

All the floors, specially ground floors, should offer sufficient resistance against dampness in buildings to ensure healthy environment. Normally, the floors of clay, tiles, terrazzo, concrete, bricks, etc. are preferred for use where the floors are subjected to dampness. The use of flooring material, like wood, rubber, linoleum, cork, etc. should to avoided for floors in damp situations. (Fig 2)

Fig 2



D.P.C.ABOVE GROUND LEVEL FOR NEW BUILDINGS

6 Sound insulation (or noiselessness)

The flooring material should possibly be such that it either produces no noise or less noise when travelled over, specially for buildings such as libraries, hospitals, colleges, universities, theatres, etc. Cork tile and rubber floorings provide excellent sound insulation properties whereas the floors of wood, linoleum, asphalt, etc. also serve this purpose satisfactorily.

7 Thermal insulation

It should be possible for a building to maintain constant temperature or heat inside the building irrespective of the temperature changes outside. It is needed to reduce the demand of heating in winter and refrigeration in summer. The floors of wood, rubber, cork, etc. are best suited for this purpose.

8 Smoothness

The floor covering should be of superior type so as to exhibit a smooth and even surface. But at the same time, it should not be too slippery, which will otherwise endanger the safe movements over it, particularly by the old people and the children. Floor coverings of tiles, terrazzo, concrete, etc. have better performance from this angle.

9 Hardness

It is desirable to use good quality floor coverings which do not give rise to any form of indentation marks, inprints, etc.

10 Comfort criteria (ie. shock-absorbing and good conductivity properties)

The flooring material should be such that it gives comfort to the occupants, under living and working conditions. The use of flooring materials, like cork tiles, rubber, wooden blocks, linoleum, plastic, etc., is preferred from comfort viewpoint as they provide floors which are good conductors of heat. The floorings of concrete, terrazzo, marble, slate, brick, etc. are generally tiresome and cold, so do not offer comfort to the occupants.

11 Fire resistance

The floor covering should be made of fire-resisting or non-combustible materials such as concrete, bricks, clay tiles, marble, etc. The floorings of combustible materials like, cork, linoleum, plastic, etc. should be laid on fire-resistant base only.

12 Maintenance considerations

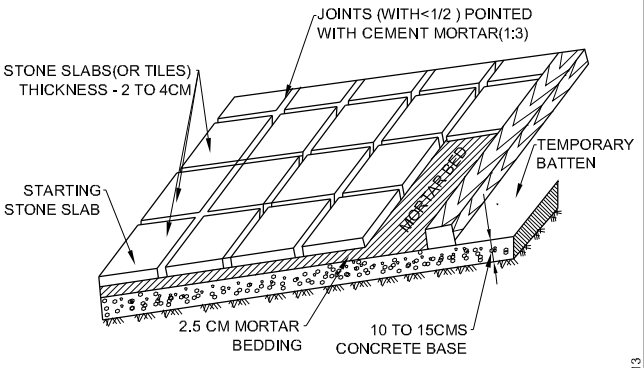
It is always desired that the maintenance cost should be as low as possible. Generally, the coverings of tiles, marble, terrazzo and concrete, require less maintenance cost as compared to the floors of wood blocks, cork, mastic asphalt, etc.

Flag-stone flooring

This flooring consists of thin slabs of stones laid on concrete bedding. The usual sizes of stone slabs are 30 cm x 30 cm, 45 cm x 45 cm, 60 cm x 60 cm and 45 cm x 60 cm and their thickness varies from 2 cm to 4 cm. The slab stones may be square, rectangular or oblong in shape with squared edges.

After excavating to the required depth the earthen base is levelled, rammed and watered. On this surface a layer of 10 to 15 cm thick lime concrete bed or subgrade, well dressed flag stones are laid and fixed with thin layer (2.5 cm) of mortar. When the stone slabs are properly set, mortar in joints is raked out to depth of about 2 cm and flush pointed with concreted mortar (1:3). A slope of 1 to 40 is generally provided in flag stone flooring for proper drainage. (Fig 3)

Fig 3



FLAG-STONE FLOORING DETAILS

During the construction of stone flooring, the following points require due consideration:

i) For stone flooring above the damp and black cotton soil, a porous layer of sand or rubble should be provided as a cushion below the base.

ii) For laying of stone slabs, the work is started by first laying only two stone slabs from diagonally opposite corners over a mortar layer of 2.5 cm thickness and then intermediate slabs are brought up from both the sides. Moreover, a string is stretched touching the tops of these two diagonal stones at required gradient (1 to 40) to facilitate drainage. All other intermediate stone slabs will be touching the string at their top.

iii) All stone slabs used should be hard, durable, tough, and of even and good quality.

iv) Normally, the joints width between the individual stone slabs should not exceed 0.5 cm (ie. 1/2 cm)

v) All stones should be dressed on edges before use. Stones with rough surface should be used on rough works, like godowns, sheds, stores, etc., whereas the stones with polished surfaces are used in superior type of work, such as schools, workshops, hospitals, etc. and that too in a definite pattern.

Merits and demerits of flag-stone flooring are as follows

Merits

i) It provides a hard, durable and wear-resisting floor surface as such can be used for godowns, stores, workshops, etc.

ii) It is easy in construction, repair and mainenance.

iii) In places, like Tamilnadu and Andhrapradesh, where slabs stones are available in abundance, this type of flooring can be used with economically.

Demerits

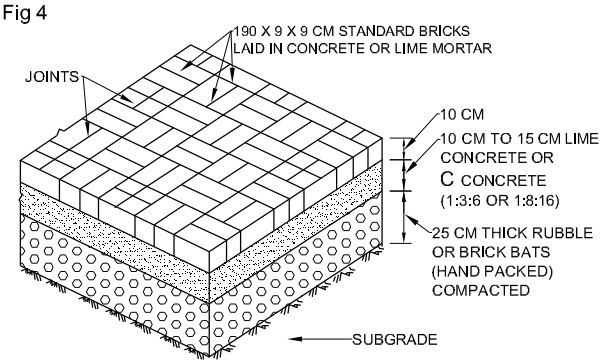
i) As it does not give a pleasing and attractive appearance, so cannot be used in residential buildings or important public buildings.

ii) Being bad in conductivity, poor in shock absorbing characteristics and not offering perfectly even surface, the use of this flooring is not comfortable for living purposes.

iii) **Brick flooring:** This type of flooring is suitable for cheap construction, and for places where heavy articles are to be stored as in case of warehouses, stores and godowns. Brick flooring is commonly used in alluvial places like U.P., Punjab, etc., where stone is scarce and well burnt bricks of good quality are readily available. The brick flooring may be laid with bricks laid flat, or on edge arranged in herring-bone pattern, or set at right angles to the walls.

The bricks, whether laid flat or on edge, are set in ordinaly mortar and pointed with cement, or set in hydraulic mortar.

Fig 4



BRICK FLOORING - DETAILS

Merits

i) It is durable and sufficiently hard.

ii) It provides non slippery and fire resistant surface.

iii) It is cheaper in initial cost.

iv) It is easy in maintenance.

v) It is absorbent.

Demirts

i) It is absorbent.

Draw the details of cement concrete floor

Objectives: At the end of this lesson you shall be able to
- **explain the construction of cement concrete floor method step by step**
- **state the merits and demerits of cement concrete floor**
- **explain graw lithic floor for public buildings and industries**
- **explain the construction methods of tile, marble, granite floors.**

Concrete flooring

This type of flooring is most commonly used these days in residential, commercial, institutional and public buildings of all types. This flooring is also known as Indian patent stone flooring. The concrete flooring consists of two components.

a) A base course on subgrade, and

b) A wearing course on floor finish.

Formation of base course on subgrade and laying lime concrete: Upon the above prepared surface of the ground, a 15 cm thick layer of broken stones or hard bricks is evenly spread. Sub-base on subgrade so prepared is also called as hard core.

Necessary slope is given to the surface. Usually a slope 1 in 120 to 1 in 240, is sufficient for inside floors and an outward slope of 1 in 36 to 1 in 40 is recommended for bath-rooms and verandah floors.

First, the lower layer, 2.5 cm thick, of lean concrete (1:3:6) is laid and rammed, and then another upper layer of 1.5 cm in thickness of richer concrete (1:1:2) is laid after half an hour. The coarse aggregate in rich concrete should be crushed well-graded hard stone below 8 mm size.

Care should be taken in mixing the sufficient quantity of water such that slump value does not exceed 4 cm.

For the joints between the panels or sections, or bays of concrete floors, a 1.5 mm hoop steel lining is generally used which is protected by oiling against adhesion with concrete. Sometimes, strips of teak, wood, ebonite iron or brass are also introduced between the panels and are oiled or white washed.

For getting a coloured finish, either the coloured cement (though best but costly) or colouring pigments are used in the topping concrete layer. The following pigments per cubic metre of concrete in topping are specified:

Red colour ... 1/10 cu.m red oxide of iron powder (or 10%)

Terra-cotta colour ..... burnt yellow ochre (nearly 10%)

Black colour ... 1/20 cu.m of manganese di oxide (or 5%)

Buff-colour ... 1/25 cu.m of yellow ochre (or 4%)

Laying of wearing coat or floor finish

After an hour of laying the cement concrete, a finishing surface or wearing coat, about 2cm thick, is laid on the surface of the former (ie. concrete surface). The finishes of several types, such as mortar finish, mosaic finish, terrazzo finish and granolithic finish, are used in different thicknesses for different puposes of floors, over the concrete base. The special finishes are discussed in subsequent types of floorings, namely Mosaic flooring, Terrazzo flooring and Granolithnic flooring.

It should be noted well that all the surfaces of the cement concrete floors are not finished and for common works, the wearing coat is generally omitted. Sometimes, in ordinary type of concrete flooring, a thin coat (1 to 2 cm thick) of cement mortar (1:1) is applied over the hard dry concrete base. This is known as mortar finish.

If a very hard wearing surface is required, as in case of floors in factories, then 2 to 3 coats of sodium or calcium silicate may be applied, each being placed after the previous coat has thoroughly dried.

Curing

After the flooring is completed, the whole surface is covered with wet socks or bags, or with 5 cm of wet sand and kept wet for atleast 10 days by sprinkling water at suitable intervals. The curing of concrete surface is important as it helps in developing strength, weather-resisting and wear-resisting qualities.

Merits and Demerits of concrete flooring

Merits

1 It is non-absorbent and hence offers sufficient resistance to dampness. This is used for water retaining floors as well as stores.

2 It possesses high durability and hence is employed for floors in kitchens, bath-rooms, schools, hospitals, drawing rooms, etc.

3 It provides a smooth, hard, even and pleasing surface.

4 It is easily cleaned and has proved overall economical due to less maintenance cost.

5 The concrete being non-combustible floor, required for fire-hazardous buildings.

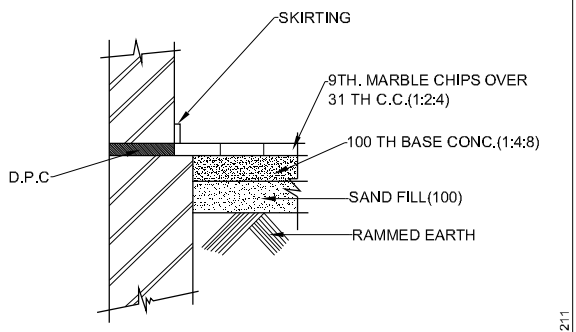
Demerits

1 The defects, once developed, in concrete floors whether due to poor workmanship or materials, cannot be easily rectified.

2 The concrete flooring cannot be satisfactorily repaired by patch work.

3 It does not possess very satisfactory insulation properties against sound and heat.

Fig 1



TERRAZO FLOORING

Types of industrial floor finishes

Types

This will deal with the selection of industrial floor finishes where the floor is subject to heavy abrasion, impact, chemical action; floor finish under special circumstances, such as, non-slippery, dustless, noiseless, non-sparking, anti-static etc.

A finish for the floor of an industrial building may be generally selected out of the following types to suit the requirements of particular case:

a) Plain concrete
b) Granolithic concrete
c) Precast concrete tile
d) Paving brick
e) Magnesium oxychloride
f) Bitumen mastic
g) Linoleum
h) Rubber, PVC sheets
i) Epoxy resin
j) Fire clay brick
k) Ceramic unglazed vitreous acid resistant tiles
l) Stones
m) Steel or cast iron units
n) Wooden block with lead lining
o) Acid resistant brick

Recommendations for floor finish for industrial buildings

Floors for heavy engineering factories, Workshops and garages

Floors in heavy engineering factories, workshops and garages shall be resistant to impact, abrasion and attack by lubricating oils. The epoxy resin floor topping is suitable for heavy industrial floors. The extent to which the floors will be subjected to heavy wear and impact will often vary widely in different parts and since the more important type of finishes are more expensive it is advisable to ascertain as far as possible.

Granolithic flooring consists of rich concrete made with very hard and tough quality coarse aggregate, such as granite so that the surface will have the maximum resistance to abrasive action. The thickness of granolithic finish should not be less than 25 mm when laid monolithically with the concrete base and not less 35 mm when laid over a hardened base (i.e., when laid non-monolithically.

For light duty floors, granolithic concrete consists of mix proportions as 1:2:3 (1 cement : 2 sand : 3 C.A., C.A. is usually well graded granite but may be used. The coarse aggregate is usually graded from 10 mm to 4.75 mm.

For heavy duty floors, this finish consists of mix proportions as 1:1:2 (1 cement : 1 sand : 2 granite chips).

In case, exceptionally hard surface is required then an abrasive grit may be sprinkled uniformly over the surface during floating operation @ 1.6 to 2.2 kg/sq.m. The surface is finally smoothened by means of steel trowel.

Tiled flooring

Tiles, either of clay (pottery) or cement (concrete) or terrazzo are manufactured in square, hexagonal and various other shapes, sizes and thicknesses these days. These tiles are used commonly for flooring purposes in residential, high class hotels, offices and other public buildings, etc., where floors are required to be installed in shorter time with pleasing appearance and good durability.

The method of laying a tiled flooring is similar to that used for stone flooring, but more care and skills are required in the execution of this type of flooring.

Over the sub-grade thus prepared, a thin layer (25 mm thick) of lime sand mortar with mix proportions 1:3 (1 lime : 3 sand) or 1:1 cement mortar, is laid to serve as a bedding mortor for receiving tiles.

Readymade tiles are laid flat on this surface, with a thin paste of cement applied on their sides.

The joints are made as thin as possible, and extra mortar that comes ot through the joints to the surface is immediately wiped clean with saw dust.

Flooring tiles in India are being manufactured in square sizes of 20x20 cm, 25x25 cm and 30x30 cm at present.

Merits and demerits of tiled flooring

Merits

i) It provides a non-absorbent, decorative and durable floor surface.

ii) It permits quick installation or laying of floors.

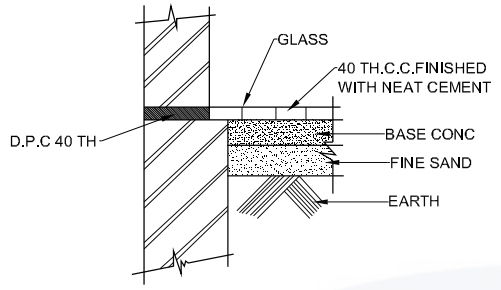
iii) It is easily repaired in patches.

Demerits

i) Tiled flooring is generally costly in initial cost as well as in maintenance cost.

ii) On becoming wet, it provides a slippery surface.

Fig 2



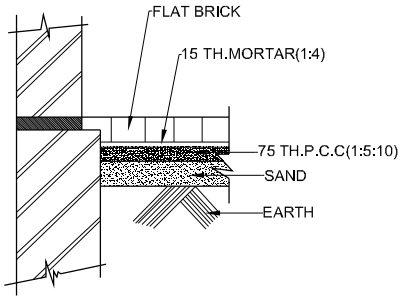
C.C.FLOORING

Marble flooring

Granite flooring is commonly used for superior type of floor construction, particularly, where sanitation and cleanliness are required as in case of hospitals, temples, bathrooms, theatres and other such buildings.

The construction of this flooring is exactly same as that of tiled flooring already discussed, except that the use of marble pieces instead of tiles is made.

Fig 3



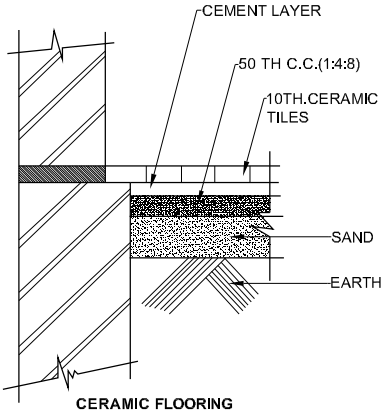
BRICK FLOORING

Plastic or P.V.C flooring

The plastic flooring is a recent development in the floor construction and has been successfully used as a covering over the concrete floor base in all type of buildings such as residential buildings, hospitals, churches, hotels, schools, offices, shops, etc. This plastic material, called P.V.C (Poly-Vinyl-Chloride), is fabricated in the form of tiles and is available in different sizes in varying colours and shades.

The plastic flooring is laid in the similar way as cement or pottery tiles, discussed already under tiled flooring.

Fig 4



CERAMIC FLOORING

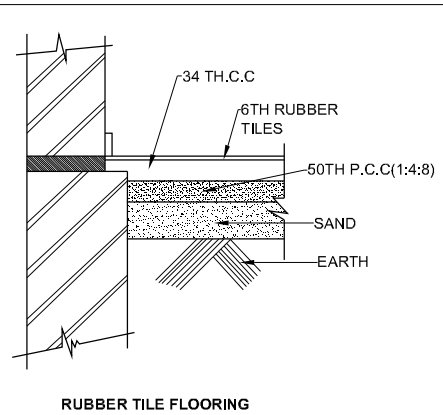
Rubber flooring

Rubber floorings are being used to a large extent in public and industrial buildings because of their good wearing qualities, resiliency (ie. elasticity) and noise insulation. The flooring material is made up of pure rubber mixed with fillers, such as cotton fibre, granulated cork or asbestos fibre and the desired colouring pigments. This type of flooring is manufactured in the form of sheets or tiles, in a variety of patterns and colours. The thickness of tiles or sheets ranges between 3 to 10 mm.

The rubber tiles are then cemented to the smooth and dry base of concrete or wood by means of a special adhesive.

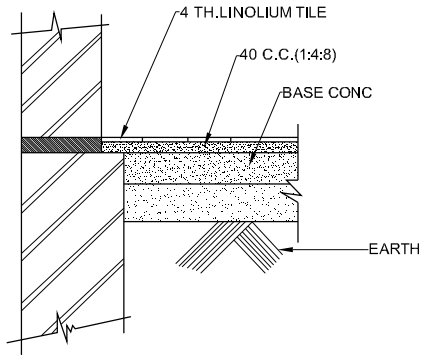
Though rubber flooring is expensive in its initial cost, yet it provides a durable wearing surface. However, oil, grease and gasoline make the floor slippery and it becomes difficult to restore it in good condition.

Fig 5



RUBBER TILE FLOORING

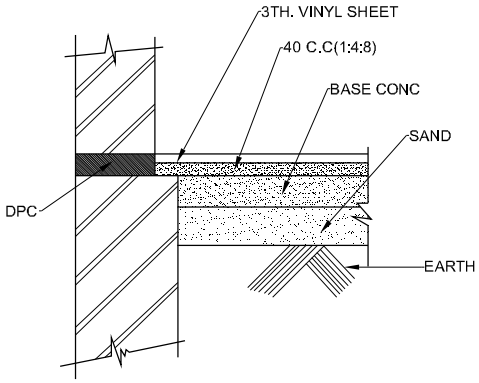
Fig 6



LINOLIUM TILE FLOOR

AA221216

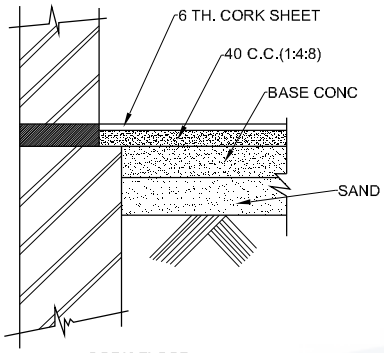
Fig 8



VINYL FLOOR

AA221218

Fig 7



CORK FLOOR

AA221217

Draw the details of wooden floor (upper floor)

Objectives: At the end of this lesson you shall be able to
- **explain the method of laying timber ground floor(suspended)**
- **state merits and demerits**
- **explain alternative ways of laying**
- **difference between the types of roof**
- **state the joints in timber flooring boards.**

Timber floors are provided in auditoria, gymnasia, dancing halls, squash courts, public balconies, galleries, skating rinks, etc, for noise retardent floor finish and in hilly areas as thermal insulating floor finish. These floors may also be used in timber framed construction to serve as structural floors.

The use of timber floors is best suited for building on hill stations or in localities where the climate is damp. In timber floors, the prevention of dampness is most important and hence all possible measures should be taken to check the dampness from rising above.

The entire area of the building below the ground floor of timber is covered with an impervious material in order to prevent dampness. This material may be either cement concrete or asphalt. Generally, a 15 cm layer of concrete known as oversite concrete, is placed all over the bed, the D.P.C. courses are inserted throughout the width of the wall immediatedly below the wall plate. (Fig 1)

Timber floors essentially consist of boarding supported on timber joists called bridging joists or floor joists, which are nailed to the wall plates at their ends. In case of large rooms, where the distance between the wall is considerable, intermediate walls, called sleeper or dwarf walls, are constructed to support the joists along their length. Longitudinal timber members called 'sleeper plates', are fixed on the top of sleeper walls and the timber joists are secured to the sleeper walls by nailing them to the sleeper wall plates.

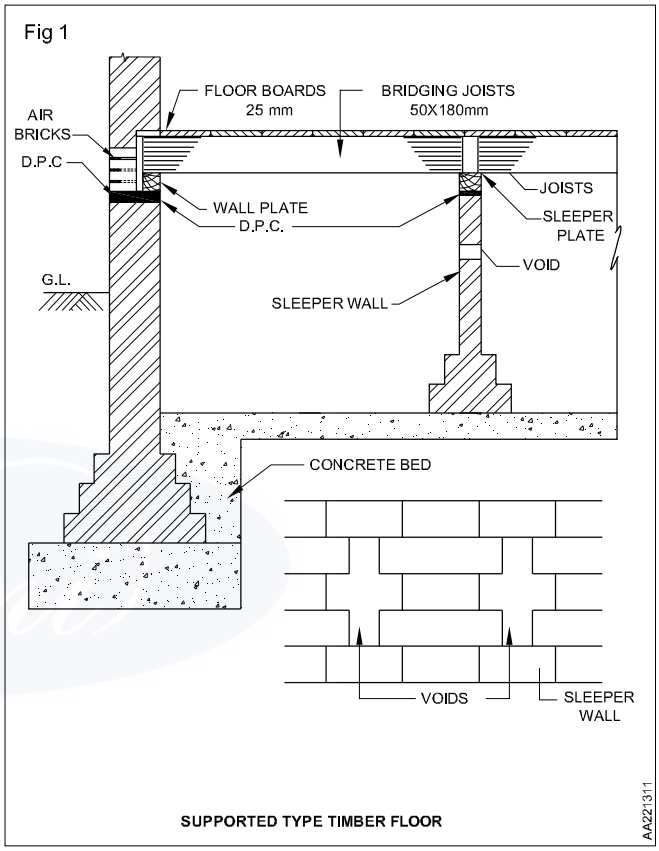
The hollow space between the flooring and the oversite concrete is kept dry and fully ventilated by keeping openings in the main walls above the ground level.

Timber floors are elastic in nature and possess enough resistance to wear. Timber flooring can be provided in the following alternative ways:

i) Strip-flooring

This is made up of narrow and thin strips of timber which are jointed to each other by tongue and groove joints (Normally strips, 6 to 10 cm in width and 2 to 2.5 cm in thickness are used).

Fig 1



SUPPORTED TYPE TIMBER FLOOR

ii) Planked-flooring

In this type of flooring, wider planks are used and they are also jointed by tongue and groove joints (Normally, plank width is about 20 cm). The species of timber recommended for floor board hardness taking teak as 100.

iii) Wood-block flooring

This consists of short but thicker wood blocks which are laid in suitable designs over a concrete base. The blocks are properly jointed together with the ends of the grains exposed. (Normally, wooden blocks of size varying from 20x8 to 30x8 cm, with thicknesses ranging between 2 to 4 cm, are used.

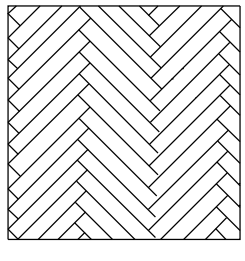
Species of timber recommended for slats, floor boards and parquet floors

Sl. No.	Name	Hardness
1	Gurjan	135
2	Rohini	130
3	Padauk	130
4	Satinwood	130
5	Maniawga	125
6	Axelwood	120
7	Kala siris	120
8	Bijasal	100
9	Laurel	100
10	White chuglam	100
11	Teak	100
12	Lendi	95
13	White cedar	95
14	Kindal	95
15	Pali	90
16	Kokko	90
17	Rosewood	90
18	Kassi	85
19	Sissoo	85
20	Piney	85
21	Jarul	80
22	Hollock	75
23	Anjan	70
24	Fir	65
25	Cypress	60
26	Machillus	55

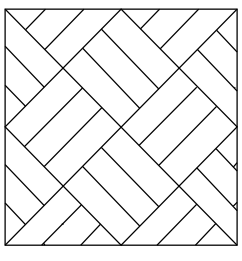
Wood block flooring patterns (Types of blocks and wood block floor)

This shall be given in Fig 2, Fig 3 & Fig 4

Fig 2



9.13AHERRING - BONE PATTERN

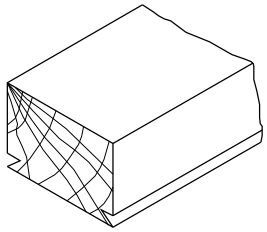


9.13B BASKET PATTERN

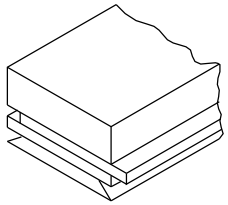
PATTERNS OF WOOD BLOCK FLOORING

AA221312

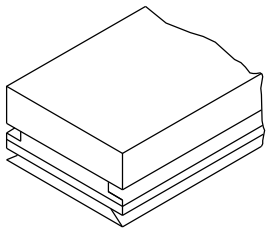
Fig 3



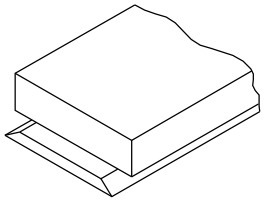
9.14A WITH DOVE-TAILED GROOVES ON THE BOTTOM



9.14B TONGUED AND GROOVED



9.14C WITH TONGUES ON THE ENDS

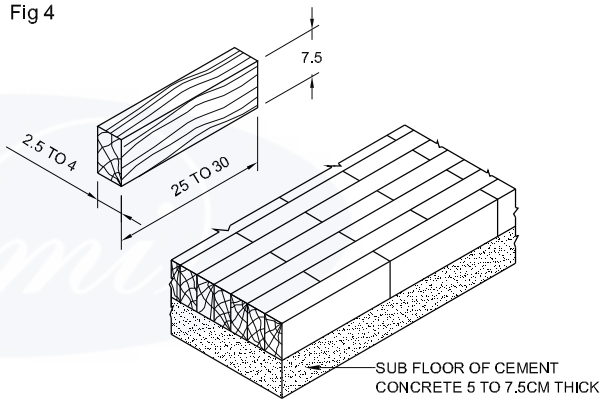


9.14D WITH A DOVE-TAIL GROOVE ON THE BOTTOM WITH A NARROW GROOVE ALROUND

DIFFERENT TYPES OF WOOD BLOCKS

AA221313

Fig 4



ALL DIMENSIONS IN CENTIMETERS

WOOD BLOCK FLOOR

AA221314

iv) Parquet flooring

This is similar to block flooring except thin (Max. thickness = 10 mm) blocks are supported on sub-floors. The blocks are laid by means of hot glue in desired pattern and then nailed with panel pins. This flooring of plywood is becoming popular these days.

1 Timber shall be seasonal and thereafter treated with preservative, ternite control coats.

2 Loose knots, of a colour contrasting with that of adjoining 1/5 of width of slat,

3 Cross grain,

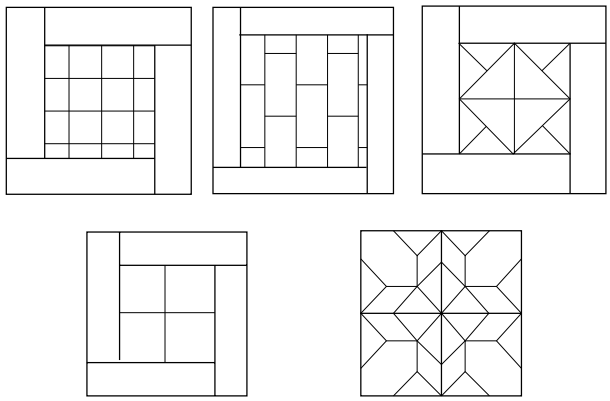
4 Waned wood; maximum 1/25 width of slat, and

5 Stains

Parequet floor patterns

They shall be as given in Fig 5 & Fig 6

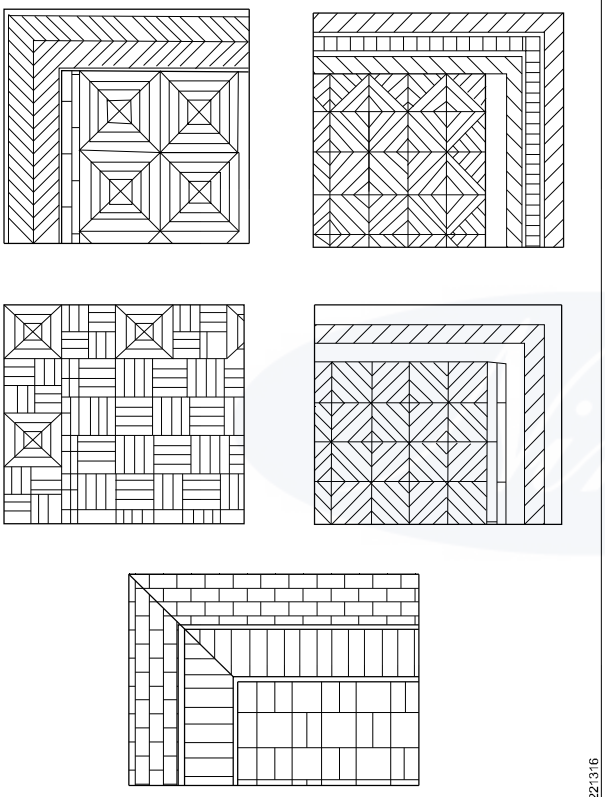
Fig 5



DIFFERENT DESIGNS OF PANEL FOR PARQUET FLOORING

AA221315

Fig 6



AA221316

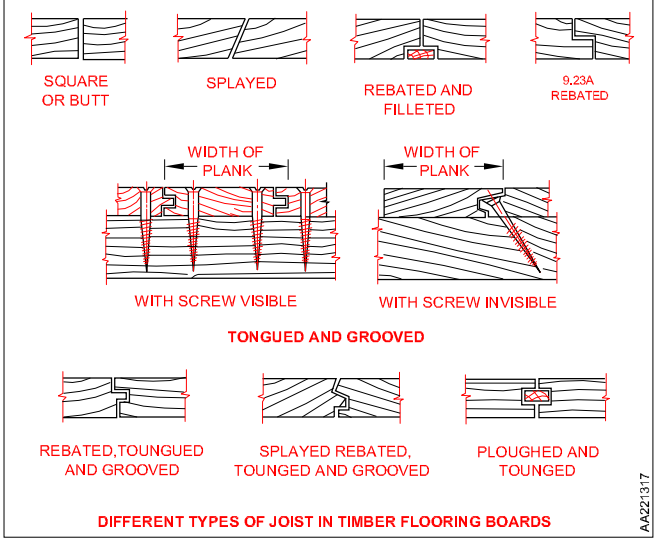
Purpose-Made floors

These are not generally made solid; they are primarily hollow floors. They are named according to purpose they serve, namely, skating-rink floor, badminton floor, squash floor, etc. Some details are as in Fig.

Timber floor boards

Timber floor boards, 25 to 30 mm thick, 100 to 150 mm wide and 2 to 3 m long are joined by widening joints listed in order of efficiency as shown in Fig 7.

Fig 7



DIFFERENT TYPES OF JOIST IN TIMBER FLOORING BOARDS

AA221317

a) Ploughed and tongued joints

b) Splayed, rebated, tongued and grooved joints

c) Rebated, tongued and grooved joints

d) Tongued and grooved joints

e) Rebated joints

f) Rebated and fitted joints

g) Splayed joints; and

h) Square butt joints

For all these joints, screws shall be driven from top of floor boards to the joints below and then concealed by putty.

The pores of timber floor shall be sealed with a floor seal.

Draw lean to roof details

Objectives: At the end of this lesson you shall be able to
- **state the definition roof**
- **explain the classification of roof**
- **identify the types of roof according to shapes**
- **difference between the types of roof**
- **state the technical terms**
- **explain above lean to roof and the technical terms**
- **state the technical terms related to roof.**

Definition of roof

A roof is defined as the uppermost part of a building which is constructed in the form of a frame work to give protection to the building against rain, wind, heat, snow frost etc.

Roof is having two components:

1 Structural members (supporting frame work may be trusses, portals slab, domes etc)

2 Roof coverings(May be AC, Sheets, GI, Shingles, Slatret)

A good roof increase the life of the building and also affords protection to the building and its contents against deterioration. A roof, therefore, must be designed and constructed to meet the requirements of climates and the covering materials available.

Requirements of a good roof:

The design and choice of roof is also as important as its foundation. The former protects the building from the damaging forces starting from its top and the latter takes its care from the likely damages at its bottom. Following are the requirements of a well planned roof.

1 It should be durable against the adverse effects of various agencies such as wind, rain, sun, etc.

2 It should grant the desirable insulation against sound and heat.

3 It should be structurally stable and sound and it should be capable of taking the loads likely to come over it.

4 It should be well-drained.

5 It should have efficient water-proofing arrangement.

6 It should be fire resistant.

Classification of roof according to the shapes

The roofs in general are classified into the following types:

1 Pitched or sloping roofs.

2 Flat roofs or terrace roofs

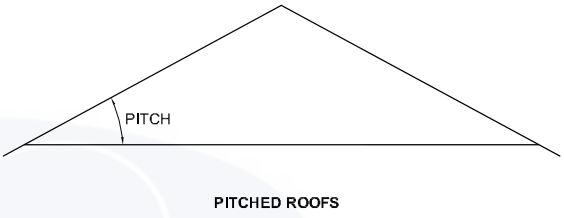
3 Shell roofs or curved roofs, and

4 Domes

The inclination of sides of a roof to the horizontal plane is known as pitch and can be expressed in terms of degrees or ratio.

The name refers to the angle formed. So it is sloped roofs or pitched roofs. (Fig 1)

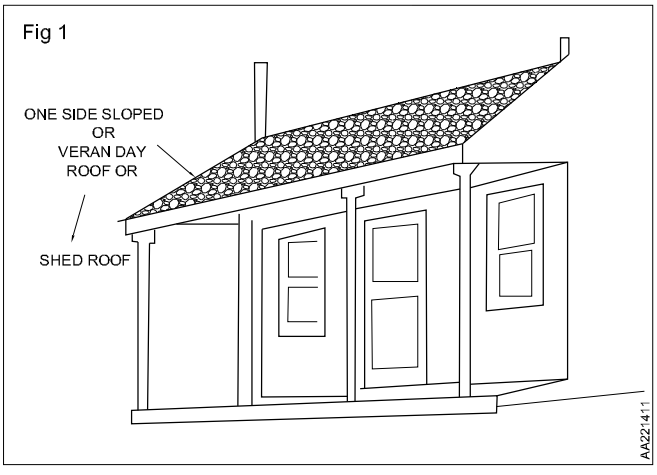
Fig 1A



Classification of roof according to the shape, forms of roof and also technical terms illustrated

1 Shed roof or lean to roof : This is the simplest type of roof or which slopes only in one direction is also called lean to roof or one side sloped or verandah roof. (Fig 2)

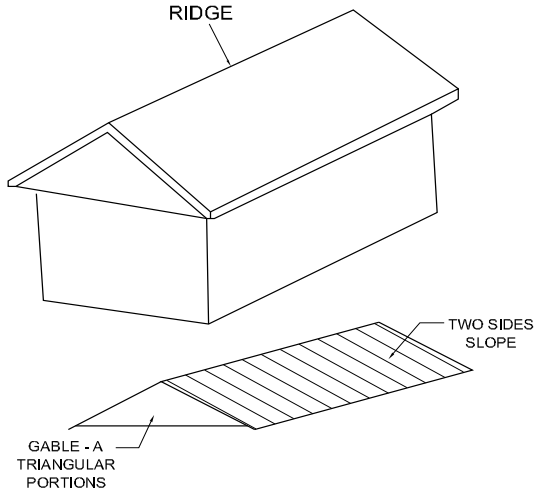
Fig 1



2 Gable roof : This roof slopes in two directions so that the end formed by intersection of slopes is vertical triangle. (Fig 3)

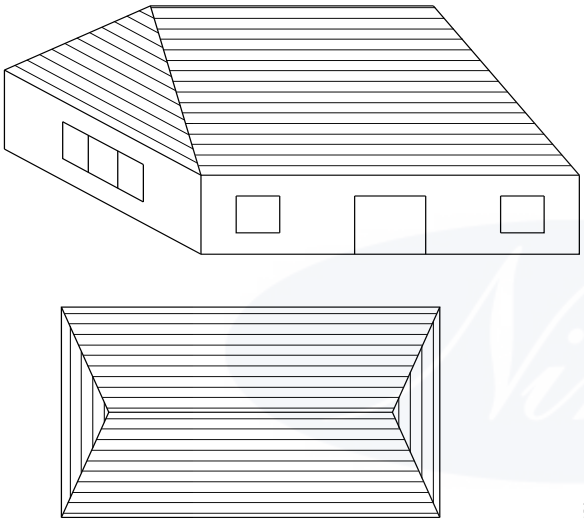
3 Hip roof : This roof slopes in four directions such that the end formed by intersection or slopes is a sloped triangle. (Fig 4)

Fig 2



BOX GABLE ROOF

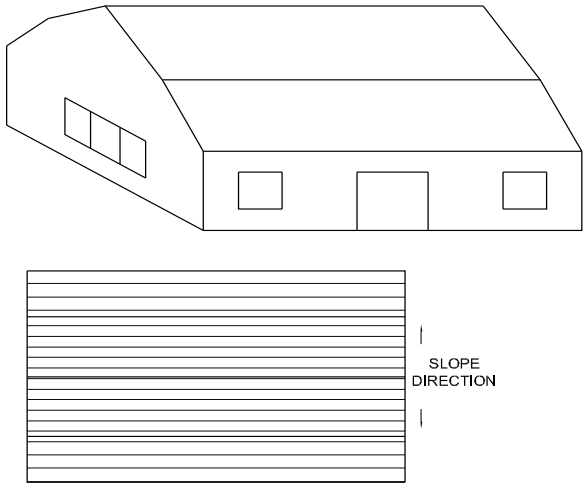
Fig 2A



HIP ROOF

4 Gambrel roof : This roof, like gable roof, slopes in two directions but there is a break in the slope on each side. (Fig 5)

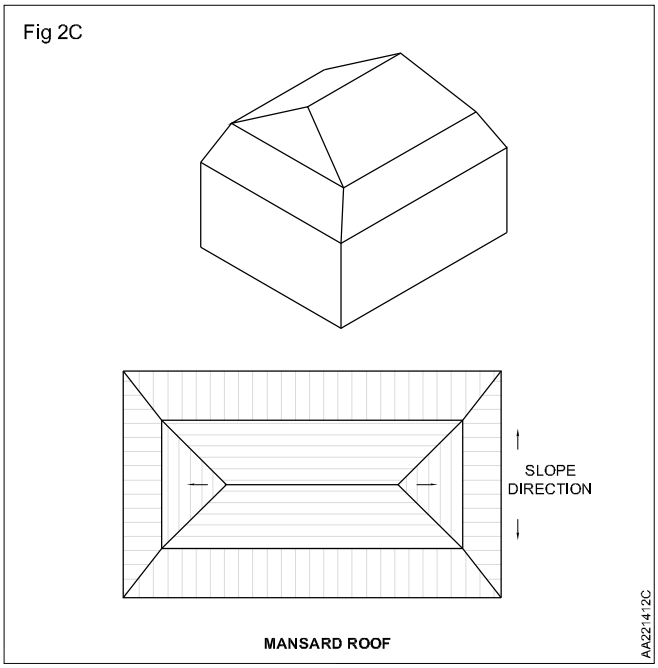
Fig 2B



GAMBREL ROOF

5 Mansard roof : This roof, like hip roof, slopes in four directions but there is a break in each slope and it is also called as curb roof. (Fig 6)

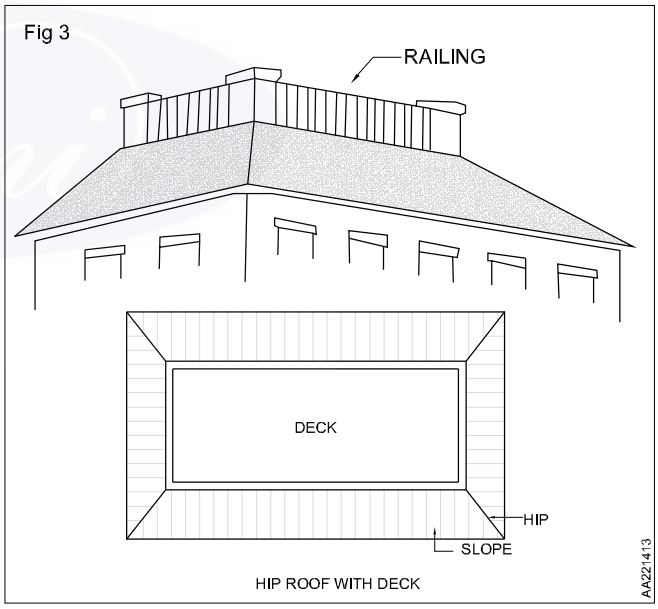
Fig 2C



MANSARD ROOF

6 Deck roof : This roof, like hip roof, also slopes in four directions but forms deck at the top. (Fig 7)

Fig 3



HIP ROOF WITH DECK

7 Hexagonal roof : This roof is like hip root but sloping in 6 directions. (Hexagonal) form. It is also called GAZEBO roof. (Fig 8)

8 A roof which is nearly flat (ie. angle to the horizontal less than 10^0) is known as flat roof. (Fig 9)

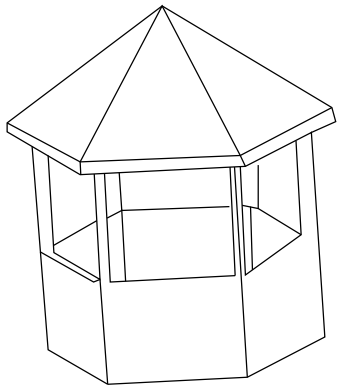
Technical terms - in pitched roof

1 Ridge : It is the apex line of sloping roof.

2 Ridge piece or Ridge beam or Ridge board

This is a wooden piece or board which runs horizontally at the apex. (The highest point in the roof)

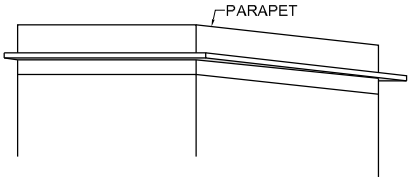
Fig 4



HEXAGONAL GAZEBO ROOF

AA221414

Fig 5



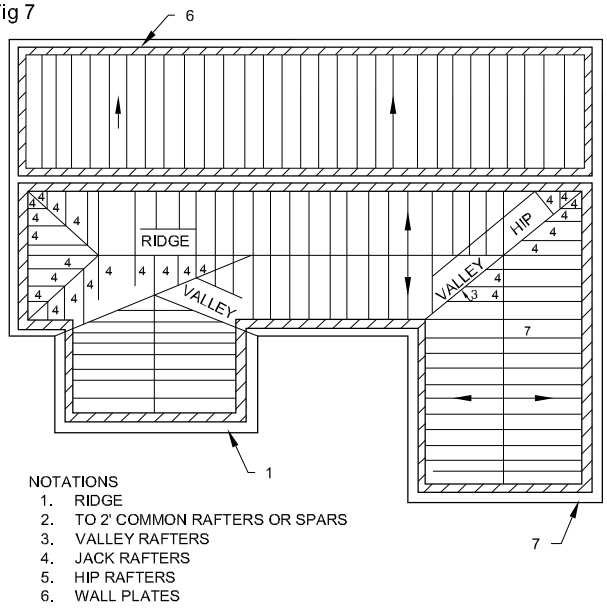
AA221415

Common rafters or spars

These are the inclined wooden members supporting the battens or boarding to support roof coverings. They run from a ridge to the eaves. They are normally spaced at 30 to 45 cm centre-to-centre, depending upon the roof covering material.

3 Vally rafter : These are sloping rafters which run diagonally from ridge to the eaves for supporting valley gutters. They receive the ends of the purlins and ends of jack rafters on both sides. (Fig 10)

Fig 7



NOTATIONS
1. RIDGE
2. TO 2' COMMON RAFTERS OR SPARS
3. VALLEY RAFTERS
4. JACK RAFTERS
5. HIP RAFTERS
6. WALL PLATES
7. EAVES BOARD

AA221417

4 Jack rafter : These are common rafters shorter in length which run from a hip to the eaves or from a ridge to a valley. A hip or valley is formed by the meeting of jack rafters.

5 Hip rafter : These are the wooden members which form the hip of a pitched roof. These rafters run diagonally from the ridge to the corners of the walls to support roof covering. They receive the ends of purlins and ends of jack rafters.

6 Wall plate : These are the long wooden members which are embedded from sides and bottom in masonry on top of walls almost at the centres of their thickness. This is essential to connect the walls to the roof. The feet of the common rafters are fixed to the wall plates by means of the simple nothing and nails.

7 Eaves-board or Facia board : This is a wooden board fixed to the feet of the common rafters at eaves. The ends of the lower-most roof covering material rest upon it. The eaves-gutter can also be secured against it. Normally, eaves board is 15 to 20 cm wide and 20 to 25 mm thick.

8 Hip : It is the line produced when two roof surfaces intersect to form an external angle which is more than 180 degrees and hipped end is a portion of roof between two hips.

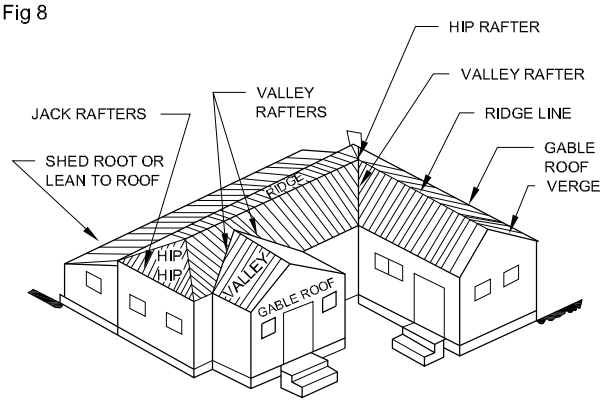
9 Valley : A valley is the reverse of a hip. It is formed by the intersection of two roof surfaces having an external angle which is less than 180 degrees.

10 Valley rafters : These are sloping rafters which run diagonally from ridge to the eaves for supporting valley gutters. They receive the ends of the purlins and ends of jack rafters on both sides.

11 Ridge : It is the apex line of a sloping roof.

12 Pitch of roof : It is the inclination of sides of a roof to the horizontal plane. The pitch of the roof is usually expressed in one of the two ways, either as ratio of the rise to the span, or in degrees. The former method is more common. (Fig 11)

Fig 8



VIEW OF A BUILDING WITH BASIC SLOPING ROOFS AND THEIR ELEMENTS

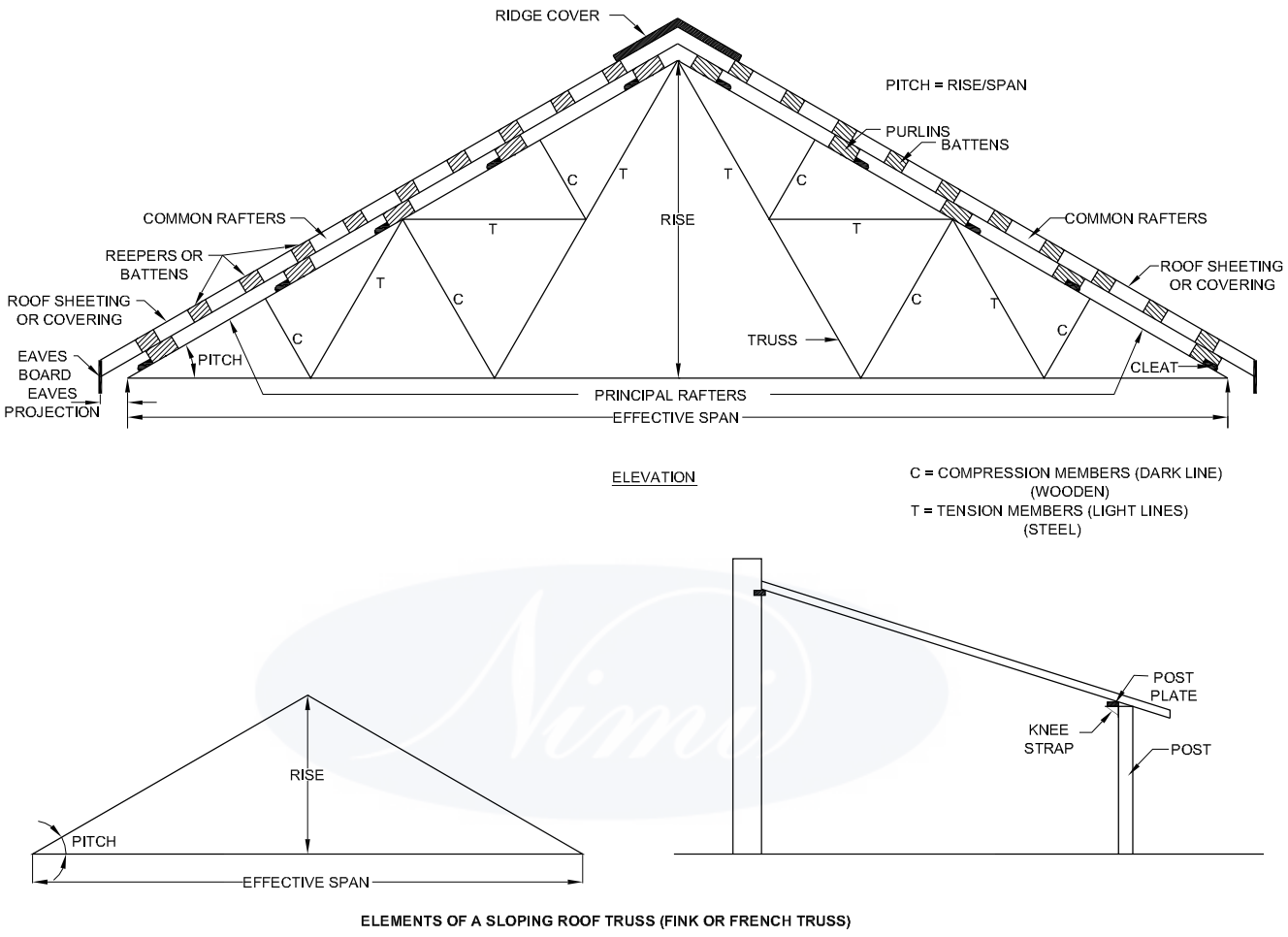
AA221418

13 Jack rafters : These are common rafters shorter in length which run from a hip to the eaves or from a ridge to a valley. A hip or valley is formed by the meeting of jack rafters.

14 Hip rafters : These are the wooden members which form the hip of a pitched roof. These rafters run diagonally from the ridge to the corners of the walls to support roof covering. They receive the ends of purlins and ends of jack rafters.

15 Gable roof : This roof slopes in two directions so that the end formed by the intersection of slopes is a vertical triangle. (Fig 12)

Fig 9



ELEMENTS OF A SLOPING ROOF TRUSS (FINK OR FRENCH TRUSS)

Sloped roof trusses

Technical terms or elements

Rise

This is the vertical height measured from the lowest to the highest points. In case of pitched roof, it is the vertical distance between the wall plate and the top of the ridge.

Span and effective span

A span or clear span is the clear horizontal distance betweem the internal faces of wall or supporters. The effective span is the horizontal distance between the internal faces of wall or supporters. The effective span is the horizontal distance between the centres of walls or supports.

Barge boards

These are wooden planks on board fixed on the gable end of a roof. They connect the ends of ridge, purlins and wall plates.

Pitch

The inclination of sides of the roof to the horizontal plane is known as pitch.

Eaves (Meaning, edges)

These are the lower edges of the inclined or pitched roof, from which the rain-water from the roof surface drops down. Normally, gutters are fixed along the eaves to collect and drain the rain water.

Boarding, sheeting or sarking

This consists of boards which are nailed to the upper edges of common rafters, and to which tiles and other roofing materials are secured.

Wall plates

These are the long wooden members which are embedded from sides and bottom in masonry on top of walls almost at the centres of their thickness. This is essential to connect the walls to the roof. The feet of the common

rafters are fixed to the wall plates by means of the simple notching and nails.

Ridge piece or Ridge beam or Ridge board

This is a wooden piece or board which runs horizontally at the apex (ie. highest point in the roof). The common rafters are fixed to this piece and are supported by it.

Post-plates or Pole-plates

These are similar to the wall plates except that they are run continuous, parallel to the face of wall, over the tops of the posts. These are used to support the common rafters at their feet and at the same time to strengthen the ends of the posts. Usually, a knee strap with bolts is provided to fix the common rafters to.

Cleats

These are small blocks of wood, or angle iron or steel, which are fixed on principle rafters of trusses to support the purlins. They are required to afford a direct support to the purlins and prevent them from sliding down.

Purlins

These are horizontal wooden or steel members laid on principal rafters on wall-to-wall to support common rafters of a roof when the span is large.

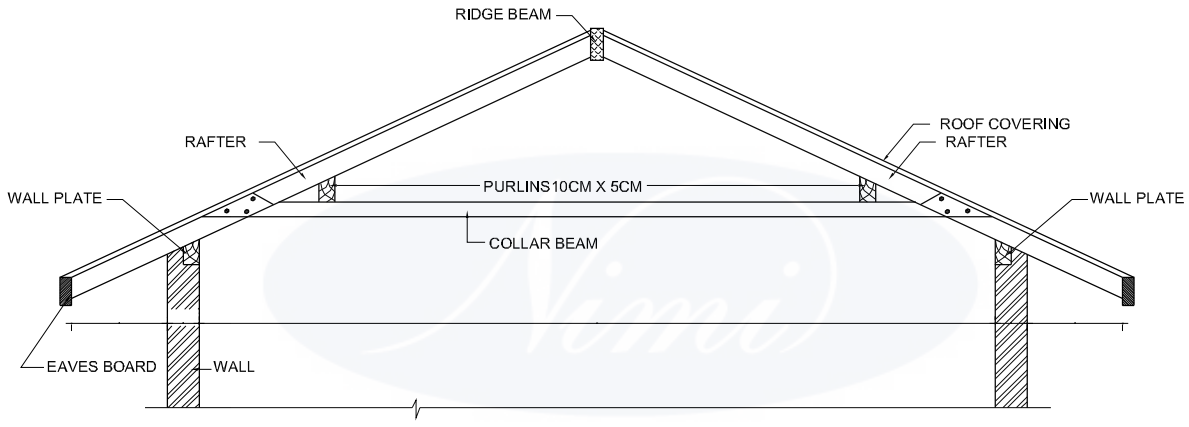
Common rafters or spars

These are the inclined wooden members supporting the battens or boarding to support roof coverings. They run from a ridge to the eaves. They are normally spaced at 30 to 45 cm centre-to-centre, depending upon the roof covering material.

Template

This is a square or rectangular block, about 10 to 15 cm thick, which is placed below a beam or a truss, so as to spread the load over a larger area. It may be made of fine-dressed flat stone, squared wood, concrete block or R.C.C block. (Fig 13)

Fig 10



ELEVATION

Battens

These are thin strips of wood ie. scanting, which are fined on the common rafters or on the top of ceiling boards to support the roofing materials like (tiles, sheets,etc.)

To study the complete aspects of the roofs, the subject matter can be grouped under the following heads for convenience.

i) Technical terms in sloping roofs and roof trusses,

ii) Pitched or Pent or Sloping roofs,

iii) Roof coverings for pitched roofs and their selection,

iv) Flat roofs or terrace roofs,

v) Shell roofs or curved roofs, and

vi) Domes.

The above roofs will now be covered under the following articles of this chapter in their serial order.

Pitched roofs or sloping roofs are classified into the 3 categories.

1) Single roofs

2) Double or purlin roofs and

3) Triple membered or framed or trussed roofs.

1) Single roofs

These roofs consist only of common rafters which are secured at the ridge and wall plates. The various forms of this type are as follws:

a) Lean-to roof or Verandah roof or Pent roof

b) Couple roof

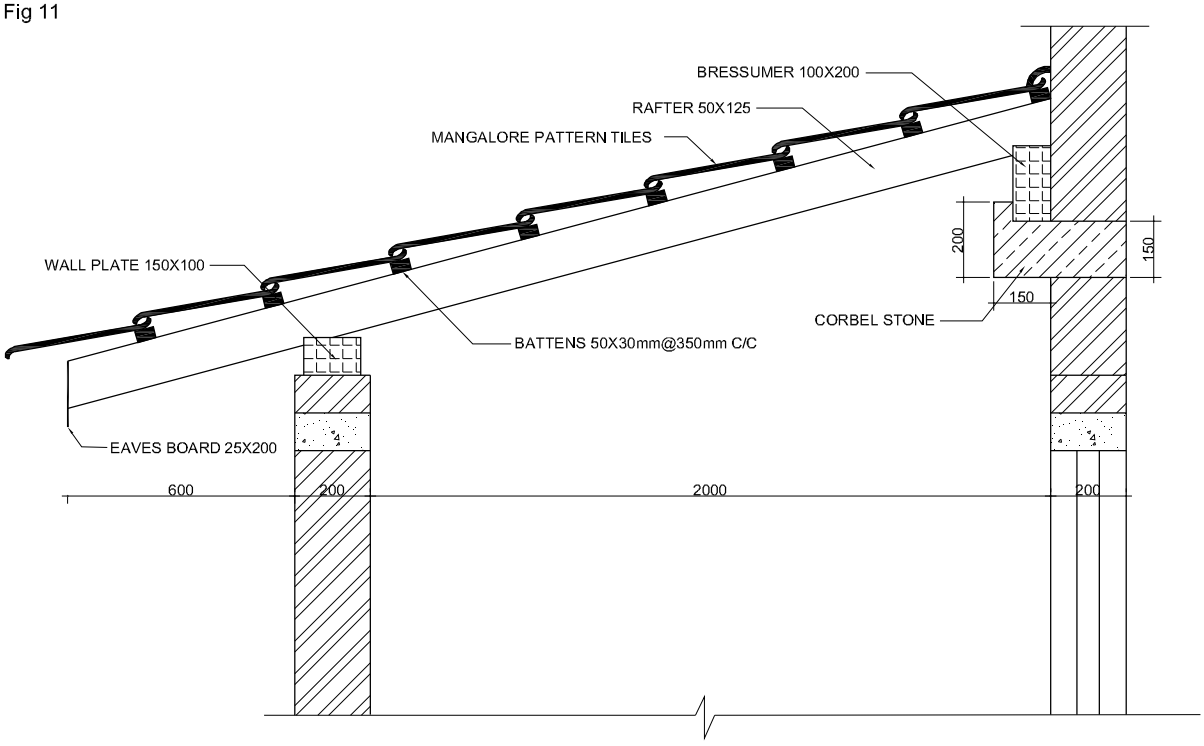
c) Couple-close roof and

d) Collar beam roof or collar tie roof.

a) Lean-to roof

This is the simplest form of pitched roof which covers the verandah of a building and projects from the main wall of the building. This consists of common rafters usually inclined at 30 degrees against a wall. This roof has been

Fig 11



LEAN-TO-ROOF

AA221421

illustrated in Fig. and is considered suitable for a maximum span of 2.5 metres.

In this type, the upper ends of the common rafters are placed on a wooden wall plate, placed on corbel which may be stone, brick or iron. The lower ends or feet of the common rafters are notched and nailed to a wooden post-plate joined to the top of posts on verandah walls.

Sometimes, the knee straps and bolts are used to connect the rafters with the posts or pillars. Eaves board, battens, roof-covering, gutter, etc. are provided as shown in Fig 15.

Lean-to roof is generally used for sheds, outhouses attached to main buildings, verandahs, etc.

b) Couple roof

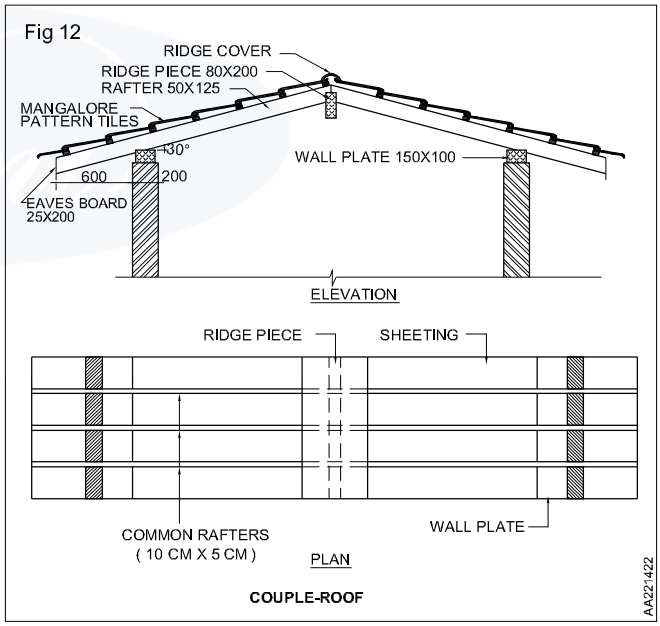
In this type of roof, each couple or pair of common rafters is made to slope upwards from the opposite walls and they are supported at the upper ends at the ridge piece or ridge board in the middle, as shown in Fig 16.

The use of this form of roof is not much favoured as it has a tendency to spread at the feet and thrust out the walls. The couple roof is, therefore, only adopted for a maximum span of 3.5 metres.

c) Couple-close roof

This type is similar to a couple roof except that the legs of the common rafters are closed by a horizontal tie known as Tie beam. This tie beam is connected at the feet of the common rafters to check their tendency of spreading outwards, and hence saves the walls from the danger of overturning. The tie may be a piece of a wood or a steel rod in tension. The connection between the tie and the feet of rafters is usually obtained by means of dovetail

Fig 12

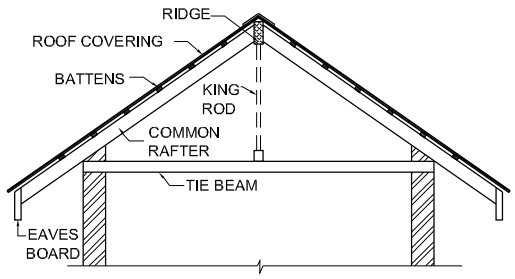


COUPLE-ROOF

AA221422

halred joint, but for inferior work, the ties are just spiked to the rafters. Under normal loading conditions, this type of roof can be used for a maximum span of 4.5 m. But for increased spans or greater loads, the rafters have a tendency to sag in the middle. To check this tendency, a couple-close roof is supported by a central vertical rod, known as king-rod or king-bolt (shown by dotted lines in Fig 17) between the ridge-piece and the centre of the tie-beam.

Fig 14



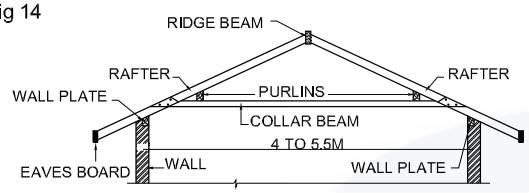
COUPLE-CLOSE ROOF (WITH KING ROD)

AA221424

d) Collar-beam roof

This is similar to the couple-close roof, except that the horizontal tie is now raised up from the feet of the rafters to almost middle of the rafters. This raised-up tie is known as collar or beam. The raising-up of tie beam checks the tendency of sagging due to further increase in span or excessive loading conditions. This collar beam roof is considered suitable for spans varying from 4 to 5.5 metres. (Fig 18)

Fig 14



COLLAR-BEAM ROOF

AA221424

Collar beam roof is also adapted to economise the space and to increase the heat of a room. It should be noted that the lower the collar position, the stronger will be the roof. The collar beam is usually fixed at 1/3 to 1/2 of the vertical height from the wall to the ridge.

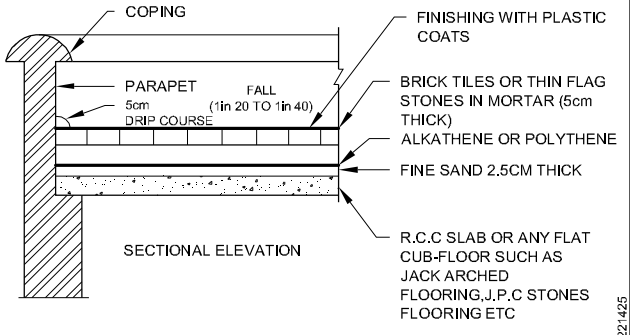
1 In case of ordinary buildings, the roof surface of concrete roofs can be finished by a cement mortar having proportions 1:4 (ie., 1 cement : 4 sand)

2 In case of R.C.C slab roof, as already mentioned, one cm thick brick-bats lime concreted (1:2:4) or brick-bats cement concrete (1:8:14) terracing is provided the rough slab. Over this concrete terracing, a suitable flooring such as C.C. tiles, terrazo, China mosaic, India patent stone, etc. is laid. In all the types of flat roofs, all corners should be rounded (ie., drip-course provided) and the surface water-proofing layer used should be carried to a height of atleast 15 cm on the surface of parapet walls and jointed there to the plaster (Refer Fig 19 also). This technique of damp-proofing is illustrated in Fig 19.

   A good fall or slope to the surface from 1 in 20 to 1 in 40, depending upon the intensity of rainfall should be given:

3 An alternative technique of damp proofing the R.C.C. flat roofs by use of plastic transparent films is illustrated in Fig.

Fig 5



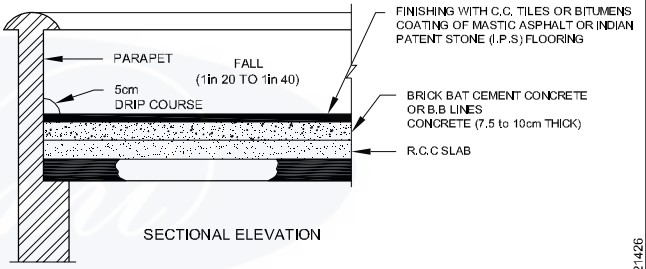
DAMP-PROOFING OF R.C.C SLAB-ROOFS

AA221425

These films of 'Alkathene or Polythene' are available in thicknesses from 100 to 700 gauge in rolls of 1.8 m width. The details of different layers provided over the R.C.C. slab for damp-proofing are shown in Fig.

4 Another technique of damp-proofing the flat roofs, made of wooden battens, R.C.C. joists or Jack arches, etc., is illustrated in Fig. The details of different layers, consisting of clay tiles, cement plaster, tar-felt, mud plasters with clayey earth in between and bitumen coats, are explained in the Fig 20.

Fig 6

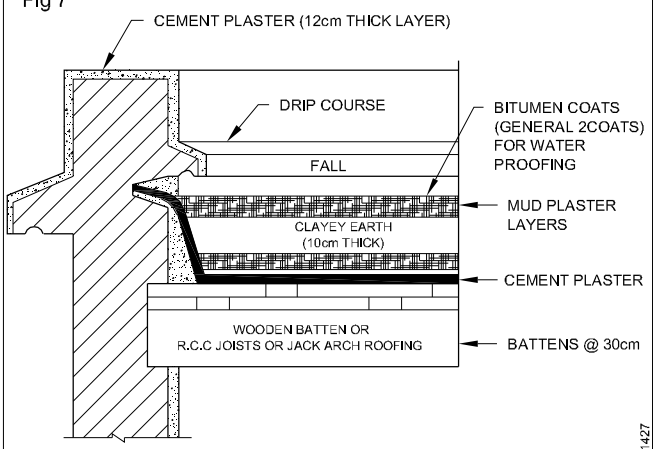


DAMP - PROOFING OF FLAT ROOFS

AA221426

5 Sometimes, a layer of hot mastic asphalt is directly laid on the R.C.C. slab and then a jute cloth is spread over this layer. Over this jute cloth, one more layer of mastic asphalt is laid so that jute cloth is sandwiched between the two layers of mastic asphalt. Sand is finally sprinkled over the entire roof surface. The lead sheets may be used at the junctions of wall and roof for better grap and water tightness.

Fig 7



DAMP - PROOFING OF FLAT ROOFS

AA221427

Draw flat roof detail

Objectives: At the end of this lesson you shall be able to
- **state the flat roof**
- **advantages and disadvantages of flat roof**
- **drainage of flat roofs**
- **RCC roofs.**

Flat roofs or terrace roofs

General introduction:

A roof which is nearly flat(ie., angle to the horizontal less than 10^{o}) is known as flat roof. It should be noted that no roof can be laid perfectly level. The flat roofs are normally laid at a slope of 1 in 2 to 1 in 6, sloping in one or more directions from centre, to drain off the rain water efficiently and smoothly.

With the advent of very reliable water-proofing and heat insulating materials, flat roof construction has replaced the pitched roofs in all types of superior constructions including the multistorey buildings. Although flat roofs have high initial cost and are difficult to construct also, but even then they are extensively adopted even in places where rainfall is heavy. The various relative advantages and disadvantages of flat or terrace roofs are stated below:

Advantages of flat roofs

1 The flat or terrace roofs can be utilised for several purposes, such as, an outdoor living room in domestic buildings, a place for celebrating functions, roof-gardens, drying yards, playgrounds, miniature golf courses, etc. A terrace roof is a great blessing in tropics.

2 The construction and maintenance of flat roofs is simpler than other types of roofs.

3 A flat roof construction provides better light, ventilation and architectural appearance to a building consistent with econonmy than the pitched roofs.

4 It is easier to make the buildings with flat roofs fire-resistant than those with pitched roofs.

5 Flat roofs possess good insulation properties. In hot climates, they keep out the heat from rooms during day time, and in cold climates they keep out cold.

6 Flat roofs require lesser area of roofing material than the pitched roofs.

7 The need of false ceilings (as used in pitched roofs) in eliminated in case of flat-roofs.

8 In case of flat roofs, the construction of upper floors can be readily taken up when desired. But, in case of pitched roofs, the entire roof has to be first dismantled and then to to be replaced by a new floor under such circumstances.

9 The flat roof is considered to be best choice for multistoreyed public buildings and apartments, due to above advantages.

10 A flat roof is proved to be overall economical than a pitched roof.

Disadvantages of flat-roofs

1 A flat roof cannot be used for long spans without the use of intermediate columns and beams

2 The flat roofs are not considered suitable at places of heavy rainfall or snowfall.

3 Due to extreme temperature variations in tropical countries like India, hair cracks are developed on the surface which cause leakage of flat roof. Moreover, the hair cracks are difficult to be traced and required in case of flat roofs.

4 The self-weight of flat roofs is comparatively heavier which makes the construction of such roofs more expensive than pitched roofs. The initial cost of flat roofs, is, otherwise, also much more than pitched roof.

5 The speed of flat-roof construction is slower than that of a pitched roof.

6 A flat roof exposes the entire building to the weather elements, whereas the projecting eaves of a pitched roof tend to protect it.

7 Proper care is needed in using construciton materials and providing slopes so as to render the roof top-surface water-tight or impervious. It should be noted that a poorly drained roof-surface leads to the leakage.

However, all the disadvantages or limitations mentioned above regarding flat roofs, which are either due to improper design or construction, can be corrected by using modern materials and advanced technology. Today, it is not at all difficult to make the roofs perfectly water-tight.

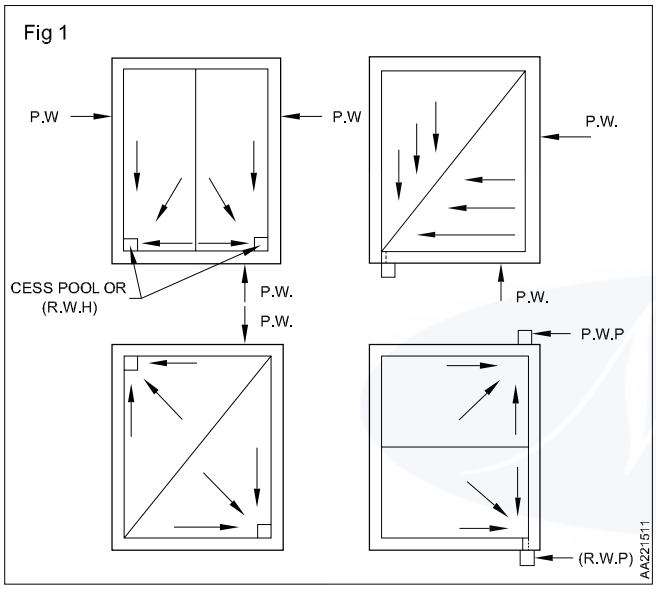
Drainage of flat roofs

It is one of the basic requirements of flat roofs that the rain water should be drained-off from roof surface easily and quickly, otherwise it will lead to leakage of roof. To achieve

water-tight roof surface, the selection of slopes and drain-outlets, depending upon the roofing materials and climatic conditions, should be made carefully.

In Fig 1 possible arrangements for drainage of flat roofs with drain-outlets (ie., rain water heads or pipes) are illustrated. The rain water pipes should preferably be spaced evenly round the building. The falls of the roof or gutters in flat roof can be arranged to one or more points depending upon the disposal requirements and their feasibility.

Normally, for porous type of flat roofs, slopes of 1 in 20 in regions of heavy rainfall and 1 in 36 in comparatively dry regions are provided, where the roofs are made of R.C.C. or Reinforced brick slabs duly water proofed or with a layer of bitumen or tar with 75 cm of earth on top a slope of 1 in 40 and 1 in 60 respectively are found satisfactory.



Reinforced concrete brick

Flat roofs

These R.C.C or R.B flat roofs are constructed in a similar way as R.C.C. or R.B floors except that they are required to be protect against weather element like rain, snow, heat etc.

A protective covering, consisting of 10 cm thick layer of lime concrete terracing with some waterproofing compound, is provided over the R.C.C or R.B. slab. This layer makes the roof leak-proof. The layer of lime concrete is thoroughly beaten by hand beaters to make it hard, impervious and compact. At the junciton of wall, the L.C terracing is taken inside the wall for a depth of 10-15 cm and the corner is given a round smooth finish. This is done to prevent the accumulation and leakage of water at junctions. The construction details are illustrated in Fig.

The lime terracing is provided with a little slope, usually 1 in 60 to 1 in 100, to drain off the rain water rapidly and easily.

Damp-proofing of flat roofs

The various methods of DPC or treatments in roofs is also called as WPC (Water Proofing Course) of treatment.

The following points should be noted regarding damp proofing of most commonly used in R.C.C flat roofs.

Draw fixing detail of AC sheets and corrogated sheets

Objectives: At the end of this lesson you shall be able to
- **state the types of roof, roof covering**
- **explain about AC sheets and corrogated sheets**
- **explain the AC sheets and also laying of AC-sheets.**

There are several types of roof-coverings, but only those which are commonly adopted in India for pitched roofs are given below:

1 Thatch covering

2 Shingles

3 Tiles

4 Asbestos-cement sheets

The above roof coverings will now be described in the following pages in their serial order:

1 Thatch covering

This form of covering is extensively used in sheds, low-cost houses and village buildings. It is considered suitable for rural areas because it forms the cheapest and the tightest material as a roof covering. Moreover, it is simple to construct and keeps the building cool. Thatch covering made from straw or reed is used. The life of thatch roof is not more than 15 to 20.

2 Shingles

The use of wood shingles as a roof covering is generally restricted to hilly areas where wood is easily and cheaply available in abundance.

Wood shingles are nothing but the sawn or split thin pieces of wood resembling slates or tiles. These sawn shingles, which are obtained from the well seasoned timber, are dipped in creosote to impart preservative qualities. To form continuous roof covering, wood shingles are laid in a similar manner as slates and tiles, described later. Shingle strips are driven on rafters and shingles are nailed on their top.

3 Tiles

The use of tiles is one of the oldest methods of roof covering. The tiles are named according to their shape and pattern, and they are manufactured in the similar manner as bricks. The clay tiles are of various types, such as flat tiles, pan tiles, pot tiles or half round country tiles and patent tiles such as Mangalore, Allahabad tiles, Sialkot tiles (ie., corrugated tiles). Sometimes, cement concrete tiles have also been used but their use is limited on accound of high cost and the difficulties in their manufacture. Clay tiles have been widely used as a roof covering for residential buildings because of the following advantages.

The method of laying or fixing clay tile is given below:

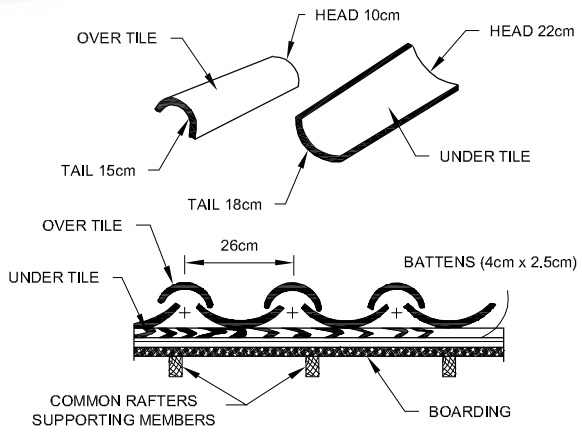
i) Flat or plain tiles

Before laying or fixing any roof covering, a certain amount of ground work is required to be donw. For this, the common rafters are laid usually at a spacing of 20 to 30 cm and then battens or reepers are fixed across the rafters at a spacing of about 6 cm. The tiles are finally laid over this with sufficient overlap on sides and edges as shown in Fig 1.

ii) Pot tiles or half-round country tiles

These tiles are laid on a ground work consisting of boarding or closely drived battens (size 5 cm x 1 cm). A layer of felt or matting can be provided on this before laying the tiles. These tiles are very commonly used for rural houses as they offer a very cheap roof-covering. Further economy is achieved by replacing battens in ground work by split bamboos. Method of fixing these tiles is illustrated in Fig 1.

Fig 1



These tiles are laid in pairs of under tiles (ie., concave upwards) and overtiles (ie., convex upwards) with a proper overlap of atleast 8 cm on all arranged that the corrugations of tiles fit in or interlock with those of other tiles, etc. These interlocking tiles, which are machine-made, provide a lighter roof covering with a decent appearance. Moreover, these tiles are available in different forms and designs in India.

In ordinary works, the ground work for these tiles consists of battens only. In superior type of construction, the tiles are laid on boardings, covered with a protective coat of tar

or felt. Boarding is directly nailed to the purlin and tiles are on battens nailed on the boarding as shown in Fig.

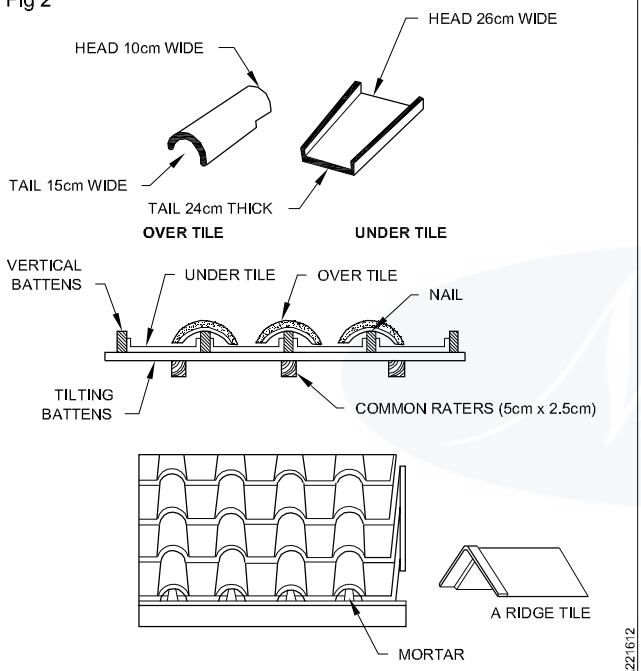
For ridges and hips, the tiles moulded into special shapes are used. They are laid dry and finally pointed with cement mortar. But the valleys are formed with the aid of lead flashing laid over boarding.

If, there is a possibility of tiles to be blown away by strong wind action, then lowermost row (ie., at eaves) should be screwed down to the battens, or secured by wires through holes drilled in them.

iii) Patent tiles or Interlocking tiles or corrugated tiles

These tiles are generally rectangular in plan, with surface corrugations so tiles are finally laid over this with sufficient overlap on sides and edges as shown in Fig 2.

Fig 2



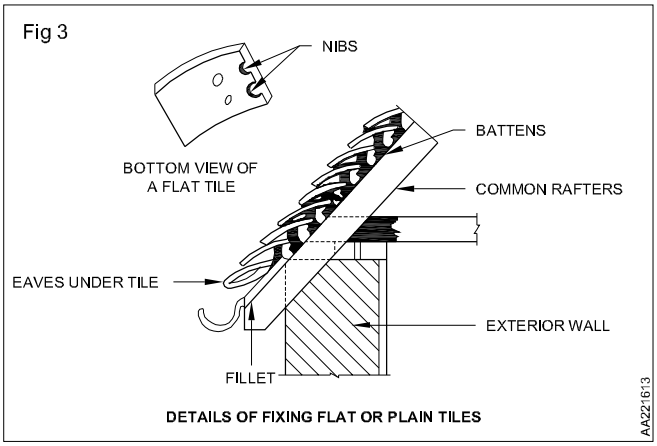
Flat or plain tiles are manufactured in rectangular shapes (size, 25x15 cm to 28x18 cm) in thicknesses varying from 9 to 15 mm. Tiles are not perfectly flat but have a slight camber, usually 5 to 10 mm. These tiles have two small projecting nibs and two or more nail holes at one end of their surface. These nibs and holes help to fix the tiles on the battens of the roof truss. The tiles should be laid at proper gauge and overlap, both at sides and edges, as it is important for their strength, durability and imperviousness. (Fig 3)

Special tiles are made for the under course at eaves, top course at the ridges, for hips and for valleys, to avoid cutting. Flat tiles, ceiling tiles or boarding may be used below the top covering of tiles for keeping out cold and heat.

iv) Curved pan-tiles

These tiles are shorter, less curved, heavier, stronger and more durable than the pot-tiles. These tiles are moulded

Fig 3

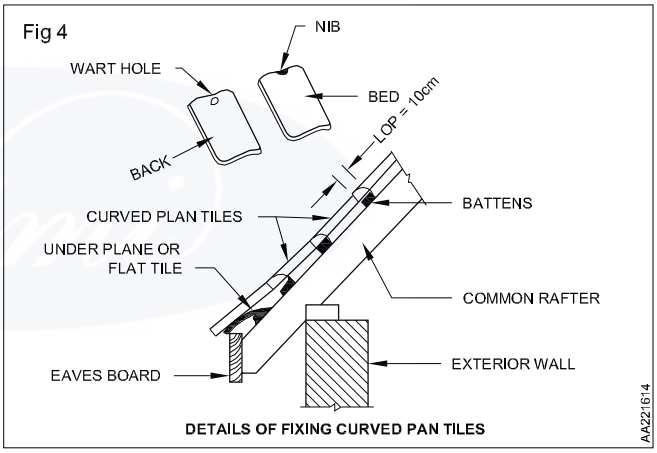


DETAILS OF FIXING FLAT OR PLAIN TILES

flat first and then the required curvature is given. These tiles may be made of clay or of asbestos cement. These tiles are about 30 to 35 cm long and are about 20 to 25 cm wide.

The curved pan tiles are fixed over battens in a similar manner as the plain tiles. These tiles have less corrugations and are laid with laps of 15 cm less corrugations and are laid with laps of 15 cm and 10 cm at ends and at the sides respectively, as shown in Fig 4.

Fig 4



DETAILS OF FIXING CURVED PAN TILES

The last row of tiles near the eaves is laid in lime or mud mortar, and is further secured in position by an iron rod on its top, tied down to the battens below it. Lead flashing is liberally used in the formation of hip and valley gutters in pan tiling.

Asbestos cement sheets, ie., A.C.Sheets

Asbestos cement is a material which consist of portland cement is a material which consists of portland cement and asbestos fibres (about 15%). Roof coverings made of this material are cheap, tough, durable, watertight, fire resisting and light in weight. Asbestos cement sheets do no require any protective paint and cannot be eaten away by vermin. Almost all varieties of roof coverings are now made with asbestos cement. On account of these properties, A.C. sheets roof covering is commonly adopted for factories, workshops, offices, garages, cinemas and residential buildings. A.C. roof coverings have added advantages of low maintenance cost and high speed of construction. (Fig 5)

However, A.C. sheets roof coverings have also some draw-backs, viz., condensation in buildings when located in colder climates, low heat insulation and low aesthetic values.

Asbestos-cement roof coverings are supplied in flat, corrugated and ribbed sheets in various sizes. Ribbed sections are available with ribs at a spacing of 30 or 40 cm. The A.C. Sheets are fixed at a very low cost as they can be cut, nailed, sawn or screwed easily where desired.

A.C. sheets are obtained in the following three types, but in various lengths from 1 to 3 metres, rising in 15 cm increments:

i) Everite big six corrugated A.C.sheets,

ii) Everite standard A.C.sheets, and

iii) Turnall trafford A.C.tiles.

The particulars of these three tiles are given in Table 1.

TABLE 1

Particulars of Asbestos Cement Sheets

Types of A.C.sheets	Standard length in	Laid width (m)	Thickness (mm)	Side laps (cm)	No.of corrugati-ons	Pitch (cm)	Depth (cm)
(i) Everite big six	1 to 3 m in	1.05 m	6 mm	5 cm or 1/2	7 1/2	13 cm	5.5 cm
(ii) Everite standard	1 to 3 m	1.05 m	6 mm	10 cm or 1 1/2	10 1/2	5.5 cm	2.5 cm
(iii)Turnall trafford	1.2 to 3 m in 15 cm	1.09 m	6 mm	10 cm or 1 corrugation	'4' but then with alternate flat portions	34 cm	5.0 cm

Fig 5

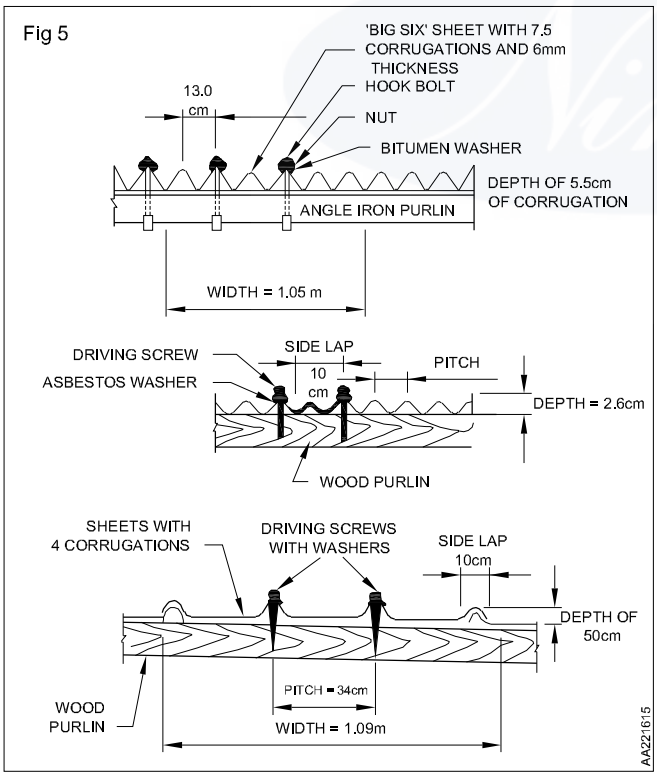
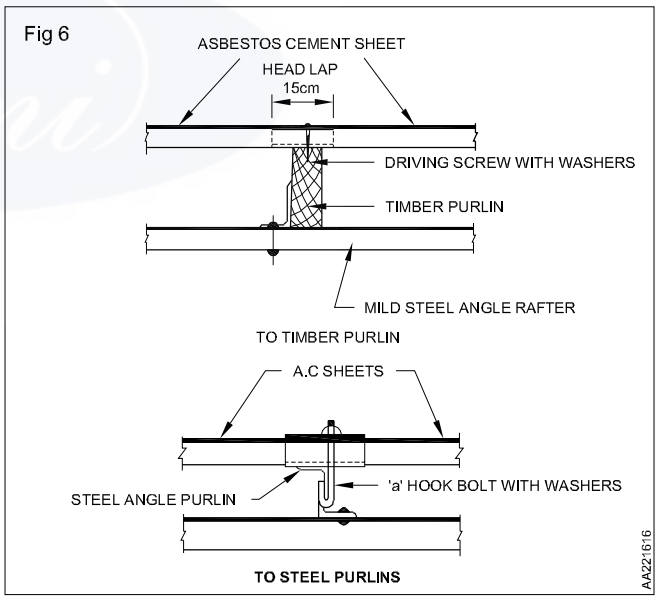


Fig 6



Fixing of AC sheets to purlins

The following points should be considered while fixing the A.C sheets:

i) The end of the A.C.sheets marked as 'Top' should be laid pointing towards the ridge. (Fig 6)

ii) A.C.sheets are usually laid with an end lap 15 cm, but this value may be slightly changed to suit the purlin spacing. If roof slopes are less than 21 1/2 degrees then the lap value should be increased accordingly.

iii) The side laps for 'Big six', 'Trafford' and 'Standard' types are kept 1/2 corrugations respectively. This side lap varies from 5 cm to about 12 cm.

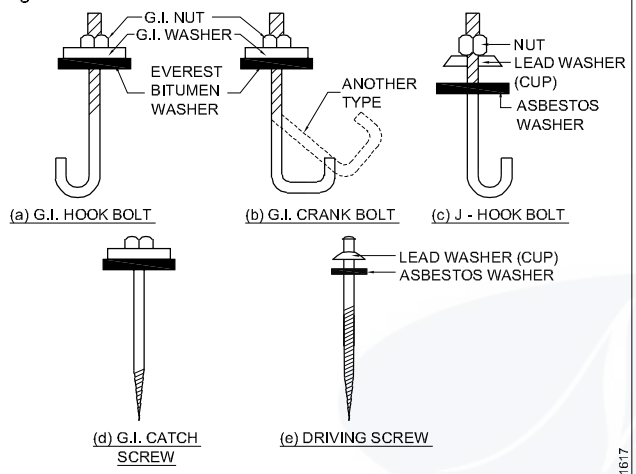
iv) The holes for fixing the screws or bolts to purlins are drilled through the tops (ie., crowns) of the corrugations with their diameter 3 mm bigger than the dia. of the screw or bolt. This provides an allowance for expansion of A.C. sheet due to temperature changes.

v) While fixing A.C.sheets the purlin spacing and length of sheets should be examined to ensure that they provide specified overhang at the eaves and proper laps as laid. The unsupported overhang at the eaves in no case should be greater than 30 cm.

vi) With the screws and bolts, the lead cupped and asbestos washers or alternatively, galvanized iron and bitumen washers are employed to ensure the water-tightness of the joints. Normally, after laying 10 or 12 A.C.sheets, the nuts of the screws or bolts are made sufficiently tight but not very tight.

vii) A.C.sheets may be laid from left to right or vice versa, but it is preferred to lay them, commencig from the end opposite to the direction of prevailing wind and rain. (Fig 7)

Fig 7



TYPICAL FORMS OF BOLTS AND SCREWS

viii) Mitring or cutting of sheets becomes necessary where four corners of the sheets are required to be joined or titted properly without gaps.

Laying of the A.C.sheets (Fig 8)

The details of laying A.C.corrugated sheets from left to right are illustrated in Fig. and described below in steps:

i) The laying of A.C. corrugated sheets is always commenced from the eaves. So, in the first row, ie., eaves course, the first sheet is laid uncut while the remaining sheets in the bottom row should have top left-hand corners cut or 'mitred'.

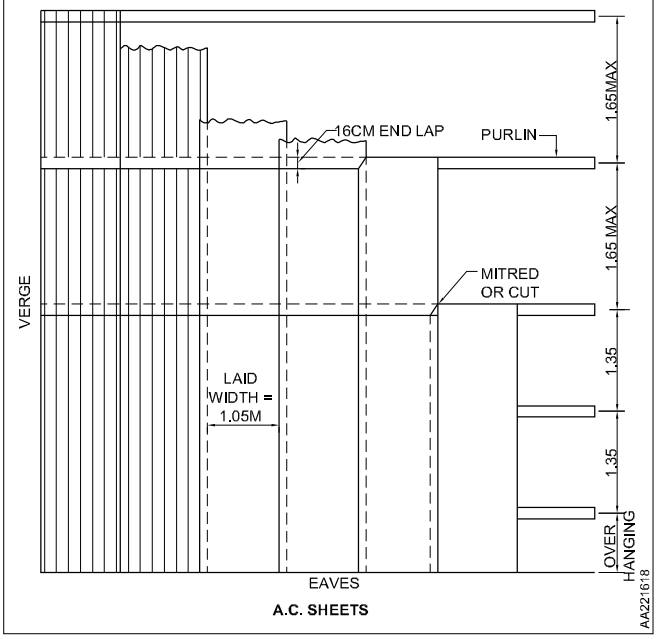
ii) While laying the second or other intermediate rows, the first sheet in each row should have bottom right-hand corner cut, while all other sheets should have both top left-hand and bottom right-hand corners cut or mitred.

iii) In laying last, ie., top-most row, all the sheets excepting the last one, should have the bottom right-hand corners cut. The last sheet is always laid uncut.

N.B.

1 Whenever the sheets are required to be laid from right to left, the whole procedure of cutting the sheets described above is reversed.

Fig 8



A.C. SHEETS

2 It should be ensured that top edges over eaves must extend by 7.5 cm beyond centre line of wood purlins or 4 cm beyond the back of steel purlins.

Recently Fibre Concrete Roofing (FCR) technology is gaining widespread attention as a low cost roofing material. FCR tiles are claimed to be less expensive, have less self-imposed weight and, in general, have less intricate quality control. FCR mix is comprised of 1 part of cement to 3 parts of sand with a fibre (15 to 25 mm) of 1 percent by weight of total mix. Only a small amount of water is required just enough to produce a plastic or workable paste. The popular roofing fibres can be classified into three main groups eg., mineral fibres of asbestos is the most popular. Vegitable fibres are easily available and are most appropriate for low-level technology production of FCR. The coir from conconut husk, stem fibre such as jute, and leaf fibre such as sisal are the most common examples of vegetable fibres which have been used with success. In general, the selection of suitable fibres should aim at avoiding fibres which are:

- Excessively stiff, oily or greasy,
- Easily impregnated by chemicals which have adverse effects on cement, eg., sugar, and
- Susceptible to large dimensional changes fro wet to dry state.

A simple test for the suitability of fibers involves chopping up a sample of the fibre and mixing it in a sand-cement mortar 100 times the weight of the fibre. The resulting concrete is allowed to set overnight. If the fibre pieces protruding from the surrounding a particular location of fibre is discoloured or powdery, the fibre is unsuitable. The main function of fibre in the concrete is to resist segregation of the fresh mix during moulding and to prevent the formation of shrinkage cracks during the initial setting and curing stages.

Draw details of king post roof truss

Objectives: At the end of this lesson you shall be able to
- **state the trusses**
- **type of truss and explain about the king**
- **post trusses and their details.**

A roof truss is frame work of triangles designed to support the roof covering or ceiling over rooms. The use of interior columns is avoided.

The roof trusses or framed structures are generally used when the span exceeds 5 metres and when there are no inside supporting walls or partitions for the purlins. The spacing of trusses depends upon the various factors, such as loads on roof, position of cross-walls, span, material or truss, etc.

The usual forms of roof trusses are as follows:

i) King post roof truss

ii) Queen-post roof truss

i) King post roof truss (Fig 1)

This wooden king-post roof truss is suitable for spans varying from 5 to 9 metres.

A king-post roof truss consists of two-principal raftes, a tie beam, a king post and two struts as shown in Fig. These roof trusses are spaced not more than 3 metres centre-to-centre and are made to rest in stone, wood or R.C.C bed blocks or bed plates. The principal rafters and prevents the walls from spreading outwards. The king-post prevents the tie-beam from sagging at its centre. These struts support centres of the principal rafters and prevent sagging.

As will be noticed from the figure, the truss derives its name from the central wooden upright called king-post. This truss has many ofter elements, viz., common rafters, cleats, purlins and pole plates as shown in Fig. Purlins are stout pieces whicha are usually placed over the joints of principal rafters and they support the common rafters. Cleats are pieces which are fixed on principal rafters to prevent the purlins from tilting. Pole plates are horizontal timber pieces which run across the tops of tie beams at their ends, or on principal rafters near their feet. The common rafters rest on the purlins, at equal distances of 30 to 45 cm; and their upper ends are supported by ridge piece, middle part by the purlins and lower ends by pole plates. The battens or reepers are nailed across the common rafters and over this frame so prepared, the roof covering is finally laid.

Details of joints between various members of king-post truss

In king-post truss, the principal rafters and the struts act as compression members whereas the tie beam and the king-post act as tension members. The common rafters and purlins are designed to carry the transverse stresses. All the connecting joints are designed accordingly to carry the intended stresses. The joints details are illustrated in Fig. and described below:

Details of joints at 'A' (ie., between the principal rafter and tie beam)

The bottom of the principal rafter is jointed to one end of the tie-beam either by a briddle joint or by an oblique mortise and tenon-joint. The joint is further strengthened by wrought iron heel strap encircline the joint or by a bolt passing through the tie-beam and principal rafter as shown in Fig.

Details of joint at 'C' (ie., between the strut and principal rafter)

The head of each strut is fixed to the principal rafter by an oblique mortise and tenon joint. This is done to prevent the strut from sliding down. The foot of each strut is also connected to the king-post by an oblique mortise and tenon joint.

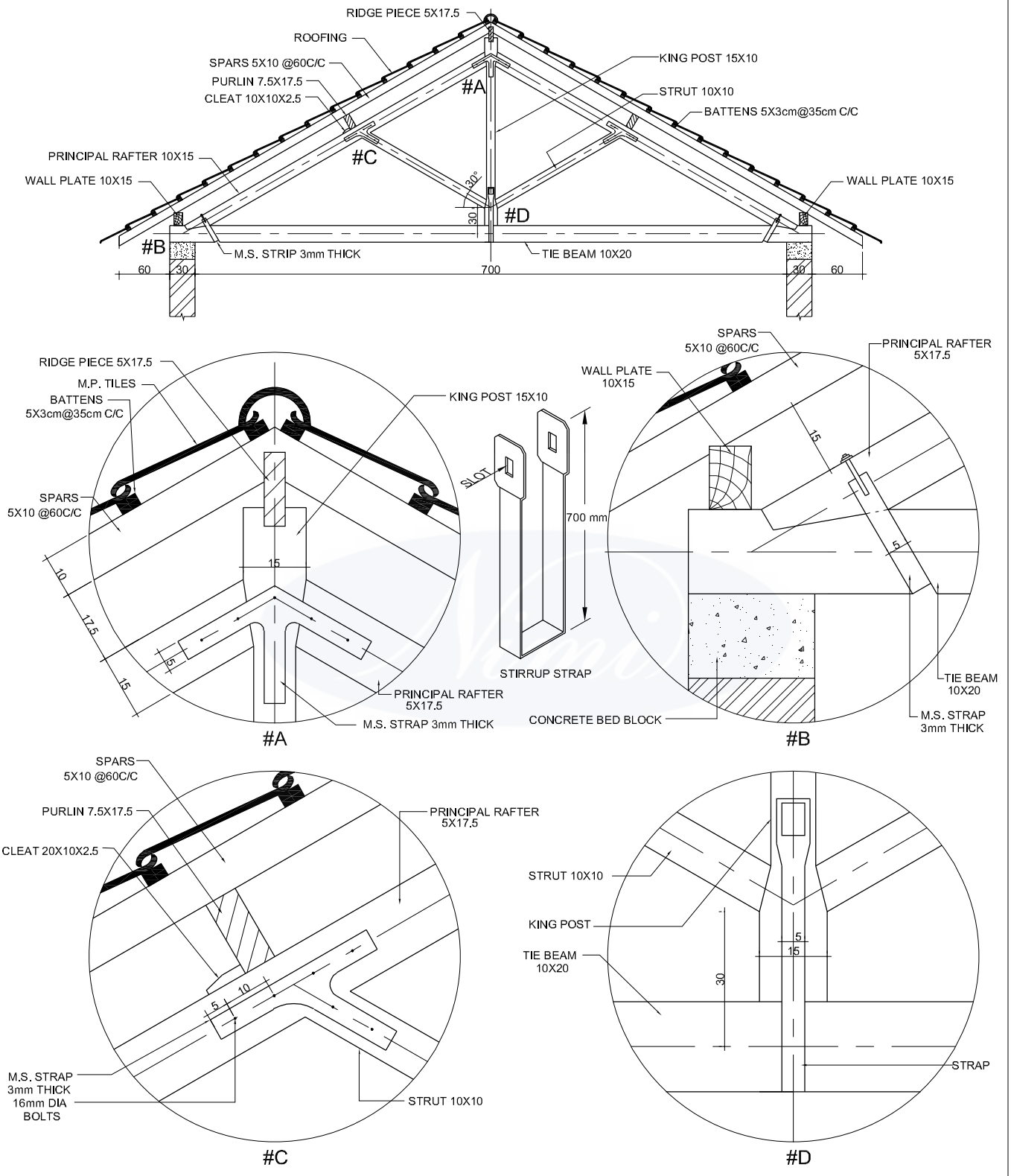
Details of joint at 'F' (ie., between king-post and tie beam)

The foot of the king-post is tenoned into the upper edge of the tie beam for a sufficient distance and is usually strengthened by a wrought iron or mild steel stirrup strap. The stirrup strap is fitted at the joint and is held in position by metal clips called gibs, and metal wedges called cotters. This joint may also be secured by a bolt or by a strap and bolts.

Details of joint at 'H' (ie., between principal rafter and king-post)

The joint between the principal rafter and the king-post is made by cutting a tenon in the principal rafter and the corresponding mortice into the head of the king-post. The joint is secured by means of a three-way wrought iron or mild steel strap on each side. The three-way straps are attached to the three pieces by means of bolts.

Fig 1



KING POST ROOF TRUSS

Draw details of queen post roof truss

Objectives: At the end of this lesson you shall be able to
- **wooden truss for varing spans**
- **state the terms and related members in the queen post roof truss and its detail at the head & foot of queen post.**

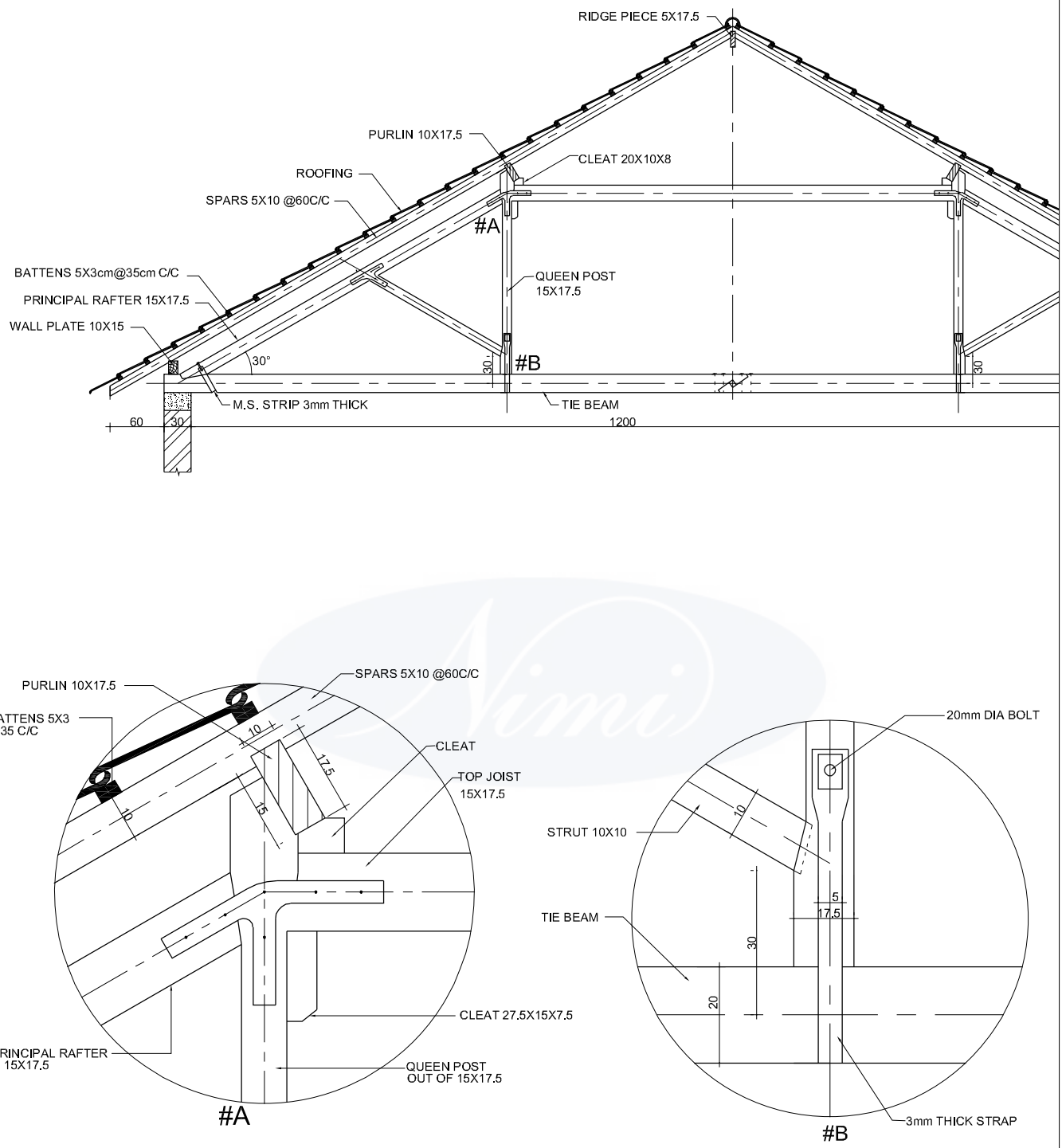
i) Queen post roof truss

The wooden queen-post roof truss is suitable for spans varying from 9 to 14 metres. This truss differs from a king-post truss in having two wooden uprights or vertical members, known as queen-posts, instead of a king-post. This truss consists of two queen posts, two principal rafters, struts, tie beam, straining beam, straining sills, purlins, cleats, etc., as shown in Fig.

The queen-posts prevent sagging in the tie beam. The upper ends of the queen-posts are kept in position by straining beam. The straining sill, which is fixed on the tie beam, between the feet of queen-posts, counteracts the thrust of struts. The principal rafters, straining beams, struts and straining sill are in compression whereas the queen-posts and the tie beam are in tension.

The joints of the queen-post trusses are made similar to those described for the king-post truss, with the exception of the joint of the queen-post. The joints at the head and the foot of the queen-post are of the mortice and tenon type. The detail of joints are shown in Fig. at head and the foot of the queen-post.

Fig 1



ALL DIMENSIONS ARE IN CMS

AA221811

QUEEN POST ROOF TRUSS

Draw details of steel roof truss

Objectives: At the end of this lesson you shall be able to
- **state the forms of steel truss**
- **explain the method of assembling**
- **state the uses of steel truss & differentiate the tumber & steel truss.**

Steel Roof Trusses

For greater span, timber trusses become heavy and uneconomical due to increase in cross - sectional area. Therefore steel roof truss can be economically used for the same span.

The steel roof truss is designed in such a way that it contains either compression or tension member and does not have any bending stress. The number and size of the members in a truss depends upon the span, slope and centre to centre distance of the truss. A truss consists of rigid but elastic members which are joined together by means of 6 mm thick gusset plates in the form of triangle. The triangle act as a beam. Generally M.S. angles, pipes and flats are used for the construction of steel roof truss. In a truss the compressive members should be short in length so as to reduce the buckling effect of the members. The number of panels in a truss are determined by the thumb rule.

n = (2/3) s

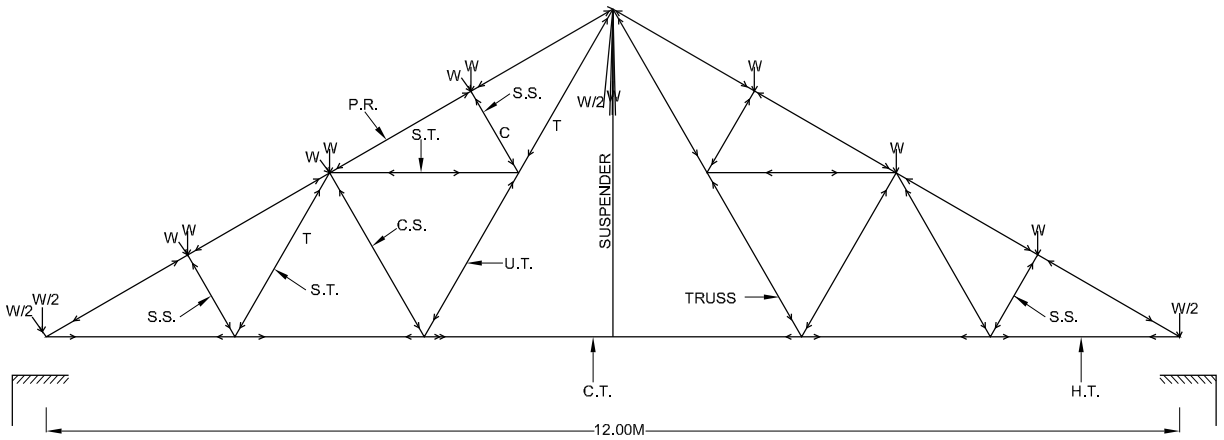
Where, n = number of panels

s = effected span of truss in metres.

Different members of the truss are connected by means of rivet, nuts, bolts, gussets, plates etc. At least two rivets should be used to connect lach member with gusset plate. The ends of the truss are made to rest on bed plates of stone or concrete and are bolted down with holding down bolts.

The steel roof truss are lighter, stronger and cheaper than wooden trusses, their life span is very large. The steel sections used are light in weight and can be connected in any desired pattern. It is also safe against white ants and other insects and moreover it is more fire resisting. They may be designed for any span. The wastage can be avoided in the fabrication of steel truss as the sections used may be obtained in any desired form and length. In building the trusses are placed at suitable interval depending upon span and type of coverings. (Fig 1)

Fig 1



ELEVATION

TENSION MEMBER	COMPRESSION MEMBER
C.T. = CENTRAL TIE	P.R. = PRINCIPAL RAFTER
H.T. = HEEL TIE	S.S. = SIDE STRUT
S.T. = SIDE TIE	C.S. = CENTRAL STRUT
U.T. = UPPER TIE	

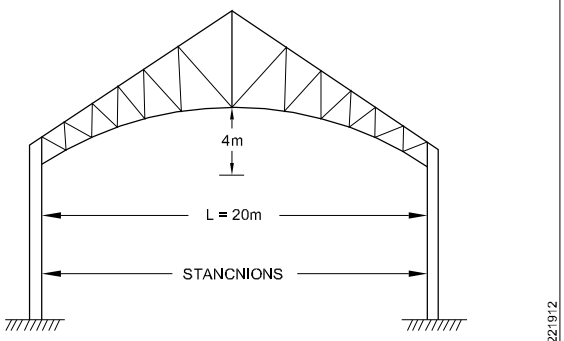
FRAME DIAGRAM (STEEL ROOF TRUSS)

AA221911

Roof covering for pitched roofs and their selection

(i) Roof covering is a material covering provided over the form work of roof structure, i.e., roof-deck, to safeguard the roof against the weather elements such as rain, sun-rays, wind action, snowfall, etc., and sometimes to give it a decorative appearance also. It should be noted that the roof covering does not share the loads in the building. It is rigidly fixed with the roof-deck by means of various types of fittings and fixtures.(Fig 2)

Fig 2



(ii) Steel truss being made of mild steel sections are free from the attack of white ants and dry rot.

(iii) Steel trusses are much stronger than timber trusses and they are equally strong in tension and compression.

(iv) These trusses have a greater resistance against fire and hence especially suited where fire-proof construction is desired.

(v) Timber trusses can only be used up to a maximum span of 14 metres or so, whereas there are no span restrictions in case of steel roof trusses. Steel roof trusses are used for structures requiring large spans such as industrial buildings, large sheds, assembly halls, hangers, auditorium, etc.

(vi) The various sections, forming a steel truss, can be easily machined and shaped in the workshop and subsequently packed and transported to site for assembling. Moreover, there is no wastage in cutting.

(vii)The erection of steel trusses from the rolled sections is very easy, rapid and economical.

The following points regarding design and construction of steel roof trusses should be noted:

(i) Steel roof trusses should be designed in such a way that all the members of a truss are either in compression or in tension and do not have any bending stress in them.

(ii) The arrangement and sizes of various members of a steel roof truss depend upon the roof slope, span, loading, wind pressure and centre-to-centre distance of the trusses.

(iii) The compression members such as struts should be as short as possible to avoid buckling and the principal rafters subjected to transverse stresses should not be longer than 3 metres maximum. The tension members should be braced together.

(iv) T-sections are best suited for use as principal rafters, whereas angle irons or channel sections are used as struts. The tension members should preferably be of a round or a flat section. The various members may be built of two or more sections, e.g., a principal rafter may be made of two angles placed side by side.

In an ideal design all the members of the structure should fail simultaneously. However, in practice, angles less than 50 x 50 x 6 mm are not used.

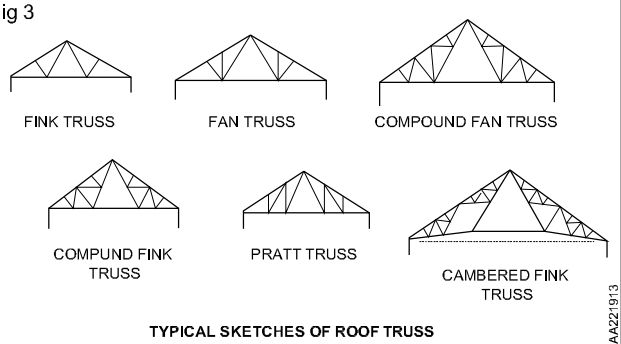
(v) Small trusses are fabricated (riveted or bolted together) at the factory or workshop and transported to the working siter whereas larger trusses are usually fabricated and assembled together at the job site owing to the difficulty of transportation. Trusses are erected by a crank gantry and connected to the building by means of rag bolts. All the mild steel roof trusses must be painted at intervals to prevent corrosion.

(vi) All the members of the truss should be arranged to form triangles so that the truss will not deform to a greater extent. Reactions at the ends of trusses are vertical for free ends and inclined for fixed ends.

(vi) The distance between the steel roof trusses should not exceed 3 metres. This distance or spacing is more for light roofs.

(viii)Three special forms of trusses, viz., North light roof truss, Bow-string truss and Arched truss are used under special circumstance or for special purposes. North light roof trusses are used for factories, workshops, etc. Where natural light and ventilation are desired. Bow string type trusses are used for very large spans. Arched truss is used for spans up to 20 metres only where it is to be erected on steel stanchions for greater heights. Usually where a tie is to be cambered, it is 1/30th to 1/40th of the span. (Fig 3)

Fig 3

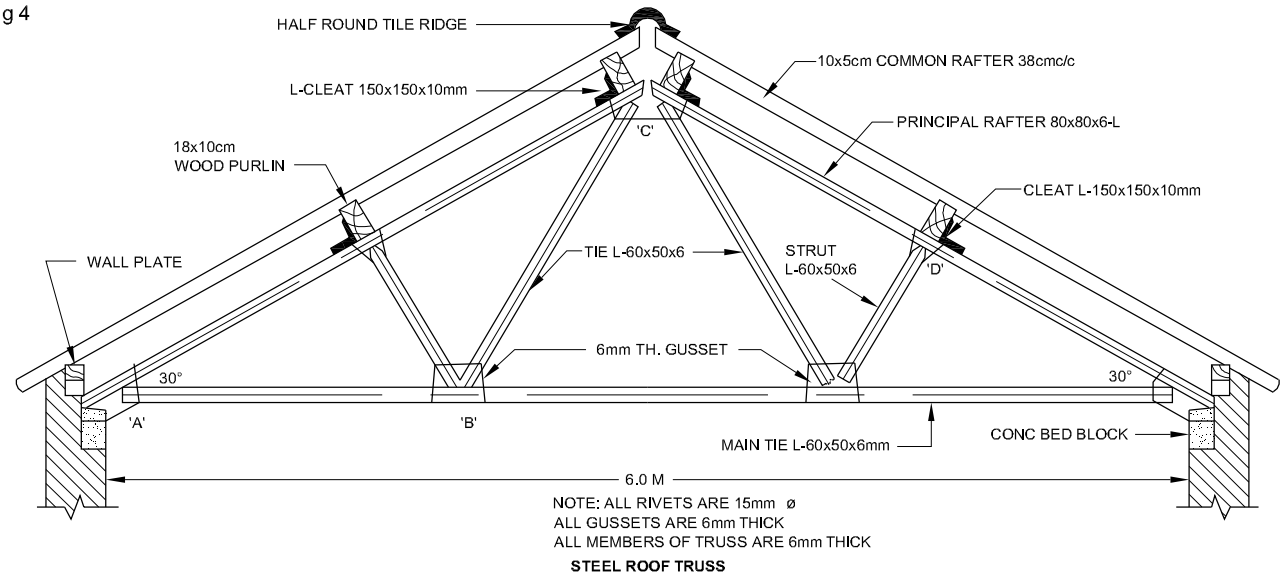


TYPICAL SKETCHES OF ROOF TRUSS

Solved problems

Question 1 : Draw elevation of steel roof truss for 6 metre span and draw detail connection of joints at A,B,C and D. (Fig 4)

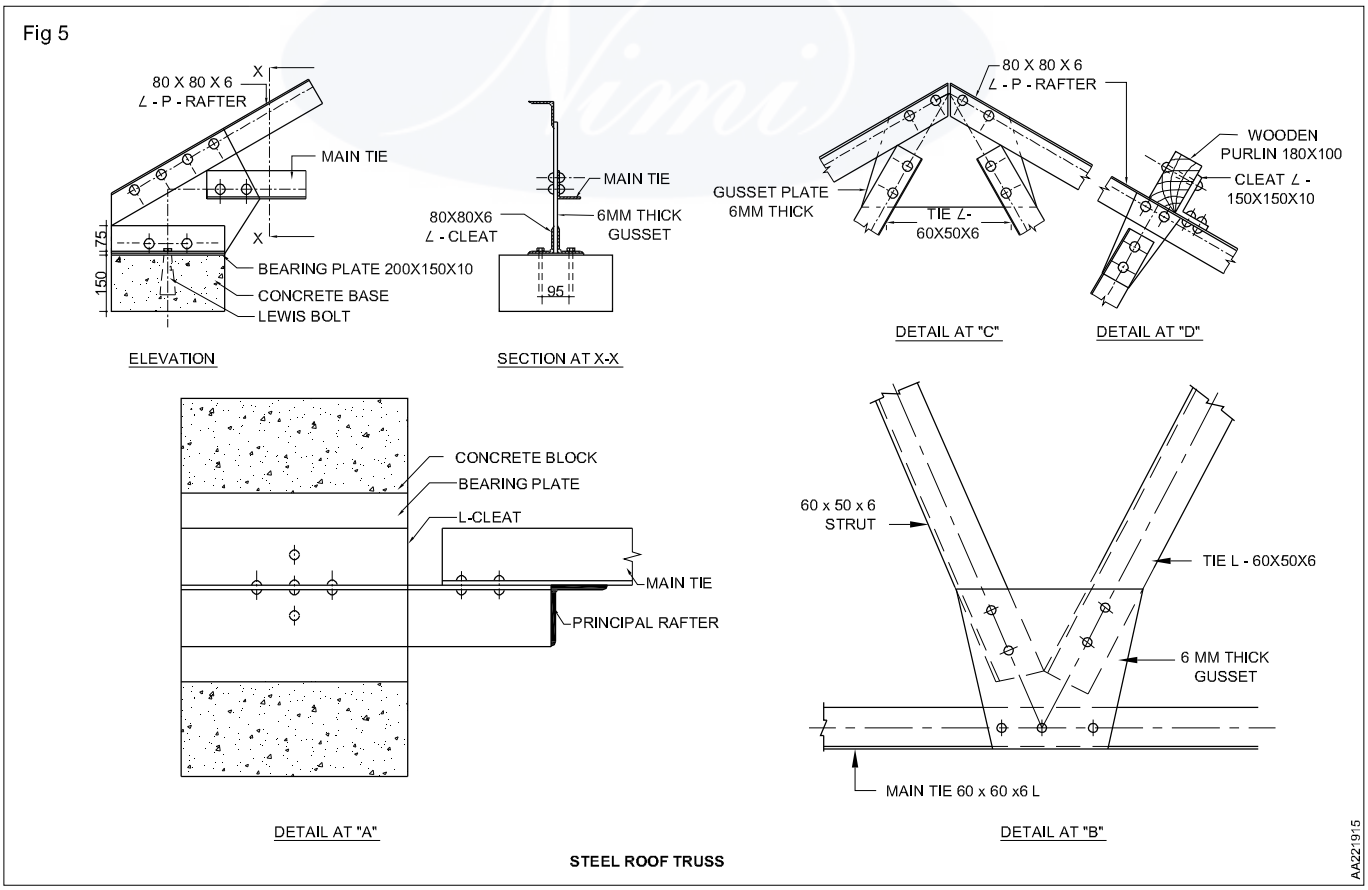
Fig 4



Dimensions are in mm where not given.

Note : All rivets are 15 mm dia, 2. All gussets are 6 mm thick, 3. All members of truss are 6 mm thick (See Fig 5)

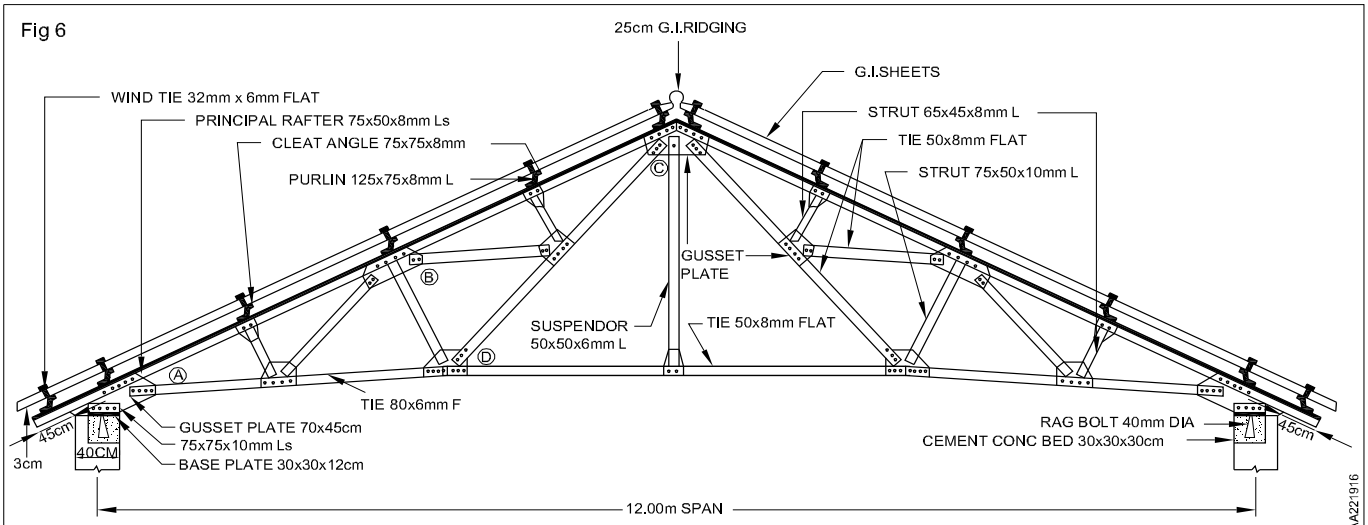
Fig 5



Steel roof truss

Question 3 : A roof truss for a span of 12.00 metres shown in the figure. Draw to suitable scale the detail of joints A,B,C and D and also show the fixing arrangement of roof covering. (Fig 6)

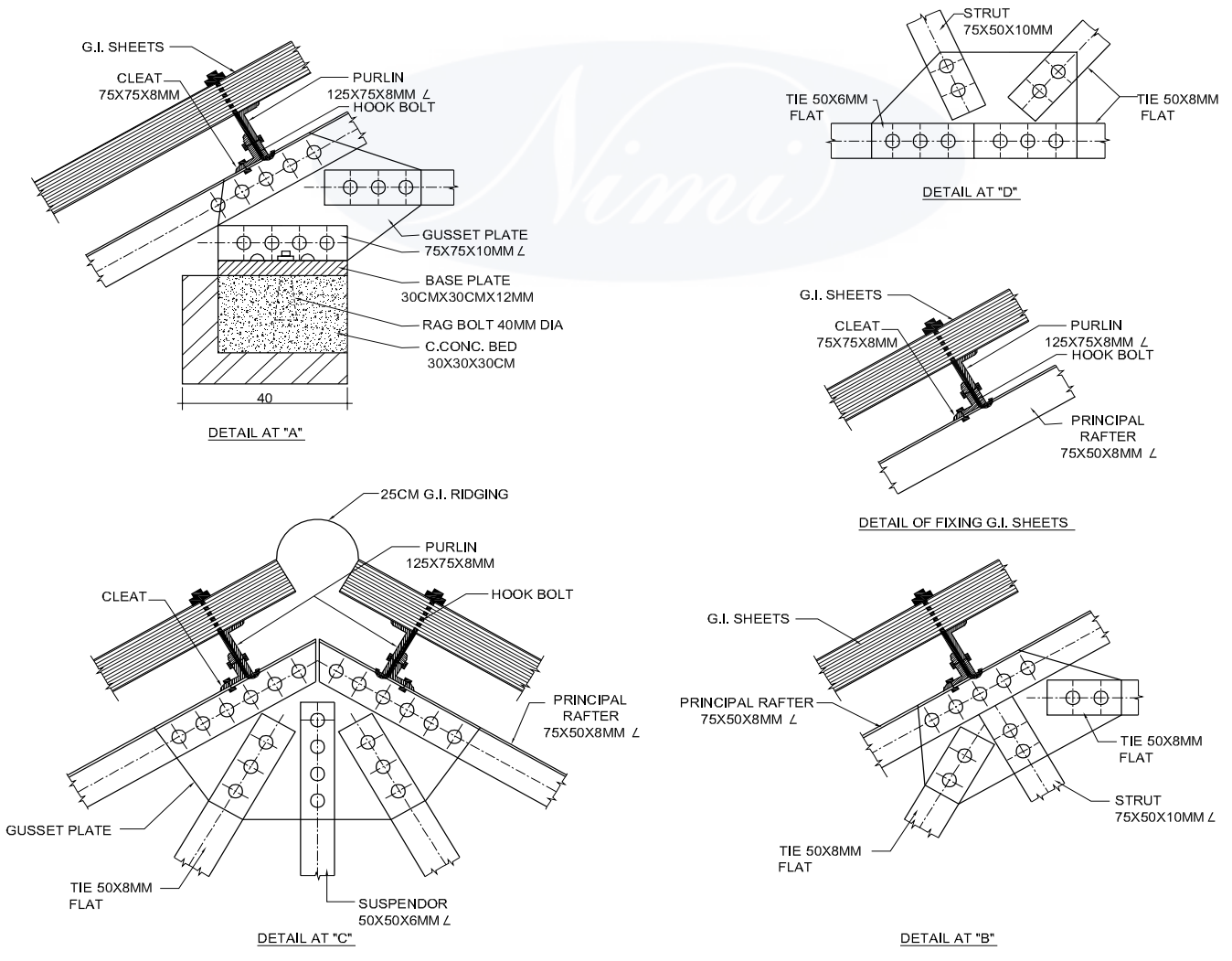
Fig 6



12M SPAN STEEL TRUSS

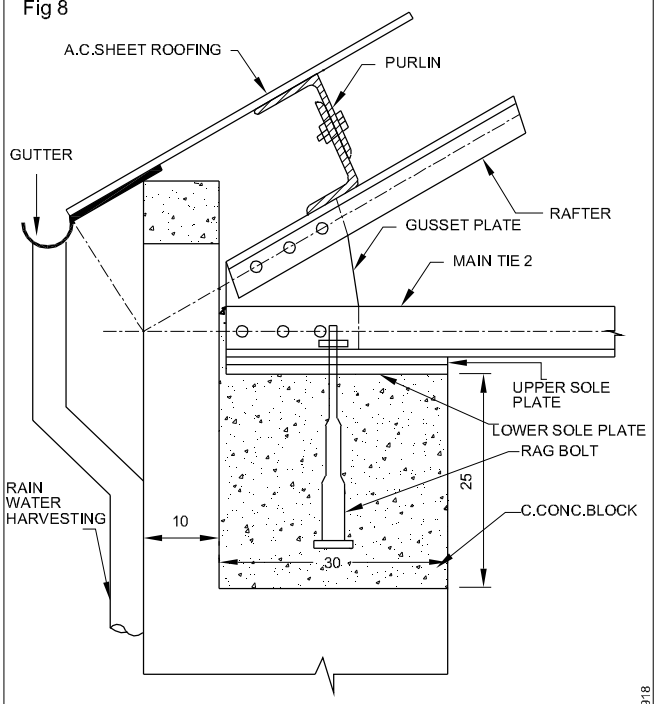
12 M Span steel truss

Fig 7



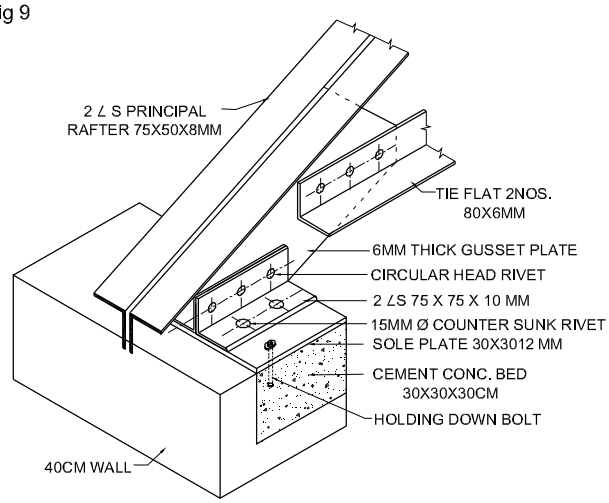
STEEL ROOF TRUSS

Fig 8



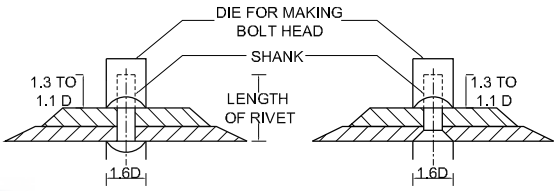
TYPICAL END DETAIL OF A TRUSS

Fig 9



DETAIL OF SHOE JOINT

Fig 10



DETAIL OF BOLT HEAD

Draw the water supply layout plan for toilet & kitchen

Objectives: At the end of this lesson you shall be able to
- **state the system of water supply**
- **explain the water supply and storage of water**
- **storage and distribution of UGR & OHT & supply to kitchen & toilet**
- **technical terms related to water supply.**

Introduction

Beside air, water is a vital component for the human existance.

The origin of all resources of water is rainfall. The water from rainfall is stored in the surface of earth as ponds, lakes, streams, rivers, etc. Ponds, lakes, streams, rivers etc. & By percolation to the earth. The underground sources of water are well, springs, deep wells, artesian etc., For our existance we tap water from different sources and supplies adequately stored by different distribution system.

Water distribution system

There are two distinct systems of supply of water to a building from the mains:

1 Direct system and

2 Indirect system.

1 Direct system

In direct system also known as upward distribution system, the supply of water is given to various floors in a building directly from the mains which has sufficient pressure to feed all the floor and water fittings at the highest part of the building.

2 Indirect system

In indirect system also known as down take supply or downfall distribution system, the water supply from the mains may be drawn either by

a) Feeding water directly into the overhead storage tank provided at roof of the building from where the water is supplied to different floors by gravity or

b) Feeding water directly into a underground water storage tank. The water from the underground tank is pumped to overhead storage tank from where the water is supplied by gravity.

Assessment of water requirements

The actual quantity of water required by an individual or a family may work out to be very small. However, when families live together forming communities, towns and cities, the requirement of water increases to a great extent. Besides domestic requirements (ie., for drinking, cooking, bathing, washing, flushing, etc.) water may be needed for air conditioning, fire fighting, civil use, institutional, commercial and industrial needs etc. In assessing the water requirement due consideration has also to be given to the local needs, people, their habits, standard of living, climatic condition, and other similar factors.

The national building code of india recommends that water requirement of 135 litres per head per day may be adopted in design of water supply system for all residential uildings provided with full flushing system for excreta disposal.

The requirements of water for buildings other than residences may be worked out from TABLE 1.

TABLE 1

Water requirements for buildings other than residences

Sl. No.	Type of building	Consumption per day (Litres)
1	Factories where bathrooms are required to be provided.	45 per head
2	Factories where no bathrooms are required to be provided.	30 Per head
3	Hospitals (including landry)	
	i) Number of beds not exceeding 100	340 per bed
	ii) Number of beds exceeding 100	450 per bed

Sl. No.	Type of building	Consumption per day (Litres)
4	Nurses homes and medical quarters	135 per head
5	Hostels	135 per head
6	Hotels	180 per bed
7	Offices	45 per head
8	Restaurants	70 per seat
9	Cinemas, concert halls and theatres	15 per seat
10	Schools	
	i) Day school	45 per head
	ii) Boarding school	135 per head
11	Railway stations	
	a) Intermediate stations	
	i) Where bathing facilities are provided	45 per head
	ii) Where no bathing facilities are provided	23 per head
	b) Junction stations	
	i) Where bathing facilities are provided	70 per head
	ii) Where no bathing facilities are provided	45 per head
12	Terminal railway station	45 per head
13	Terminal bus station	45 per head
14	International and domestic airports	70 per head

Technical terms related to water supply

Water supply system

The system of water supply consists of service pipe, the other connecting pipes, pipe fittings, control valves etc. which are connected together to supply water to a building for the use of its occupants.

Water main

Water main which is also called as street main is a water supply pipe laid by the administrative authorities like municipal committee from which the house connections are allowed by it.

Storage tank

It is a tank or cistern in which water is stored and is connected to the water main by means of supply pipe.

House plumbing

The materials and systems used for the installation, maintenance, extension, alternation of pipe system of a house or building is called house plumbing.

Plumbing system

It includes supply and distribution pipes, fixtures, taps, valves, soil, vent and waste pipes, drains, sewers and all their connections.

Available head

It is the water head available from a water main to the plinth level of the building.

Air gap

It is the unobstructed vertical distance through the free atmosphere between the lowest opening from any pipe supplying water to a tank, plumbing fixture or other device and flood level rim of the receptable in a water supply sytem.

Back flow

It is the flow of water or any other liquid in distribution pipes of water supply system from any source or sources other than its regular source.

Back syphonage

It is the flow of used water from a plumbing fixture or vessel into the supply pipe due to the lowering of pressure in supply pipe.

Residual head

It is the pressure available at the tail end of the distribution system.

Wash out valve

It is the device which is fitted at the bottom of the tank for the purpose of draining the water out for cleaning and maintenance.

Service connection

Service connection is a water connection given by the local body (municipal corporation or municipality etc.) from city water distribution mains to a consumer. The consumer may be owner of a single house, a multistoreyed apartment, a planned block development or a water district buying water wholesale. (See Fig 1)

Fig 1

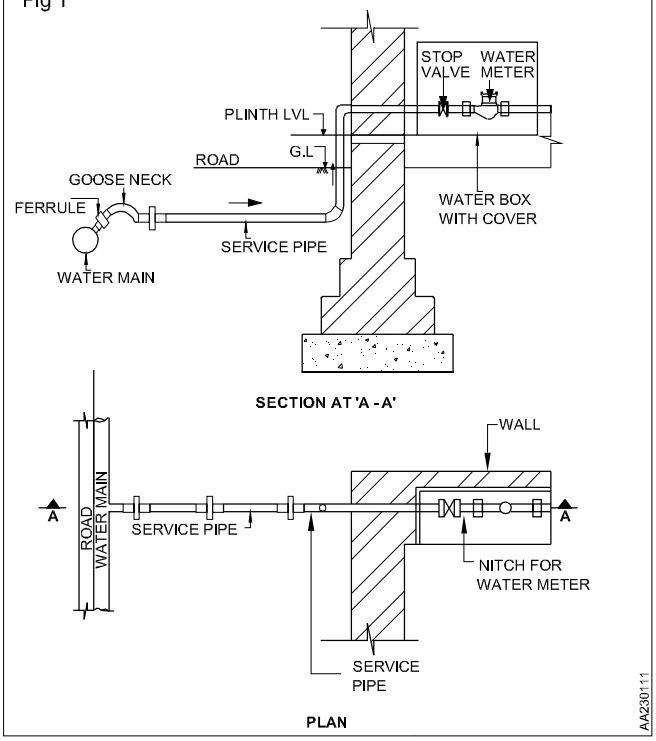
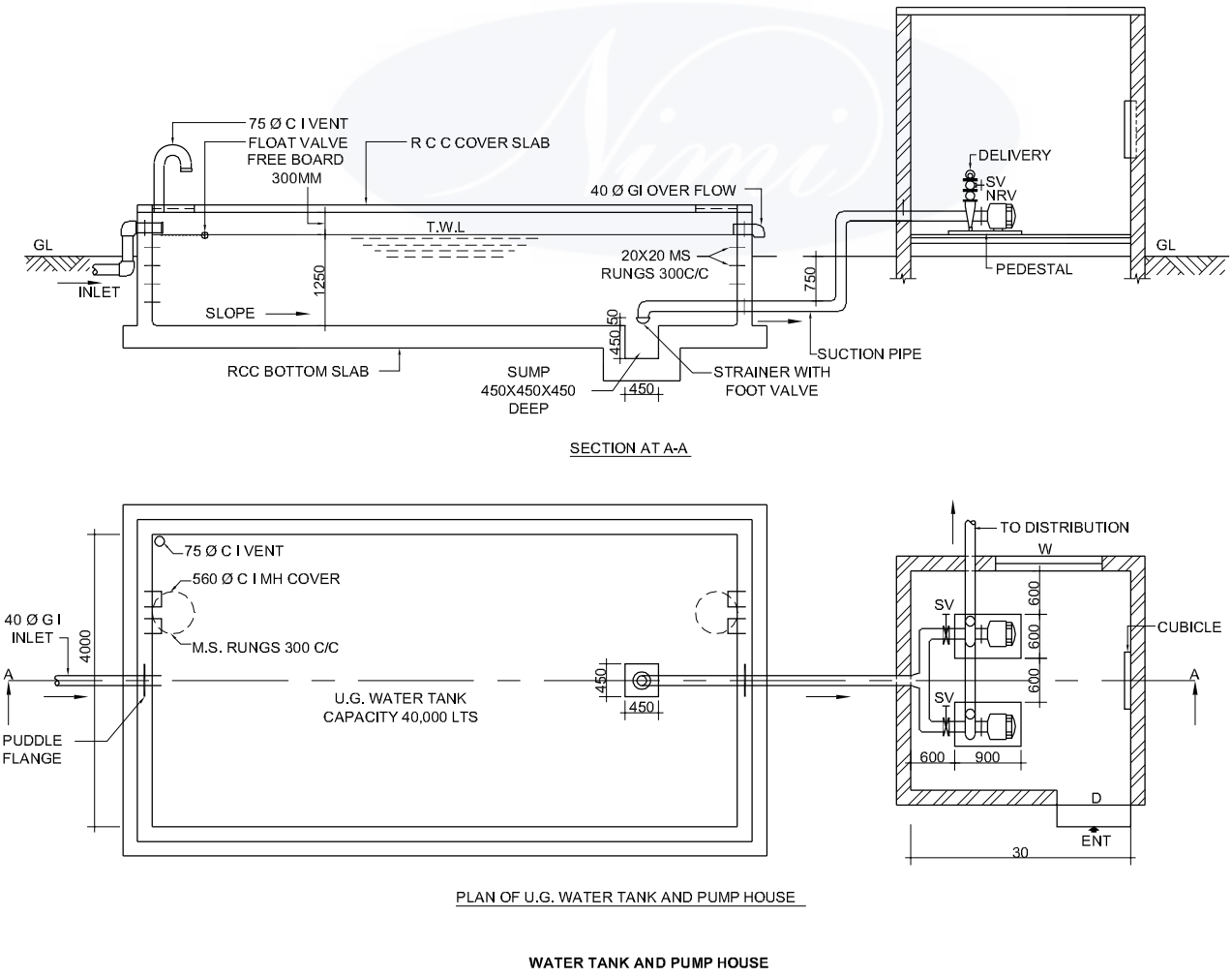


Fig 2



A domestic service connection comprise of the following components.

1 Brass or bronze ferrule

Ferrule is a special type of appliance made up of brass or bronze. It has a vertical inlet for screwing on to the water main and a horizontal outlet to be connected to service pipe. The water main which is usually under pressure is drilled and tapped and the ferrule is screwed in without shutting down the mains. The normal size of the ferrule to be used is usually half the size of the service pipe.

2 Goose neck

This is 40 to 50 cm long flexible curved pipe made up of brass, copper or lead inserted between the ferrule and the service pipe. The goose-neck is provided to accomodate the possible movement, displacement or settlement that may take place between the water main and the service pipe due to water pressure and prevent damage to the connection.

3 Stop cock

This is provided before water meter in a chamber with a cover to cut off the supply of water from the street main to the building for repairs to the plumbing system within the building. (Fig 2)

4 Water meter

Water meter is installed in a chamber provided with a cover for the purpose of measuring the quantity of water used by the consumer. The local body raises water bill to the consumer based on consumption recorded by the water meter.

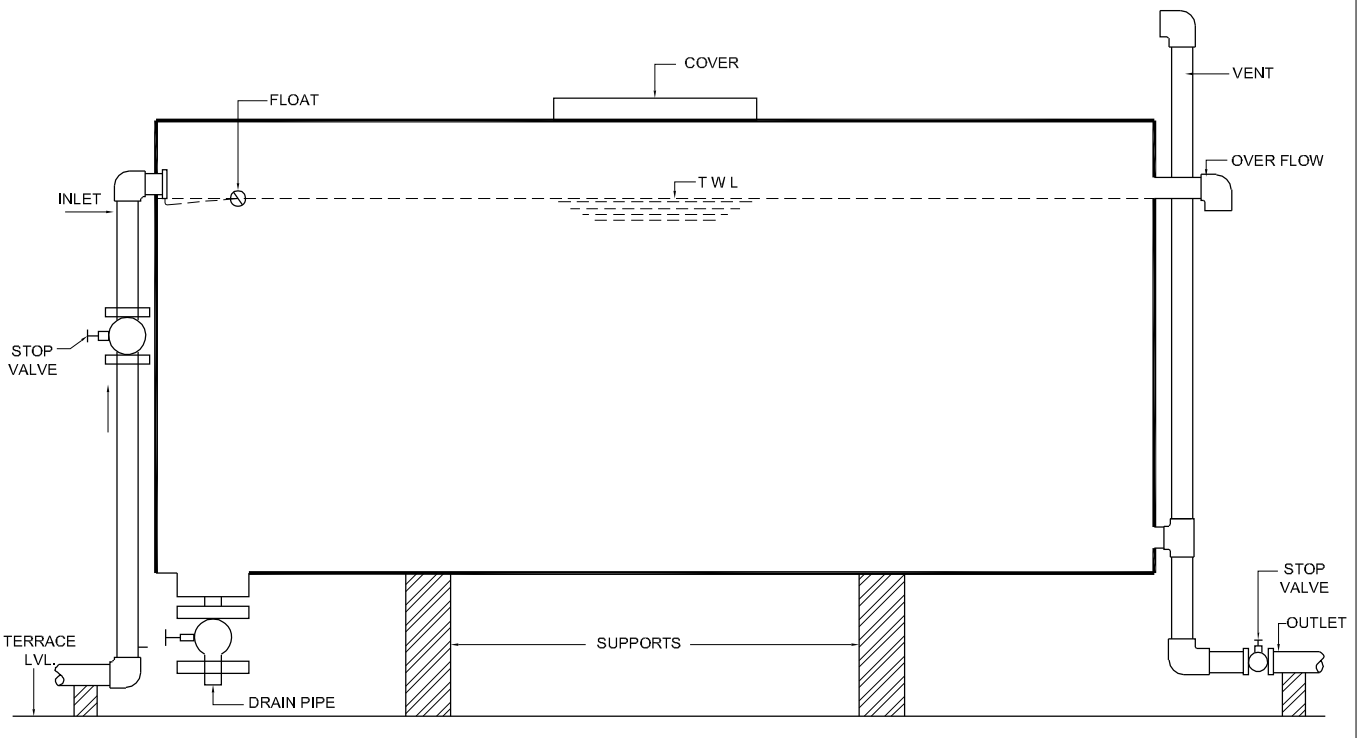
Underground tank or reservoir is a storage system with in the house for the water supply from the municipally is stored & with pump. It is stored in over head tank, & distributed to pipes & taps to the kitchen toilets & utility areas.

Storage tanks in buildings

Water supply to a building from city mains could be either continuous or intermittent. Normally due to continuously increasing demand and shortage of water, the local authority plan distribution of water in different city zones in two or three shifts (ie., morning, evening and sometimes in afternoon). Even in areas where continuous supply of water is available the pressure of water in the mains may not be adequate to raise the water to upper floors. Thus provision of storage tank is made in a building to ensure availability of water during non supply is stopped.

In case of multi-storeyed buildings besides meeting demand of water for domestic consumption, it is mandatory to make provision of adequate overhead storage of water for fire fighting requirements. As explained earlier in case the pressure in the mains is not sufficient to feed all floors directly, it becomes necessary to feed water from mains to an underground storage tank. Thereafter the water from the underground tank is pumped to overhead tank for distribution to various floors by gravity.

Fig 3



SECTION OF OVERHEAD TANK

The storage tanks can be made from brick or stone masonry, G.I.sheets, pressed m.s.plates, P.V.C or R.C.C. Normally underground tanks are made from masonry or R.C.C. Overhead flushing tanks or tanks of small capacities are made of G.I. sheets, pressed steel plates or P.V.C. Overheads tanks of large capacities are always made of R.C.C. The various accessories connected with water storage tanks are given below:

Fig 3 shows arrangement of various accessories in an overhead water storage tank.

1 Ball valve with float

This is provided at the inlet to the tank to control the flow of water in the tank and to automatically shut off the supply when correct level has been reached.

2 Inlet pipe

The pipe supplying water to the tank is termed as inlet pipe.

3 Outlet pipe

This pipe is installed at 3 to 5 cm above the floor of the tank. The pipe is always provided with a stop valve to stop supply of water to downtake pipe.

4 Overflow pipe

This pipe is provided a little above the inlet pipe to allow the incoming water to overflow in case the ball valve assembly does not function properly and it is not able to shut off the incoming supply of water. This pipe is provided with mosquito proof netting to prevent entry of mosquitoes, flies etc. into the tank.

5 Scour pipe

Also known as drain pipe is provided at the floor of the tank for cleaning the tank.

6 Cover

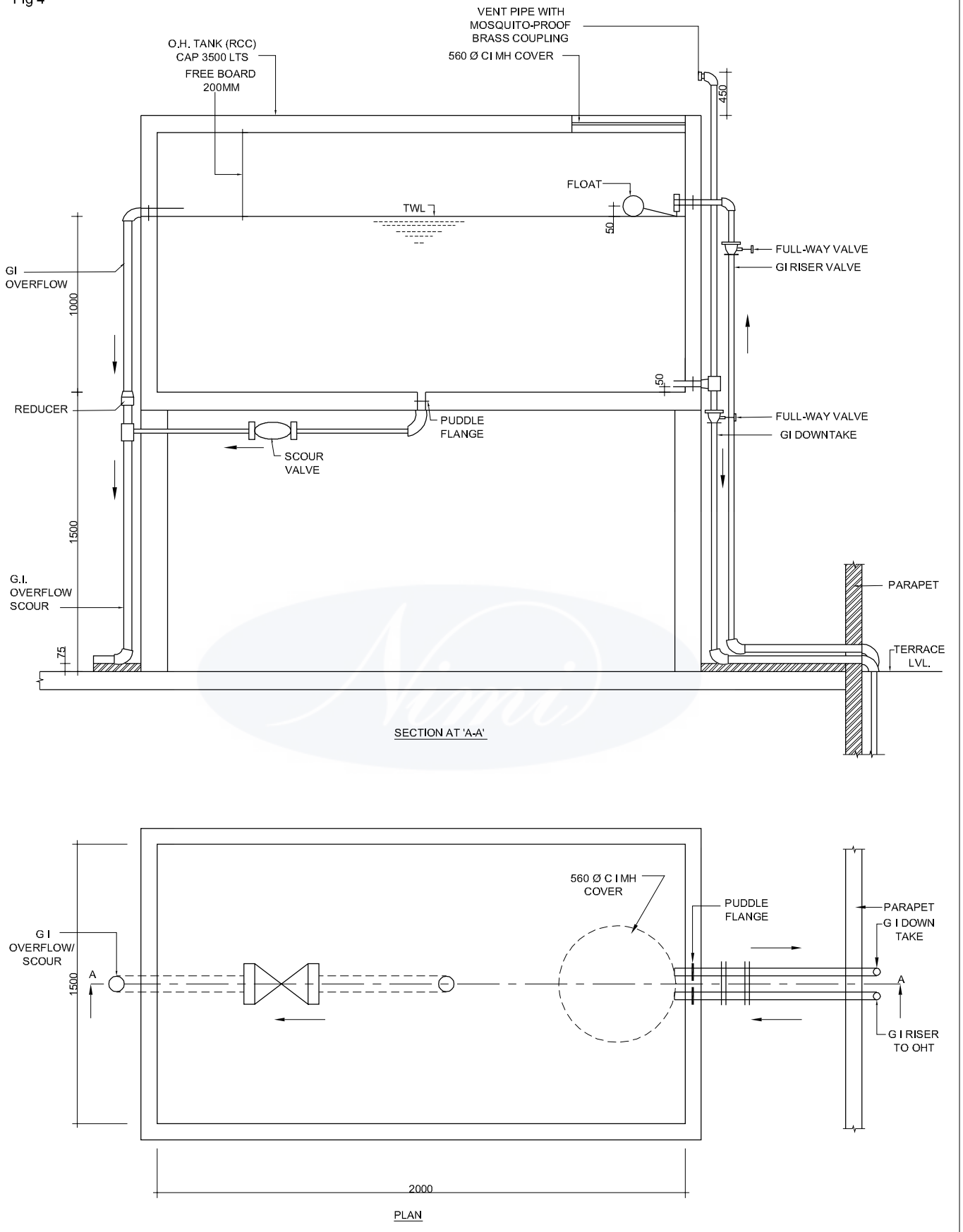
The manhole cover on the roof of the tank should be tight fitting type to prevent entry of dust, mosquitoes, etc. in the tank.

Water supply and Drainage system

Details of various pipe connections to an RCC overhead (OH) water storage tank are shown in Fig 4.

Water supply arrangement in toilet. (Fig 5)

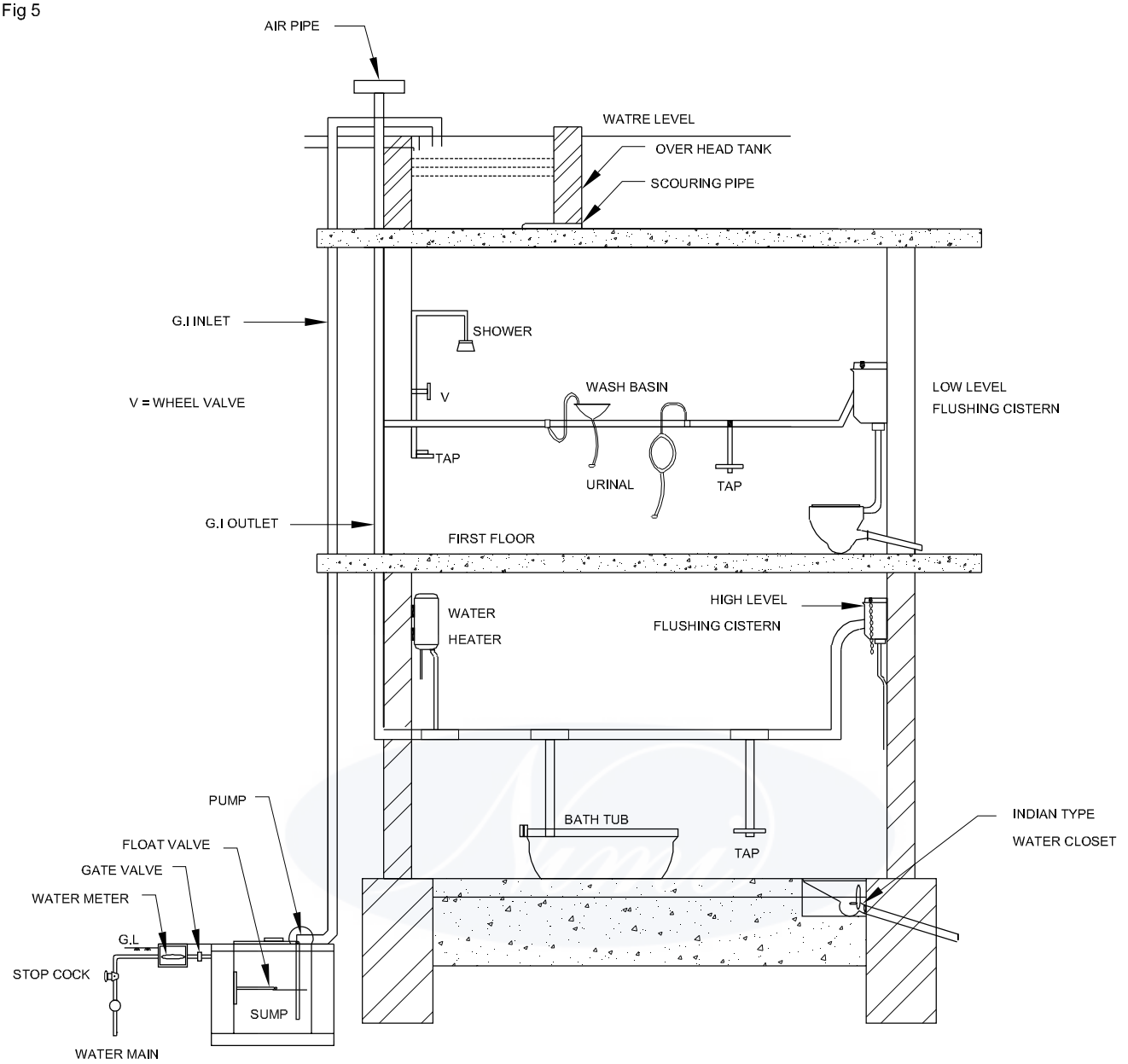
Fig 4



DETAIL SHOWING PIPE CONNECTIONS TO OVERHEAD TANK ON TERRACE

AA230114

Fig 5



WATER SUPPLY LAYOUT

Draw drainage layout plan for toilet and kitchen

Objectives: At the end of this lesson you shall be able to
- **state the system of sanitation**
- **explain method of collection of dry waste system & also house drainage**
- **water carriage system**
- **combined system**
- **technical terms related to plumbing.**

Systems of sanitation

In every town, waste materials in solid and liquid shapes are required to be disposed off in such a way that it may not effect the health of its inhabitants. The work of collection and disposal is administered by the administrative authorities of the town. Generally the disposal of waste products of a town comprises of two systems. ie., collection works and disposal works.

In the olden days, the excreta was used to carry by manual labour, but now a days due to advancement of public health engineeing, the night-soil is carried by water carriage system in underground laid sewers. Dry waste from the house is carried by means of tractor trollies and dumped outside the cities. Liquid matter collected in sewers is treated for its final disposal.

Methods of collection

The following two methods are generally employed for the collection of waste in a town or a city:

i) Conservancy system

ii) Water carriage system

i) Conservancy system

From the very ancient periods this system is being used. The waste of different types are collected separately and disposed off in a separate manner. This method now a days is out of date. It is only used in small towns and village and in the undeveloped portions of the big cities.

All the garbage or dry refuse is collected in the dust bins placed at the sides of the road. From the bins it is collected in trucks or carts once or twice in a day is taken away from the town for its disposal.

The non combustible materials are dumped into the pits or low lying areas and the combustible materials like papers leaves etc. are first burnt and then dumped. The peelings of vegetables and fruits and other such materials are first dried and then burnt and dumped.

In this system night-soil or human excreta is collected separately through human agency and is taken outside the town in closed carts, trucks or tanks or tractor trailors and is burried in trenches. This burried night soil is converted into manure in a period of about 2 years which can be used for the crops.

The sullage and storm water is carried by drains constructed outside the houses which may be open or closed. This sullage and storm water etc. is carried upto point of disposal where it is allowed to mix up with the stream, river or sea. The sullage may also be used for farming and gardening.

Merits and Demerits of conservancy system

Merits and Demerits of conservancy system are given as under:

Merits:

1 It is the cheaper system. It is carried with low initial cost because latrines and open drains may be constructed economically.

2 In this system the quantity of sewage to be carried at the treatment plant for disposal is low.

3 The storm water is carried in open drains and the sewer sections in this case shall be small and thus they will run full for the major portion of the year and thus sewer lines will be free from silting and other deposits.

4 In case the water level in rivers rises at the out falls due to floods, pumping of sewage for disposal may be done at a nominal cost.

Demerits:

1 For burrying night soil more space is required.

2 There is every possibility that storm water may go in sewers which may cause heavy loads on the treatment plants.

3 There is also every possibility of finding access in the sub-soil of liquid refuse which may pollute underground water.

4 As the latrines in the house are to be provided away from the inhabited rooms in a building, it creats inconvenience to use. If provided near the rooms, it emits foul smell.

5 The excreta is not carried by the carts or trucks directly from the laterines, but it is first collected by human agency and placed at roadside for its further collection

by carts etc. which causes insanitary conditions dangerous to public health.

6 In the presence of conservancy system, the aesthetic appearance of the city cannot be increased.

7 The conservancy system completely depends upon the mercy of sweepers. So if they go on strike due to some reasons, there is every possibility of the spreading of diseases in the city due to decomposition of foul matters.

Water carriage system

Due to development of engineering and technology it has become possible to collect the sullage and night soil etc. by the carriage system without taking the help of human agency. By experiments it was found that the water is the only cheapest material which can be used for collection of sullage and its conveyance. As the water is main substance in this system, hence it is called water carried system. Human excreta from the water closets is mixed with water and becomes a semi-solid which is carried by properly designed underground sewerage system to the treatment plants for its final disposal. In this system 99% of the sewage is in liquid form and can easily be carried by properly designed sewer lines.

Merits and demerits of the water carriage system are given below:

Merits

1 No human agency is employed in this method and the excremental matters are collected and carried by water in underground sewer system hence this method is not unhygenic.

2 Due to carriage of sewage in closed underground sewers, the nuisance in towns is elliminiated and hence risk of epidemics is reduced.

3 In this system only one sewer is laid which require less space as compared to conservancy system in which two separate sewers are required.

4 Compact design of building is possible in this case as toilets and WCs are attached to the bed rooms which do not emit any foul smell due to water seals provided for the closets and traps etc.

5 As only one sewer is laid in this system, it carries large quantity of sewage due to which self cleaning velocity can be obtained even at smaller gradients.

6 This system is not dependent fully on human agency except when sewers get blocked.

7 No additional water supply is required because the usual supply of water is sufficient to cope with the needs of this system.

8 Less land is required for disposal works in this system as compared to conservancy system in which more area is required to burry the excremental matter.

9 The sewage after proper treatment can be used for various purposes like irrigation etc.

Demerits

1 Initial cost in this system is much more than conversancy system.

2 Its maintenance cost is also high.

3 During the rainy season large quantity of sewage is to be treated, but during the remaining period of year only small volume of sewage is carried for treatment.

So keeping in view the merits and demerits of the above two systems it is seen that water carriage system is most suitable in the present day requirements.

Sewerage system

Sewerage is the system by which sewage is carried. It may be classified into the following three types:

a Separate system

b Partially separate system

c Combined system

When the system of sewers is laid separately to carry domestic and industrial sewage in one set of sewers and the storm water in another set of sewers, it is called separate system.

When one set of sewers provided to carry a portion of storm water and the remaining portion of storm water is carried in a separate set of sewers, this system is called partially separate system.

It is said to be a combined system of sewerage when only one set of sewers is laid to carry both the domestic and industrial sewage and also the storm water. The combined system is used in areas which have a small rainfall and that too scattered evenly throughout the year. In such places self cleaning velocity will be available almost in all the sections. This system is also employed in the towns where quantity of the sewage is small.

In the areas where ther is a heavy rainfall during the rainy season, it is advisable to provide the separate system because the self cleaning velocity shall not be available for most of the period of the year.

As explained above, the merits and demerits of each of the above system can be explained as under.

a) Separate system

Merits

i) As two separate sewers are provided to carry sewage and storm water, the quantity of sewage to be treated at treatment plant is small due to which design of treatment works can be made economical

ii) The separate system is generally cheaper due the fact that only sanitary sewage is required to be taken in closed sewer. The storm water can be taken in open drains which are constructed with much less cost.

iii) There is no fear of stream pollution in the separate system.

iv) If only the sewage is to be pumped during disposal, this system is cheaper.

Demerits

i) As separae set of sewers is laid for sewage and storm water, therefore its maintenance cost is more.

ii) Due to small quantity of sewage in the sewer, it is difficult to get self cleaning velocity. Therefore flushing of sewer is required for its cleaning.

iii) There is always a possibility of storm water to get mixed with sewage sewer which may cause overflowing of sewer and making heavy load on the treatment plant.

iv) The two sewers laid in a lane may create a great inconvenience to the public at the time of its maintenance.

b) Partially separate system

Merits:

i) It is an improved form of separate system. The size of sower can be designed as per requirements and economically.

ii) The work of house plumbing is reduced because rain water from roofs, sullage from bathrooms and kitchen is allowed to mix with sewage in the same sewer which carries the discharge from water closets but the water from all other places can be taken in separate sewer or drain.

iii) As the small portion of storm water is taken in the same sewer which carries sewage due to which self cleaning velocity is obtained and hence no flushing of the sewer is required.

Demerits

i) As a portion of storm water is taken with the sewage, therefore the cost of pumping is increased than separate system.

ii) In dry weather, there is every possibility that self cleaning velocity may not develop in the sewer.

iii) The possibility of overflow is also not ruled out in partially separate system.

c) Combined system

Merits:

i) In combined system self cleaning velocit is easily available at all places in sewer. So there is no need of flushing the sewer.

ii) The sewage is diluted by rain water due to which it can be treated easily and economically.

iii) House plumbing can be easily done because only one set of pipes is required to be laid.

iv) In congested areas, it is easy to lay one large sewer than two separate sewers.

Demerits:

i) Combined system has a high initial cost.

ii) As the quantity of sewage is increased in this case, therefore pumping of it is not economical.

iii) The areas which have a rainfall for the smaller period of the year, the combined system is not suitable at such places because it shall not be possible to develop self cleaning velocity during dry weather as the flow will be small which shall result in sitting of the sewer and hence flushing of the sewer shall be necessary.

iv) During the period of heavy rains, the overflowing of sewers may endanger the public health.

Draw drainage plan for toilet and kitchen

Objectives: At the end of this lesson you shall be able to
- **state the aims of building drainage**
- **define the technical terms related to plumbing and**
- **explain the layout of toilet & kitchen drainage**
- **state the types of plumbing ie. one pipe system & two pipe system.**

The term house drainage covers the entire sanitary arrangement of a building above the below the ground. The term is usually applied for pipe which carry the waste liquid and sewage to the sewer or to the sewerage disposal plant from a house or a group of houses. The sewage may be domestic or industrial which is admitted into the sullage may also be admitted to the conduit. The sullage contain the waste discharge from kitchen, bath, wash water from privies and also a considerable quantity of urine. The sullage differ from the sewage as it does not contain human excreta.

Aims of building drainage

(i) To dispose off liquid waste as early as possible.

(ii) To prevent entry of four gases from the sewer to the building.

(iii) To dispose off the storm water into open surface drain.

(iv) To facilitate quick removal of four matter.

(v) To provided health condition in the building.

The plumbing include design, layout, construction and maintenance of drain of waste water, surface water and sewage together with all ancillary works such as connections, inspection chamber etc. Used within the building and from the building connecting to a possible sewer or to treatment works, a septic tank, a cesspool, a soak way or natural drain.

Various terms used in plumbing are as given below:

1 **Plumbing system**: It include the water supply and distribution pipe, plumbing fixtures and traps, soil, waste and vent pipe, sewer and their respective connections, devices and appurtenances within the building premises and water using equipments.

2 **Waste pipe**:The pipe which carry liquid waste and do not include night soil.

3 **Sullage**: It include the waste discharge from sink, bath and wash basin.

4 **Soil pipe**: The pipe which receive the discharge from water closet, urinals and other soil fitments.

5 **Soil waste**: It is the liquid waste from water closet, urinal, slope sinks and cow-sheds, gullies

6 **Back syphonage**: It is the flow back of used or polluted water from a plumbing fixture into a water supply pipe due to reducing of pressure.

7 **Anti-syphonage pipe**: It is a device to preserve the water seal in a trap by providing ventilation.

8 **Self syphonage**: It is the breaking up of the trap-seal as a result of removing the water there due to sudden flush of water from a fixture on the upper floor.

Technical terms

Some of the technical terms used in connection with drainage system are as under;

1 **Soil appliance.** This includes water closets, urinals, bed-pan washers etc.

2 **Soil pipe**: A pipe which carries discharge from W.C., urinal, or any other soil appliances.

3 **Waste appliance**. This includes wash basins, sinks, bath tubs, washing trough, drinking water fountain etc.

4 **Waste pipe**. A pipe which carries waste water from kitchen, bathroom, floor traps, nahani trap or any other waste appliance.

5 **Rain water pipe**. This is a pipe provided to carry rain water.

6 **Ventilation pipe**. Also known as vent pipe is a pipe which ventilates drainage system. This pipe is open at top and it is connected to a soil pipe or waste pipe at its bottom. This pipe is extended above the roof of the building to permit exit of foul gases into the atmosphere. This pipe only ventilates the system and does not carry any discharge from soil, waste or rainwater pipe.

7 **Stack.** It is a term used for any vertical pipeline of a drainage system.

Barrel: It is that portion of pipe in which its diameter and wall thickness remain uniform throught.

Bedding: It is the support provided to pipe on the trench floor by concrete or any other suitable material.

Benching: The sloped floor of a man hole or inspection chamber on both sides and above the top of the channel is called benching.

Antisyphonage: It is the device provided in a trap to preserve its water seal.

Drain: It is the line of assembled pipes with all fittings and equipments like manhole, traps and gulleys etc. Which is used to carry used water from a building or buildings to the sewer. Drain may be open or under ground type.

Drainage: Drainage is the system by which used and contaminated water in a building is removed by means of drains.

Sewer: It is a underground pipe line used to carry night soil from water closets in a building or other water borne waste.

Sewerage: It is the system of underground sewers to carry sewage by water carriage system away from the towns or cities to dispose it off in such a way that it may not cause any damage to human health.

Sub soil water drain: It is the drain which carries sub-soil water.

Surface water drain: It is the drain which carries surface water and storm water for its disposal.

Vent pipe: It is a pipe which is used to provide flow of air to or from drainage system. It provides air circulation to the system and protects trap seats from the syphonage or back flow.

Ventilating pipe: It is the pipe which is used to discharge foul gases in the drain or sewer into the atmosphere.

Refuse: It includes all types of house waste and garbage in dry form.

Garbage: it is the solid or semi-solid waste from a house like peelings of vegetables and fruits, wastes of foods etc.

Rubbish: Rubbish includes solid wastes like waste papers, broken furniture and pottery, waste materials of building etc.

Ashes: It is the residual substance obtained after burning the wood, coal, coke etc. in hearths and furnaces etc. in the building.

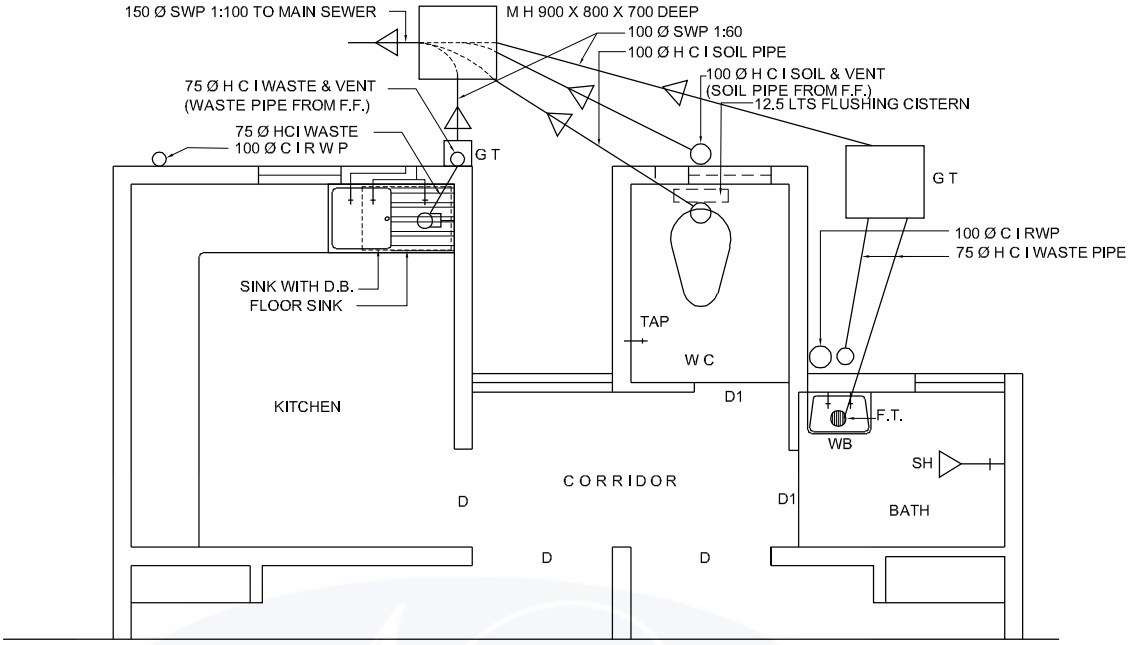
Manhole: It is hole or shaft provided in a drain, sewer or any other closed structure in which a man may enter for inspection, cleaning or maintenance operation. A manhole is provided with a cover at top.

Cleaning Eye: It is an opening in a drain or sewer which is used for cleaning any obstruction in it by means of drain rod. It is provided with removable cover.

Soak Away: It is a pit which is suitably prepared to receive soil waste water or partially treated sewage for seepage into the ground.

Sewage: Sewage includes all types of liquid wastes in a building. It may be storm sewage or sanitary sewage. (Fig 1 & Fig 2)

Fig 1

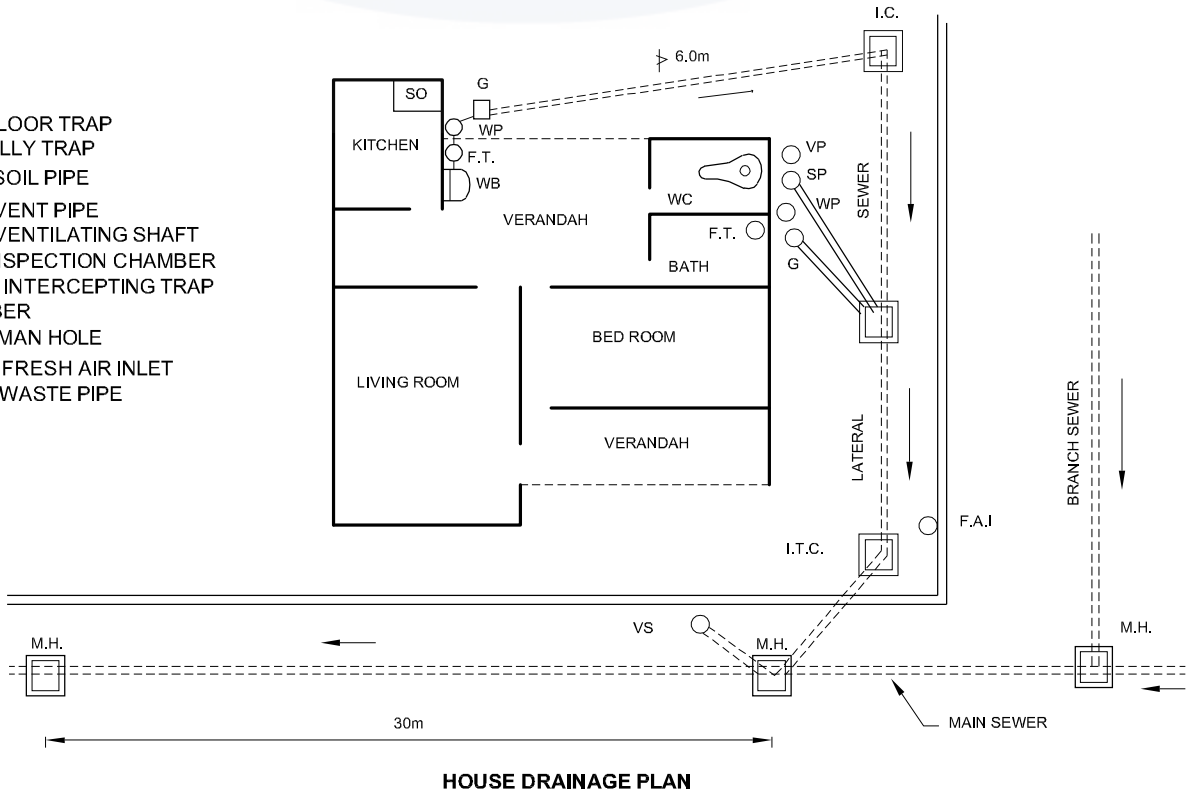


DRAINAGE LAYOUT

AA230211

Fig 2

F.T.= FLOOR TRAP
G = GULLY TRAP
S.P. = SOIL PIPE
V.P. = VENT PIPE
V.S. = VENTILATING SHAFT
I.C. = INSPECTION CHAMBER
I.T.C. = INTERCEPTING TRAP CHAMBER
M.H. = MAN HOLE
F.A.I. = FRESH AIR INLET
W.P. = WASTE PIPE



HOUSE DRAINAGE PLAN

AA230212

Toilet & kitchen details of a residence or house.

150 Ø (diameter) soil waste pipe (SWP)

75 Ø (diameter) waste pipe (W.P)

100 Ø (diameter) rainwater pipe (RWP)

PVC/storeware pipe can be used.

WC Water closet

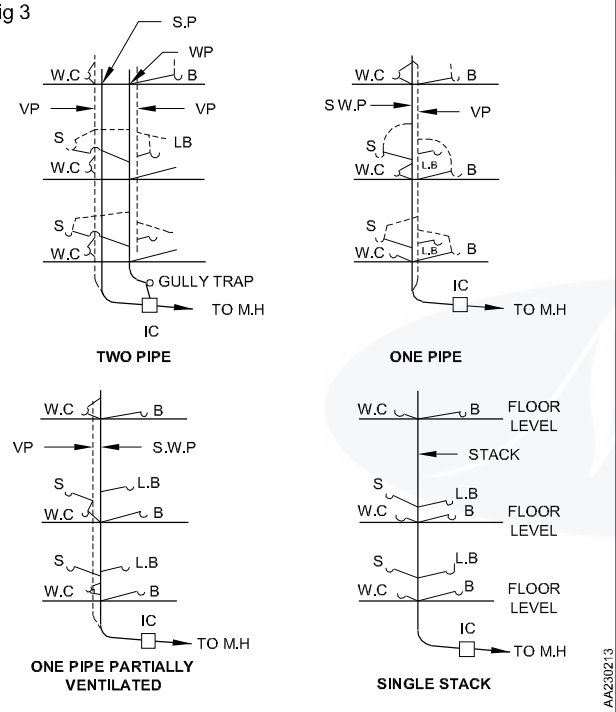
WB Wash basin

GT Gully trap

MH man hole

House drainage plan: Before starting the building work it is most essential, first to prepare the drainage plan as shown in Fig 3. The following points should be kept in mind while preparing the drainage plan.

Fig 3



(a) Drain should be laid in slope so that self cleaning velocity is developed in them. The slope for different diameter pipe are 1 in 40 for 10 cm, 1 in 60 for 15 cm and 1 in 90 for 25 cm diameter.

(b) The drainage system should be properly ventilated and vent pipe should be taken at higher level from the building.

(c) Future safety of the pipe should be considered before laying.

(d) Drain is laid in such a way that in future extension is possible.

(e) All the rain water pipe and discharge from bath, sink, etc. Should be connected to drain through gully.

(f) Soil pipe connected directly to drain.

REFERENCES	
B	= Bath
L.B.	= Lavatory Basin
S.P.	= Soil Pipe
S.W.P.	= Soil and Waste Pipe
S	= Sink
V.P.	= Ventilating Pipe
W.P.	= Waste Pipe
W.C	= Water Closet
I.C.	= Inspection Chamber
M.H.	= Man Hole

(g) Flushing tank may be provided in case the quantity of sewage is small.

Plumbing system: There are four systems of plumbing as shown in fig.

(i) Two pipe system: In this system soil and waste pipe are separate, the soil pipe being connected to drain directly and waste pipes through a trapped gully.

(ii) One pipe system: In this system the waste connection from bath, sink and wash basin and soil combined into one common down pipe which directly connected to the drainage system but all the traps are thoroughly ventilated to preserve the water seal.

(iii) Single stack system: This system include single pipe without trap ventilation work i.e., all traps directly connected to single stack.

(iv) Partially ventilated single stack system: In this system the discharge from all the fitments join to one pipe along with a relief vent which ventilates only the trap of water closet.

Fig 6

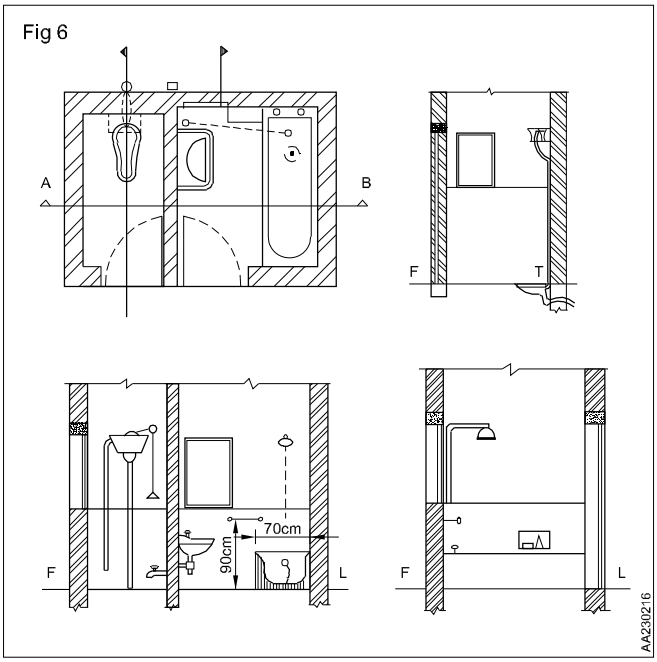
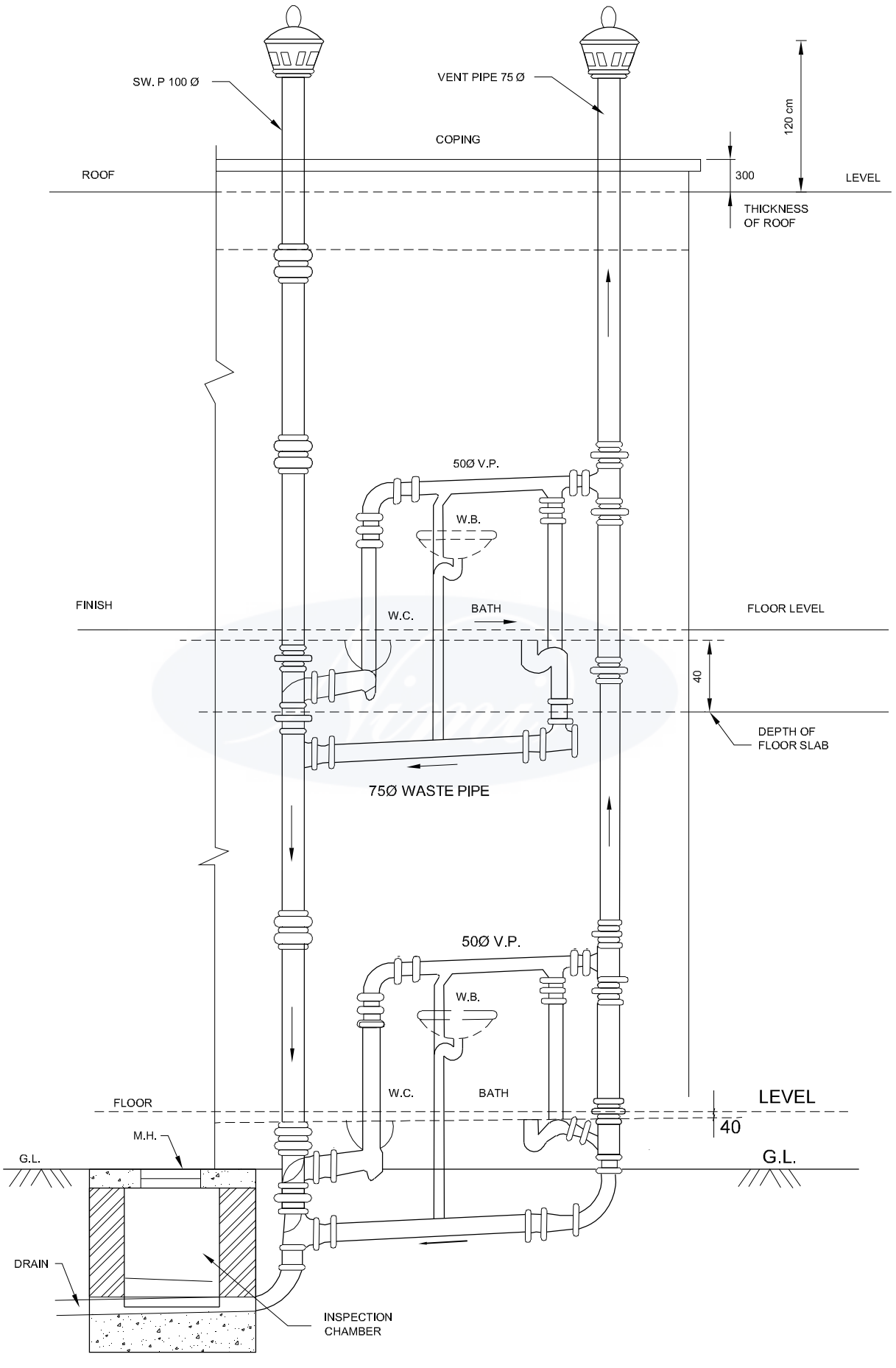


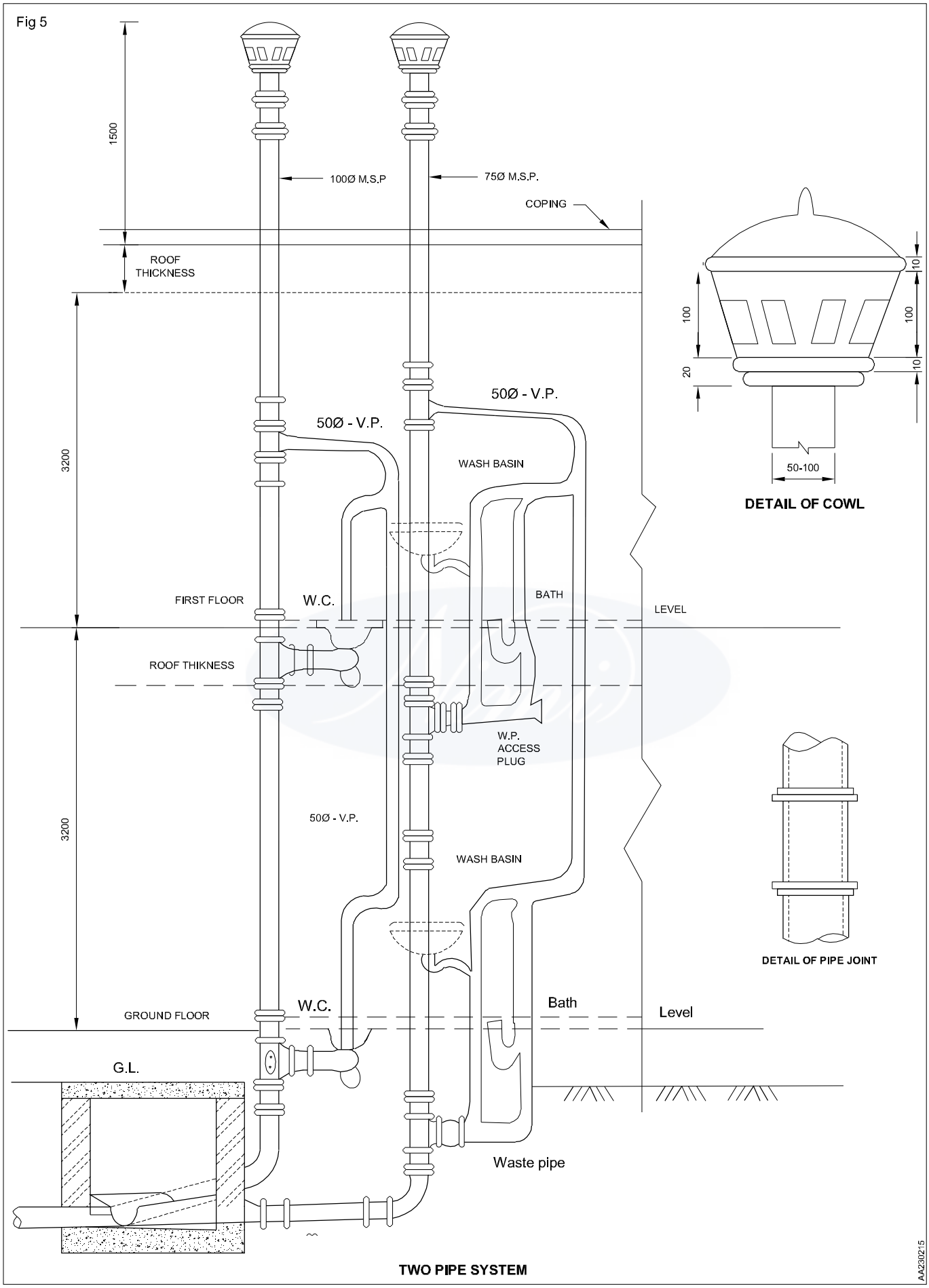
Fig 4



ONE PIPE SYSTEM

AA230214

Fig 5



TWO PIPE SYSTEM

Draw gully trap details

Objectives: At the end of this lesson you shall be able to
- **describe requirement of drainage system**
- **explain types of pipes used in drainage system**
- **define traps, utility of different traps, sizes of traps, shapes of traps, etc.**
- **enumarate essential requirements of traps.**

General

As explained earlier, potable water supplied to a buildings is distributed to various areas like kitchen, bath, W.C etc. through a network of pipes provided with plumbing or sanitary fittings at their terminal ends, adequate arrangements are required to be made for quick collection, conveyance and disposal of used water from the fittings without any risk to the health of the occupants. It is also essential that the rain or storm water from the roof and paved areas of building and the ground surface is suitably collected and discharged without flooring the area.

The term drainage or sewerage includes the system of removal of sullage or waste water (from floor traps, kitchen, bath and wash basin), soil water (from W.C. and urinals) and storm water from a building and conveying the same upto its ultimate point of treatment and disposal. Ths system of drainage can be broadly divided in two parts.

1 Drainage below the ground

2 Drainage above the ground

1 Drainage below the ground: this comprises of a system of underground house drain, inspection chamber, main drain or sewer, manholes, ventilation shafts etc. Provided for conveying the sanitary sewage (soil water and waste water) and storm water for final treatment or disposal.

Underground drainage can be divided into the following three systems.

i) Combined system

ii) Seperate system

iii) Partially combined system.

i Combined system: In this system the storm water is completely mixed with the sanitary sewage and conveyed through a single drain or sewer.

ii Separate system: In this system the storm water is not allowed to get mixed with sanitary sewage. Two separate drains are provided, one for sanitary sewage and other for drainage of storm water.

iii Partially combined system: In this system a part of storm water (usually run off from roofs, paved yards and streets etc) is mixed with sanitary sewage and conveyed through sewer and the remaining storm water is conveyed through separate surface drains.

2 Drainage above the ground: This consists of a system of vertical stacks, horizontal branches, floor traps etc. Provided for conveying sanitary sewage (soil water and waste water) storm water (rain water) etc. to the underground drainage system for final disposal.

This system is also known as house or building drainage system.

Types of pipes

The pipes used in drainage system may be of cast iron, reinforced concrete, pre stressed concrete, mild steel, wrought iron, asbestors. PVC or stoneware.

For drainage work above ground, cast iron, asbestos cement or P.V.C. pipes are generally used. The pipes may be jointed either with cement mortar or lead. Stoneware pipes are commonly used for house drain. For sewers, stoneware pipes, cement concrete pipe or C.I. pipe are normally used.

Minimum size of pipes commonly used in house drainage are as under.

(i) Underground horizontal pipes laid to slope ..... 100 mm dia.

(ii) Vertical soil pipe (above ground)..... 100 mm dia.

(iii) Vertical waste pipe (above ground)... 50 to 75 mm dia.

(iv) Branch soil pipe..... 60 to 75 mm. dia.

(v) Vent pipe..... 50 mm dia.

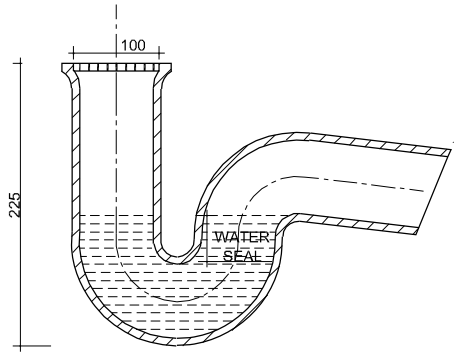
(vi) Rain water pipe..... 75 mm dia.

(vii) Waste pipe from individual kitchen, sink, wash basins etc. .....40 mm dia. G.I. pipe.

Traps

A trap is a fitting provided in a drainage system to prevent entry of four air or gases from the sewer or drain into the building. The barrier to the passage of foul air is provided by the water seal in the trap. In its simplest form a trap is merely a double bend or loop in the sanitary fitting, the depth of water seal being the distance

Fig 1



DETAIL OF 100X75 CI FLOOR TRAP

AA230311

between the top of the first bend and bottom of the second. (Fig 1)

The deeper the seal the more efficient is the trap. Depending upon the design of the trap, the depth of water seal vary from 40 mm to 75 mm. The trap should always be fitted close to the waste or soil fitting unless the trap form an integrated part of the fitting as in case of European W.C. (siphonic type)

Essentials of a good trap

A good trap should have the following characteristics:

1 It should maintain an efficient waterseal under all conditions of flow, both during the water flow as well as in the absence of water flow.

2 It should be self cleaning.

3 It should not have any internal projections, angles or contractions so as to permit unobstructed flow through it.

4 It should have a smooth inner surface so that each part is automatically scoured by flow of watr and there is no possibly of dust, dirt etc. getting struck to it.

5 It should be provided with suitable means of access for cleaning purposes.

Causes of loss or breaking of water seal. The primary object of providing a trap is lost, in case it is not possible to retain its water seal. The water seal in a trap may break due to the following causes.

1 Evaporation of water in the trap caused on account of not using the appliance for long time.

2 Use of defective trap, defective installation of trap or development of crack in trap after installation.

3 Creation of partial vacuum caused due to discharge of another fitting connected to the same stack leading to emptying of the water of the seal by induced siphonage.

4 Build up of back pressure of sewer gas in the drain forcing up the water of the trap seal.

5 Pressure on seal of trap due to sudden discharge of water in large quantity into the fitting (bucket full of water into a W.C.) forcing the seal to break due to self siphonage.

6 Due to capillary action caused by piece of some porous material getting struck at the outlet of the trap in such a manner that one end of the piece remains in water of the seal and the other end of the piece remain hanging over the outlet.

Type of traps

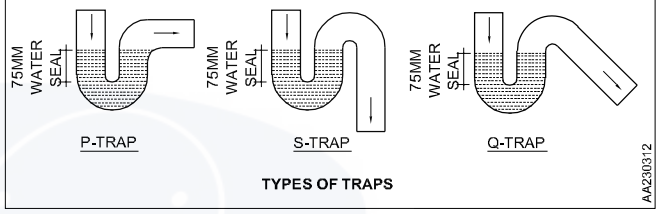
Traps can be made in different shapes and they are normally named after the shape of the letter they resemble. Out of the different shapes, the trap resembling the letter, P (or P-Trap), Q (Q-Trap) and S (S-Trap) are more common. The traps are normally made of cast iron and glazed stone ware. Depending upon the use and location, the various types of traps can be broadly summarized as under (Fig 2)

(i) Floor trap or Nahani trap

(ii) Gully trap

(iii) Intercepting trap

Fig 2



TYPES OF TRAPS

AA230312

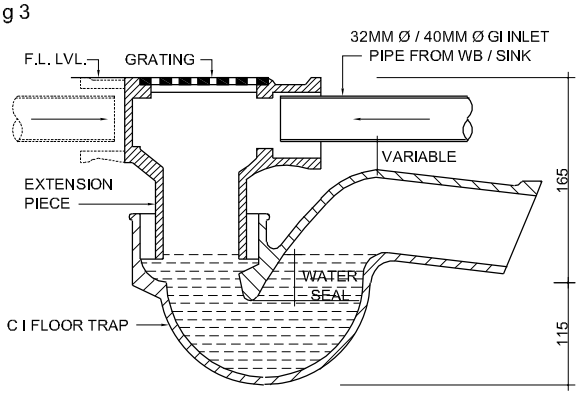
(iv) Grease trap

(v) Silt trap

(i) Floor trap or Nahani trap:

Trap provided in floors to collect used water from floors of bath room, kitchen or washing floor etc. are known as floor traps or Nahani traps. This type of trap is made of cast iron and it is provided with a removable grating on top. The grating intercepts dust or other solid matter and

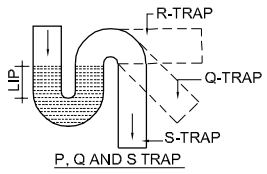
Fig 3



DETAIL OF 100X75 CI FLOOR TRAP

AA230313

Fig 4



TYPES OF TRAPS

AA230314

prevents blockage of trap. The depth of water seal of floor trap should not be less than 40 mm. Details of a 100 x 75 CI floor trap are shown in Fig 3 & Fig 4.

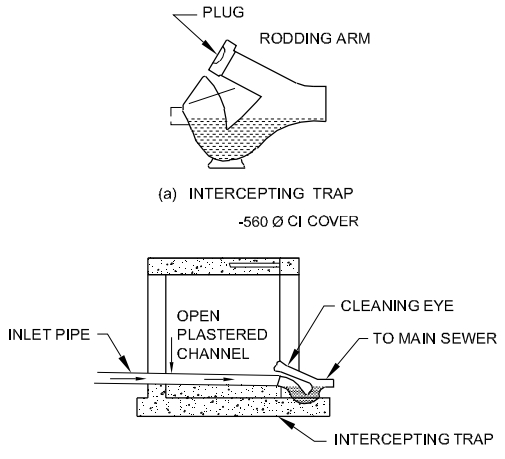
(ii) Gully trap

Gully trap is a deep seal trap which is provided on the external face of wall for disconnecting the waste water flowing from kitchen, bath, wash basin & floors from the main drainage system. The deep water seal forms a barrier for preventing the passage of foul air from house drain to the inside of the building. It is made of cast iron or glazed stoneware. The stoneware gully trap has top square in plan where as the top of cast iron trap is normally circular. It is fitted in a small masonry enclosure to meet the requirements of invent levels of waste pipes discharging into the gully trap. Grating is provided on top of the trap to intercept and retain all solid matter and prevent it from flowing into the drain. The bars of the grating should not be more than 10 mm apart. (Fig 5)

(iii) Intercepting trap

This trap is provided at the junction of house drain (inspection chamber) and street sewer to prevent entry of foul gases from sewer into the house drain. The intercepting trap is thus provided to disconnect the house drain from the street sewer. The trap is made of glazed stoneware and has a opening at top (known as cleaning eye). The opening is kept closed with a tight fitting plug which is taken out only during cleaning of the trap. It has a deeper seal than normal traps (not less than 100 mm) (Fig 6)

Fig 6



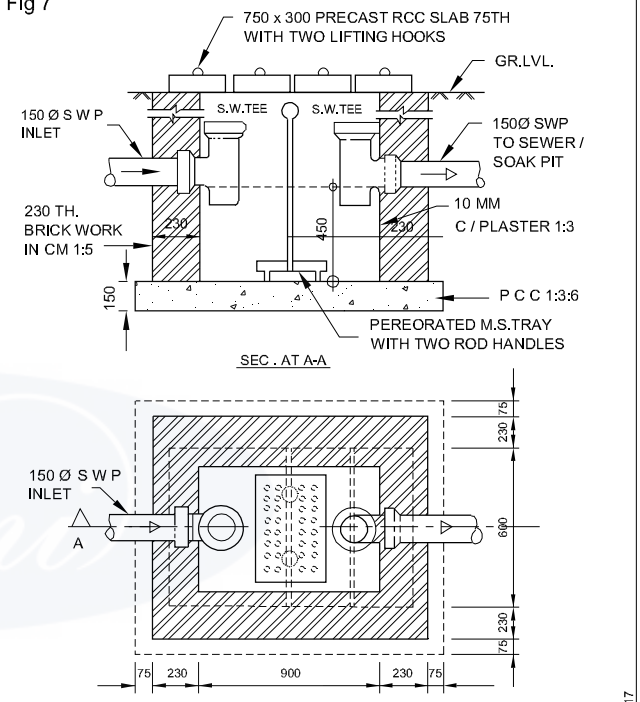
MANHOLE WITH INTERCEPTING TRAP

AA230316

(iv) Grease trap

Grase traps are provided in large hotels, restaurants or other industries producing large quantity of greasy waste with the primary aim of removing the grease content of waste water before discharging the same into drain. If the greasy or oily matter is not removed, being sticky in nature, it will induce deposition of solids in the drain which can cause obstruction to the flow of water in the drain and may finally result in blockage of drain. Grease trap is a small masonry or cast iron chamber with a T or bent pipe to serve as the outlet. The velocity of waste water flow gets reduced on entering the grease trap (because of sudden increase in area of holding of waste water) and this results in separation of oily or greasy matter from the waste water. The greasy matter appears as floating (in the trap) which is removed periodically with the help of a mild steel tray. The details of the Grease tray are shown in Fig 7.

Fig 7



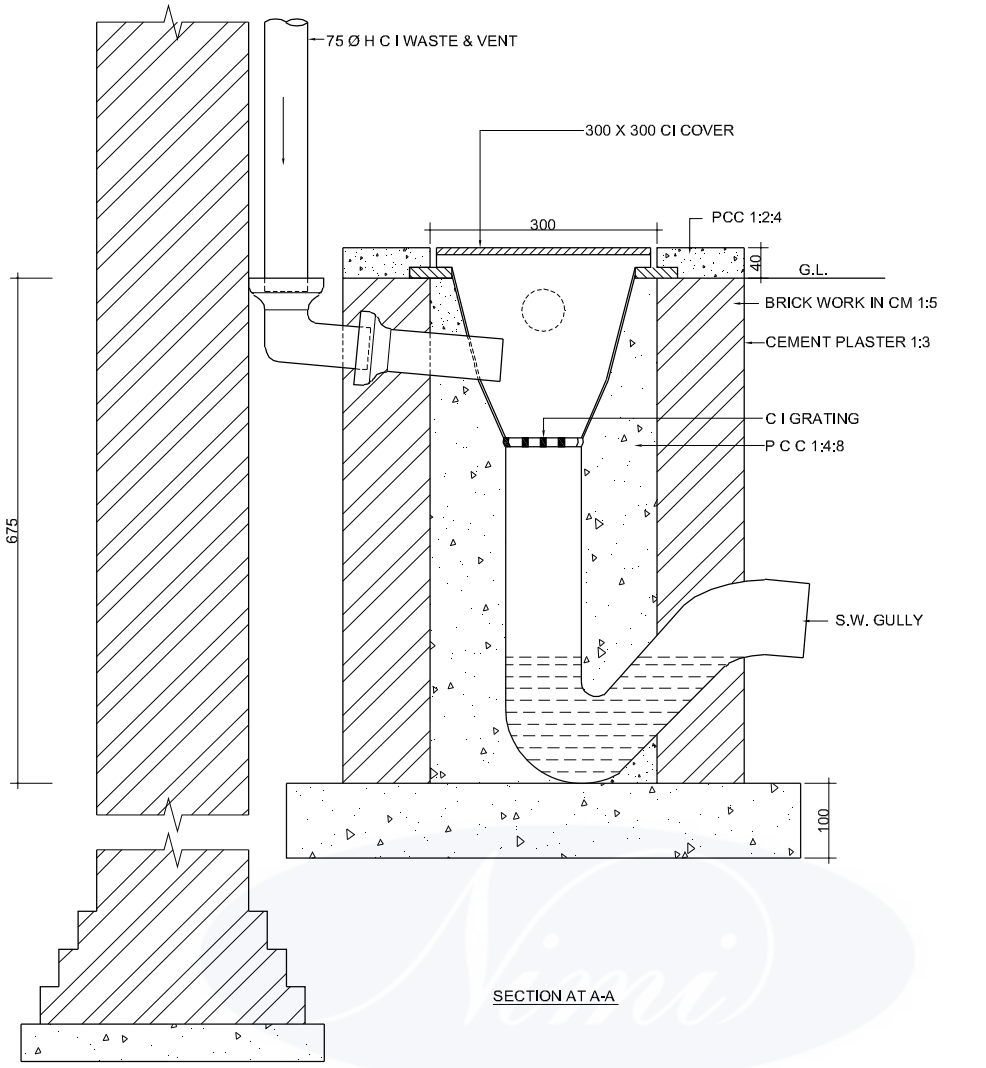
PLAN OF GREASE CHAMBER

AA230317

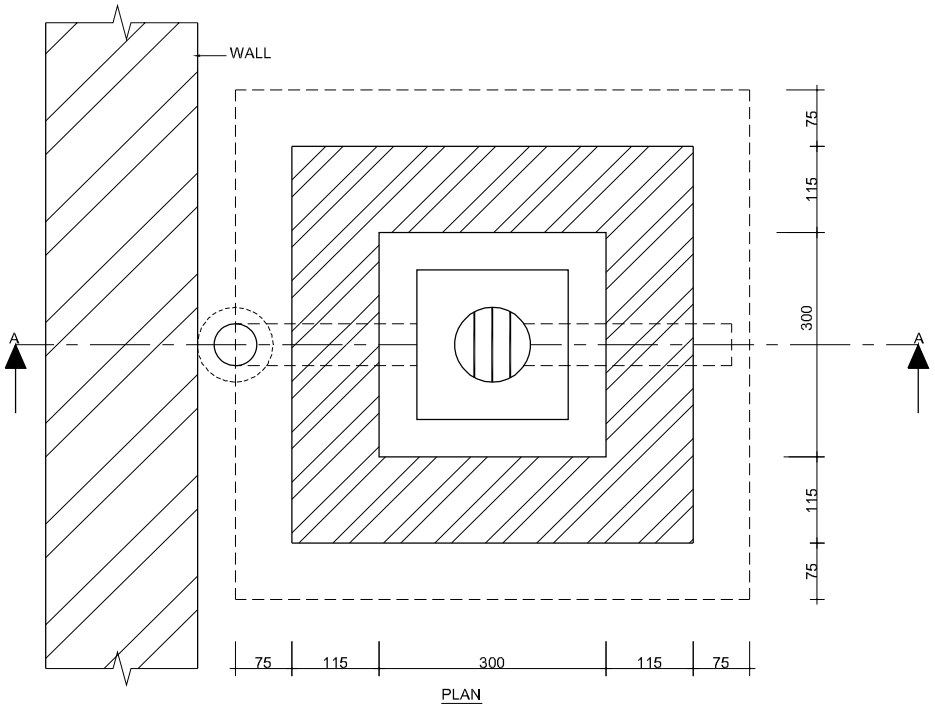
(v) Silt trap:

Silt traps are provided only in situations where the waste water carries large amount of silt, sand, coarse particles etc. It is a masonry chamber which functions like grit chamber where the silt, sand etc. Settle down before the waste water is discharged into the drainage system. The details of the silt trap or silt chamber are shown in Fig 8.

Fig 5



SECTION AT A-A

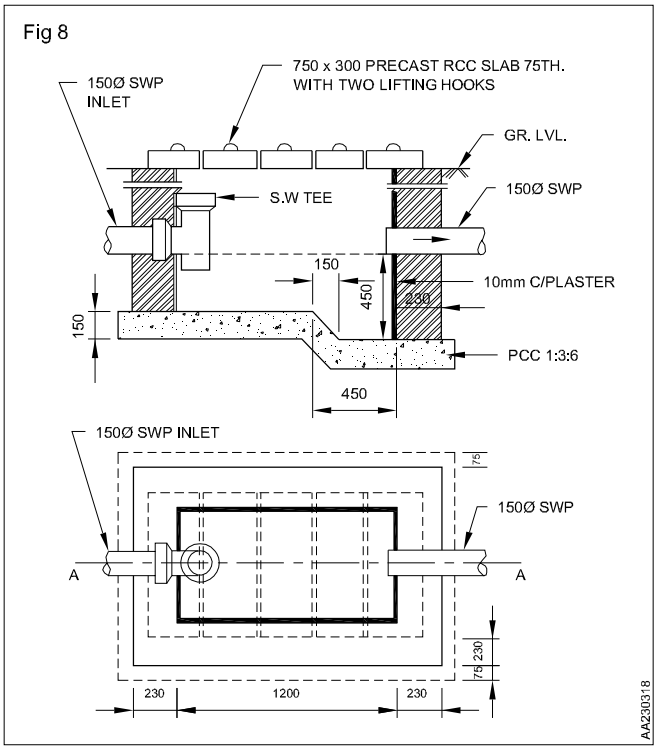


PLAN

DETAIL OF GULLY TRAP

AA230315

Fig 8


150Ø SWP
INLET
750 x 300 PRECAST RCC SLAB 75TH.
WITH TWO LIFTING HOOKS
GR. LVL.
S.W TEE
150Ø SWP
150
450
230
10mm C/PLASTER
150
PCC 1:3:6
450
150Ø SWP INLET
75
150Ø SWP
A
A
75
230
230
1200
230
AA230318

Draw man hole detail

Objectives: At the end of this lesson you shall be able to
- **enumarate the requirements of manhole**
- **state manhole details and uses**
- **explain details of manhole construction.**

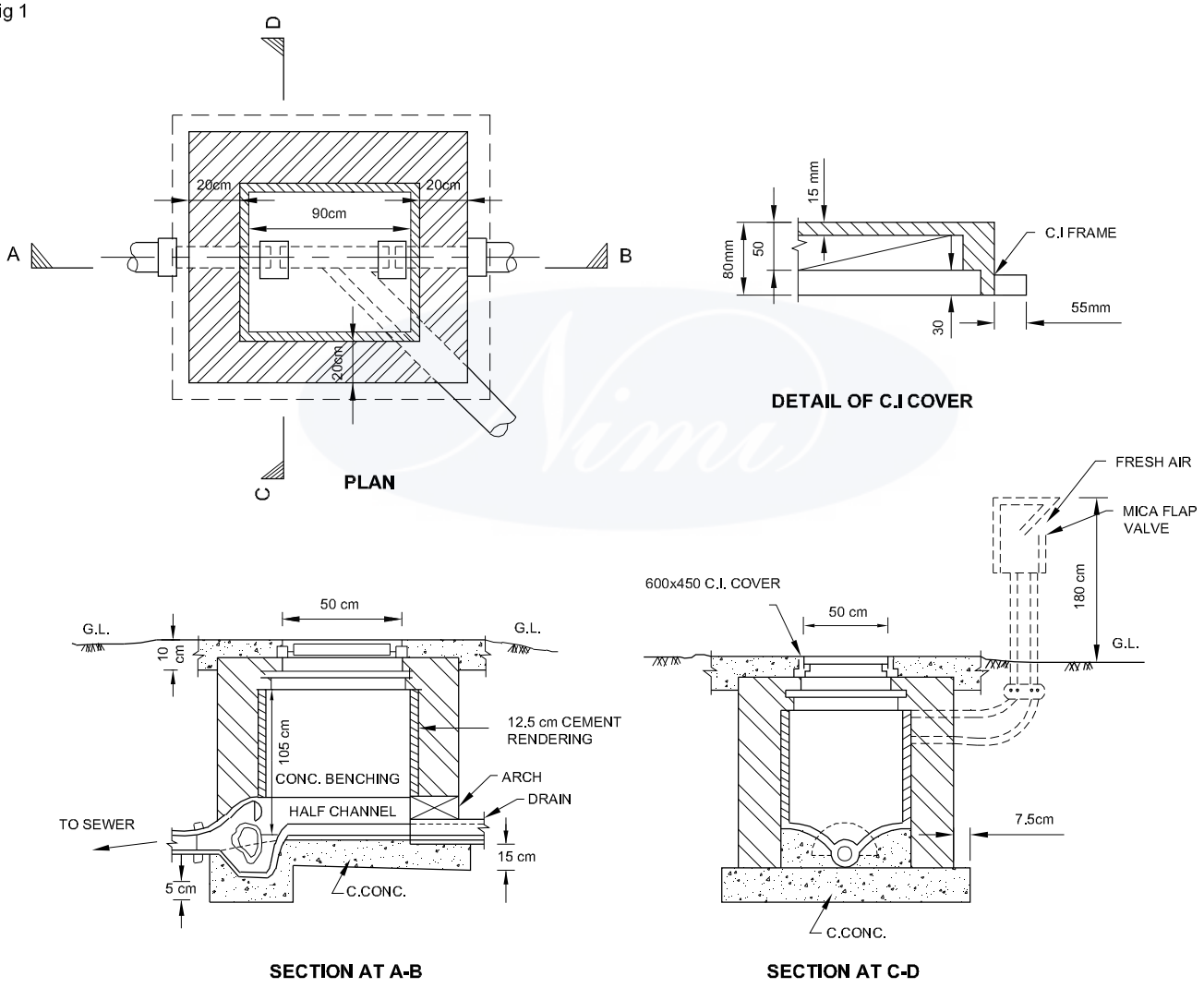
General Information

Manholes are also masonry chambers provided at suitable location and on the line of the sewer for the purposes of inspection and cleaning the sewers.

Inspection chamber (a small masonry chamber)

Man hole - a large masonry chamber with an opening in seware line. for a man to enter (for inspection & cleaning) (Fig 1)

Fig 1



Man-holes

A manhole is defined as an opening in the sewer line for a man to enter through it for inspection, cleaning, repair and maintenance. These are masonry or R.C.C. chambers and fitted with cast iron cover at the top. These are provided at every bend, junction, change of gradient or change of diameter. These are constructed at 30 meter interval in straight length of sewer. For other details see Fig 2 and 3. The man-holes are classified according to the depth of sewer.

Types	Depth	Size
1. Shallow man-holes or inspection chamber	0.80 meter or less	0.80 x 0.80 m
2. Normal man-hole	between 0.80 m to 2.10m	1.2 x 0.90 m circular chamber
3. Deep man-hole	more than 2.10 m	1.40 cm dia or rect. chamber 1.20 x 0.90 m

Inspection Chamber

The man-hole provided in house drainage for the purpose of cleaning and inspection is called an inspection chamber. The inspection chamber is provided with in 6 meter from the house gully. The inspection chamber is called manhole when built on the top of sewer instead of drain. The manhole having greater depth, are provided at bends or change of direction or change in gradient at regular intervals as shown in Fig 2, Fig 3 and Fig 4.

Fig 2

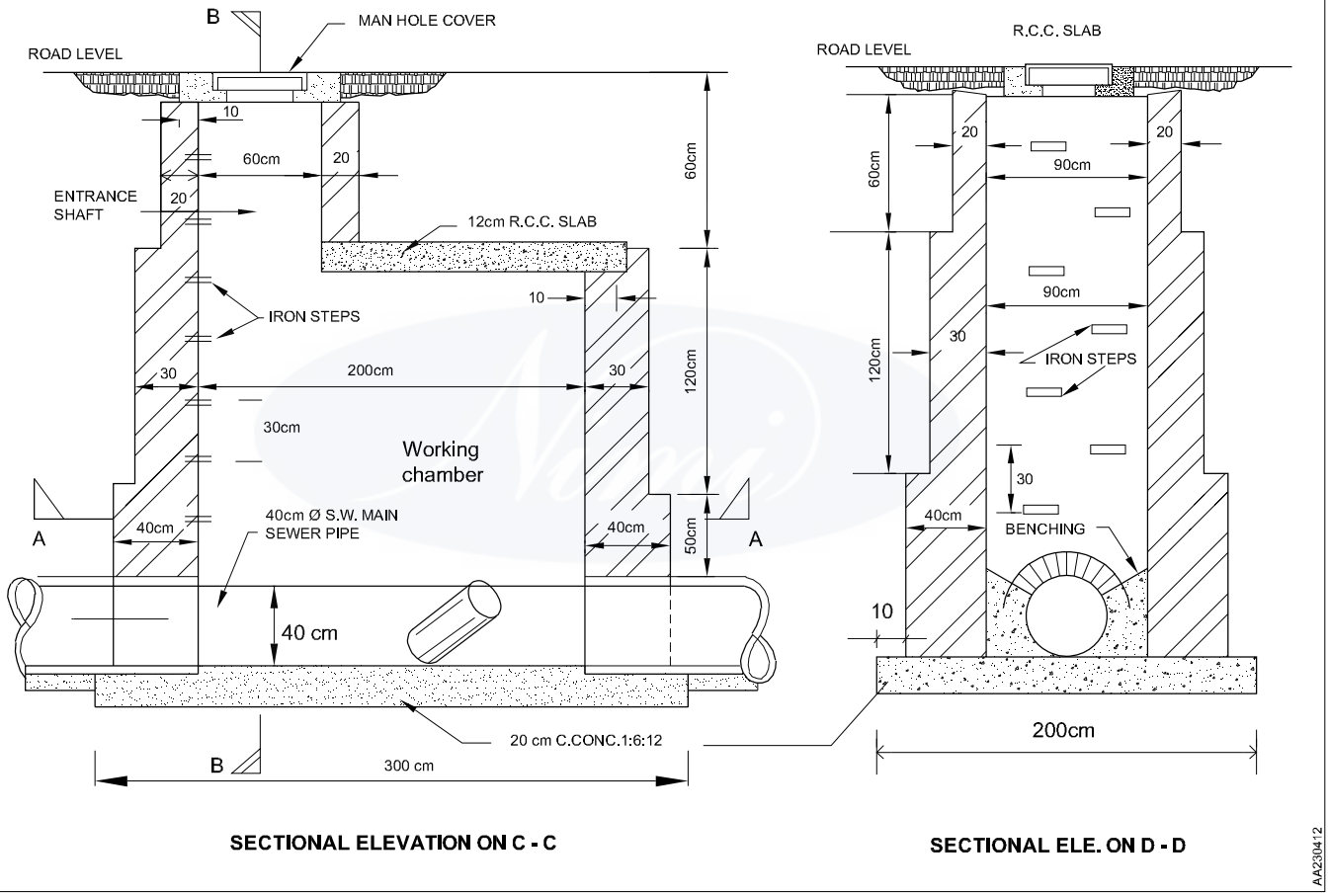
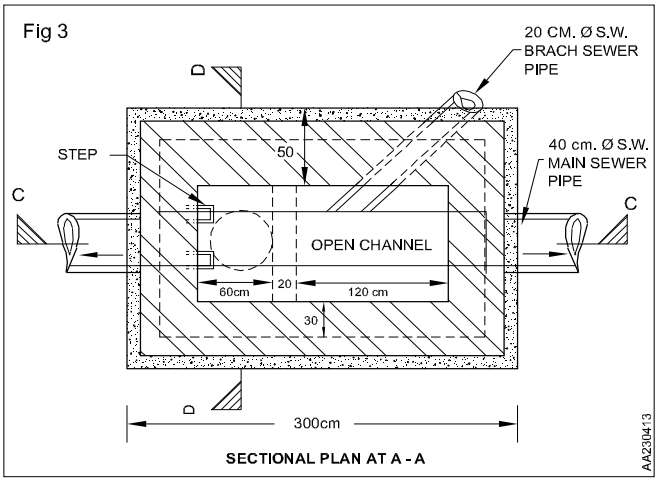


Fig 3



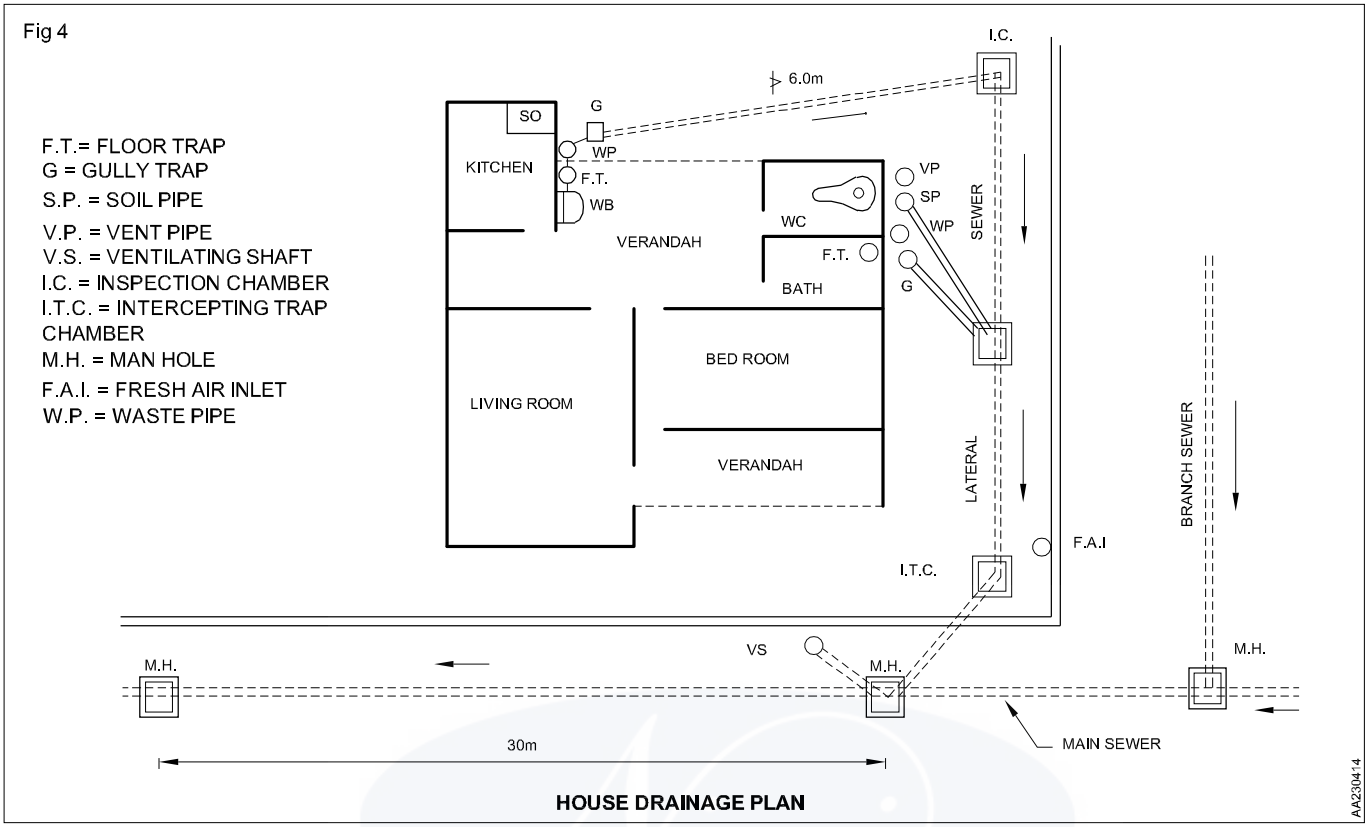
Intercepting chamber

It is the last chamber of a house drainage system and connected with intercepting trap has a water seal of about 100 mm. The main idea of providing this chamber with intercepting trap to prevent the entry of sewer gases from the public sewer line into the house drain. The intercepting trap contain an inspection arm closed with plug for the purpose of cleaning and inspection. A fresh air inlet is also provided for the entry of fresh air as shown in the sketch.

Drop manhole:

When a branch sewer enters a manhole more than 60 cm above the main sewer, the sewage should not be allowed usually to drop directly into the manhole but it should be brought into it through a vertical pipe carried down from the branch sewer to the bottom of the manhole. If drop is only a few meters, the down pipe can be laid at an angle of 45° but if it is more, it will be cheaper to make it vertical.

Fig 4



HOUSE DRAINAGE PLAN

House drainage plan:

Before starting the building work it is most essential, first to prepare the drainage plan as shown in Fig 5. The following points should be kept in mind while preparing the drainage plan.

(a) Drain should be laid in slope so that self cleaning velocity is developed in them. The slope for different diameter pipe are 1 in 40 for 10 cm, 1 in 60 for 15 cm and 1 in 90 for 25 cm diameter.

(b) The drainage system should be properly ventilated and vent pipe should be taken at higher level from the building.

(c) Future safety of the pipe should be considered before laying.

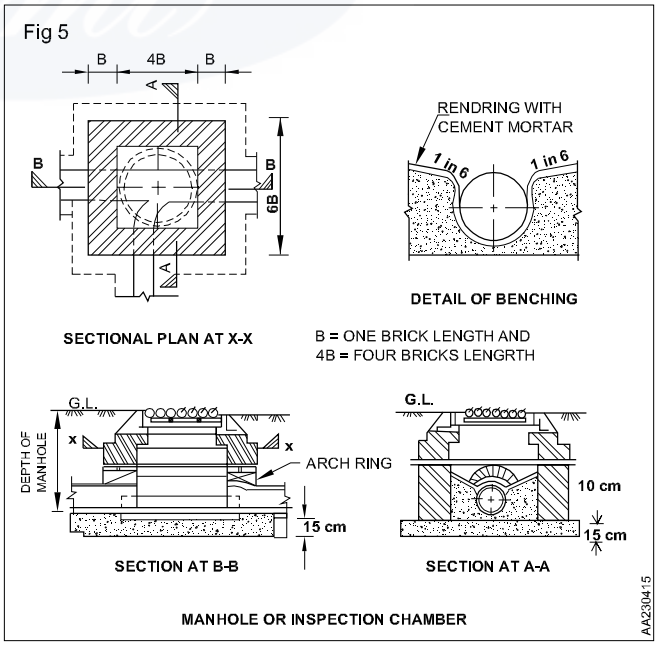
(d) Drain is laid in such a way that in future extension is possible.

(e) All the rain water pipe and discharge from bath, sink, etc. should be connected to drain through gully.

(f) Soil pipe connected directly to drain.

(g) Flushing tank may be provided in case the quantity of sewage is small.

Fig 5



MANHOLE OR INSPECTION CHAMBER

Site plan showing building services

Objectives: At the end of this lesson you shall be able to
- **explain building services to the site of the building**
- **enumarate the slopes to be mainted for the design.**

House drainage plan

Before starting the building work it is most essential, first to prepare the drainage plan as shown in Fig 1. The following points should be kept in mind while preparing the drainage plan.

(a) Drain should be laid in slope so that self cleaning velocity is developed in them. The slope for different diameter pipe are 1 in 40 for 10 cm, 1 in 60 for 15 cm and 1 in 90 for 25 cm diameter.

(b) The drainage system should be properly ventilated and vent pipe should be taken at higher level from the building.

(c) Future safety of the pipe should be considered before laying.

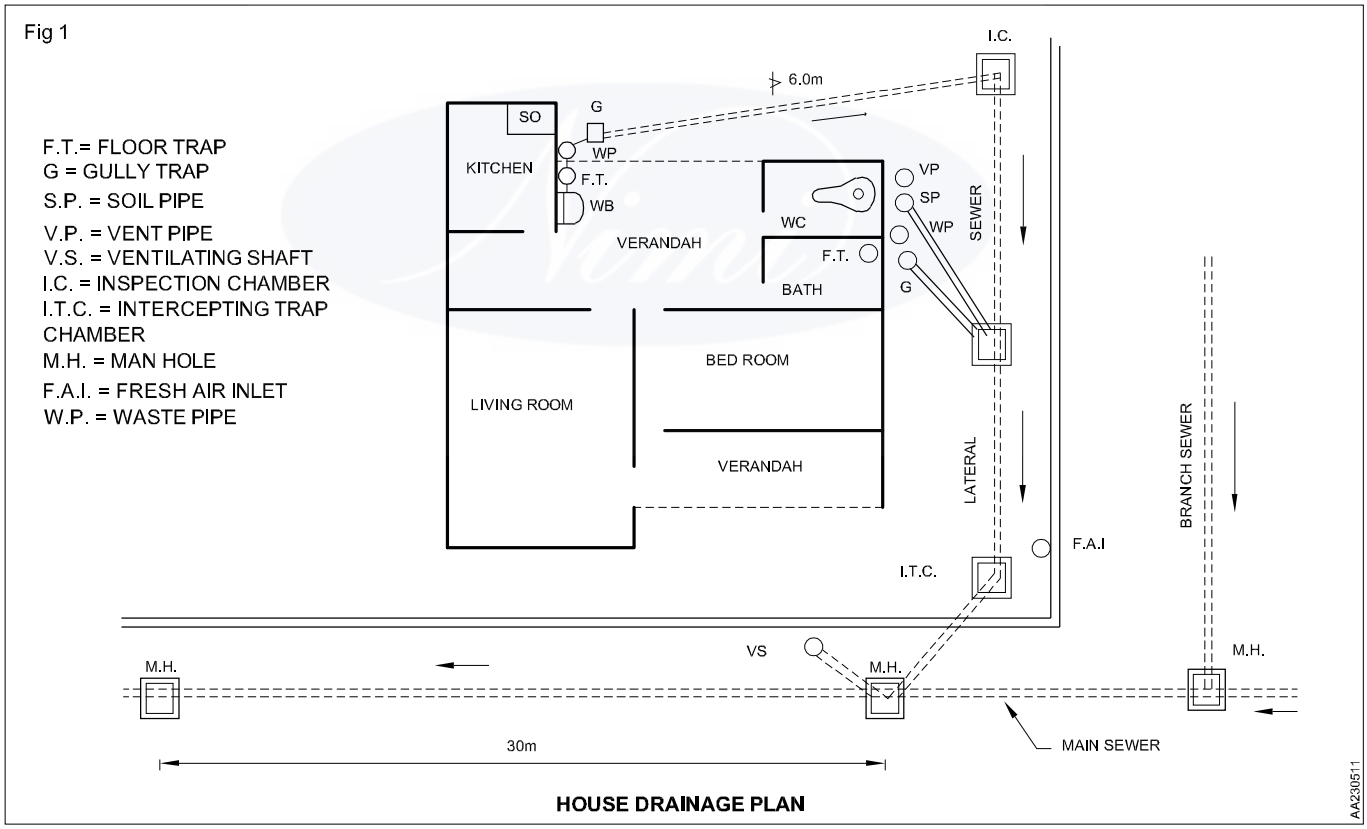
(d) Drain is laid in such a way that in future extension is possible.

(e) All the rain water pipe and discharge from bath, sink, etc. should be connected to drain through gully.

(f) Soil pipe connected directly to drain.

(g) Flushing tank may be provided in case the quantity of sewage is small.

Fig 1



HOUSE DRAINAGE PLAN

Draw rain water harvesting detail

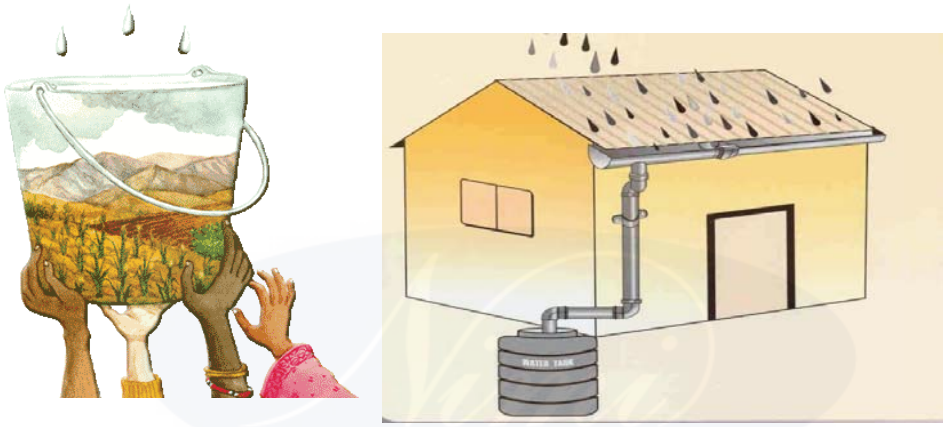
Objectives: At the end of this lesson you shall be able to
- **state the importance of rainwater harvesting**
- **define rain water harvesting and the uses, methods of (RWH)**
- **explain rain water harvesting collection channelising, filtration storage**
- **enumarate the residential rain water harvesting systems.**

Introduction

What is rainwater harvesting? Why is it required?

Rainwater harvesting is a technique of collection and storage of rainwater into natural reservoirs or tanks, or the infiltration of surface water into subsurface aquifers (before it is lost as surface runoff). One method of rainwater harvesting is rooftop harvesting. (Fig 1)

Fig 1



In the present scenario management and distribution of water has become centralized.

People depend on government system, which has resulted in disruption of community participation in water management and collapse of traditional water harvesting system.

As the water crisis continues to become severe, there is a need of reform in water management system and revival of traditional systems. Scientific and technological studies needs to be carried out to assess present status so as to suggest suitable mitigative measures for the revival to traditional system/wisdom. Revival process should necessarily be backed by people's initiative and active public participation.

Living creatures of the universe are made of five basic elements, viz., earth, water, fire, air and sky, obviously, water is one of the most important elements and no creature can survive without it. Despite having a great regard for water, we seem to have failed to address this sector seriously.

Human being could not save and conserve water and it sources, probably because of its availability in abundace.

But this irresponsible attitude resulted in deterioration of water bodies with respect to quantity and quality both.

Now, situation has arrived when even a single drop of water matters. However. "better late than never", we have not realized the seriousness of this issue and initiated efforts to overcome those problems.

Fig 2

1 Basics of rainwater harvesting

Water is one of the most commonly used substances on our earth. We need water for all our activities in day-to-day life. Water supply in urban area is always short against the total demand. Surface water is inadequate to meet our demand and we have to depend on ground water. Due to rapid urbanization, infiltration of rainwater into the subsoil has decreased drastically and recharging of ground water has diminished. This scenario requires an alternative source to bridge the gap between demand and supply. Rainwater, which is easily available and is the purest form of water, would be an immediate source to augment the existing water supply by "catching water wherever it falls".

Rainwater harvesting has emerged as a viable alternative to traditional perennial sources of water in hilly areas, in places where the level of fluoride and arsenic is above permissible limits and in urban areas facing water shortage and flooding during monsoons.(Fig 3)

Fig 3

Definition: Rainwater harvesting (RWH) is the process of collecting and storing rainwater in a scientific and controlled manner for future use. Rainwater harvesting in urban areas include

1 Roof top rainwater harvesting

2 Rainwater harvesting in paved and un-paved areas (open fields, parks, pavement landscapes etc.)

3 Rainwater harvesting in large areas with open ponds, lakes, tanks etc.

Benefits of rainwater harvesting

1 Environment friendly and easy approach for water requirements.

2 RWH is an ideal solution for water requirements in areas having inadequate water resources.

3 Increases ground water level.

4 Improves ground water quality.

5 Mitigates the effects of drought.

6 Reduces the runoff, which otherwise flood storm water drains.

7 Reduces flooding of roads and low-lying areas

8 Reduces soil erosion.

9 Cost effective and easy to maintain.

10 Reduces water and electricity bills.

Rainwater harvesting

- Traditional water harvesting in all the states underlines the importance of step wells, lakes, tanks, channels etc., as water storage bodies, the basic purpose of which was to establish a chain of water storage structures. However, a vanishing "Lake culture" due to urbanization and industrialization has caused these systems to be neglected.
- To make rainwater harvesting (RWH) a success, we should have a thorough knowledge of the following: 1 geographic location;2 climate;3 geology;4 soil;5 land use; 6 water requirements; 7 existing water supply system; 8 cost of water;9 systems & forms of RWH and the potential of harvesting rainwater.

RWH has the following unique advantages

- Capturing rainwater in-situ and augmenting supply water at a marginal cost.
- Replenishing groundwater through recharging of rainwater by using the soil column.
- Reducing pollution and contamination.
- Reducing the water bill for the state exchequer.
- Providing clean and safe water.
- Least capital investment with maximum benefits to households and the city as a whole.
- The demerits of RWH
- It is dependent on the monsoons and intensity of rainfall.
- It depends on intensive participation from house level to the city level.
- It is only a supplementary source and cannot replace the existing supply system completely.

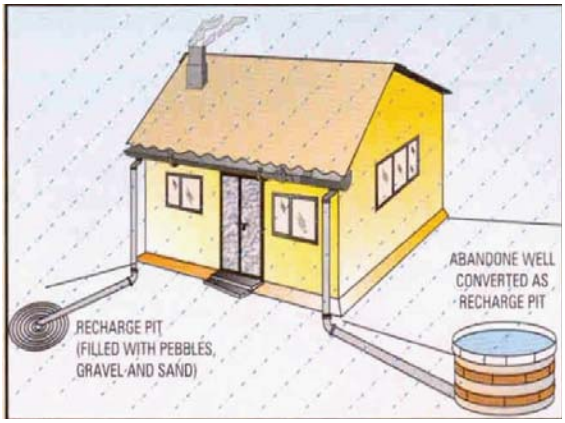
Quality of rainwater harvested

As the primary source of water, rainwater is the purest form of water. Rainwater harvesting not only solves the problem of availability of water, but also provides good quality water.

However, certain precautions need to be taken to ensure that the stored water is not polluted.

- Keep the roof or the water collection area clean before the rains
- Flush the rainwater collected in the first few minutes.
- Store the collected rainwater in a closed container (avoid sunlight). (Fig 4)

Fig 4



- The quality of water deteriorates in the presence of sunlight and air.
- Water can be kept clean over a period of five to six months in a clean container stored in an enclosed area protected from sunlight.

Who can harvest rainwater and where?

- People planning construction of houses, modification of houses, existing house, etc.
- From rooftops of Govt. buildings, institutions, hospitals, hotels, shopping malls etc.
- From rooftops and open areas.
- Farmlands, public parks, playground, etc.
- Paved and unpaved areas of a layout/city/town/village.

Need for rainwater harvesting

Water harvesting is an activity of collection of rainwater and storing in containers for direct use or can be recharged in to the ground.

1 As water is becoming scarce, it is the need of the day to attain self-sufficiency to fulfill the water needs.

2 As urban water supply system is under tremendous pressure for supplying water to ever increasing population.

3 Groundwater is getting depleted and polluted.

4 Soil erosion resulting from the unchecked runoff.

5 Health hazards due to consumption of polluted water.

Methods 1 : Rainwater harvesting

Rainwater stored for direct use in tanks above ground or underground sumps or overhead tanks and used directly for flushing, gardening, washing etc.

2 Ground water recharge

Recharged to ground through recharge pits, dug wells, bore wells, soak pits, recharge trenches, etc.

3 Rainwater harvesting potential

Rainwater harvesting potential in urban areas is huge. Considering the availability of rainwater in a residential site of 40 x 60 feet (an area of 2400sq.ft./223 sq.mts.), around 2,23,000 its of rainwater can be harvested in a location where the rainfall is around 1000 mm or 39.4 inches (Bangalore receives around 1000 mm of rainfall annually). The amount of rainwater that can be harvested from the available rainwater in the plot depends on potential rainfall, catchment area available, collection methods and its efficiency etc. Collection methods and its efficiency etc. (Fig 5)

4 Rainwater harvesting for domestic applications water requirement of a house can be broadly classified into

a) Drinking

b) Cooking

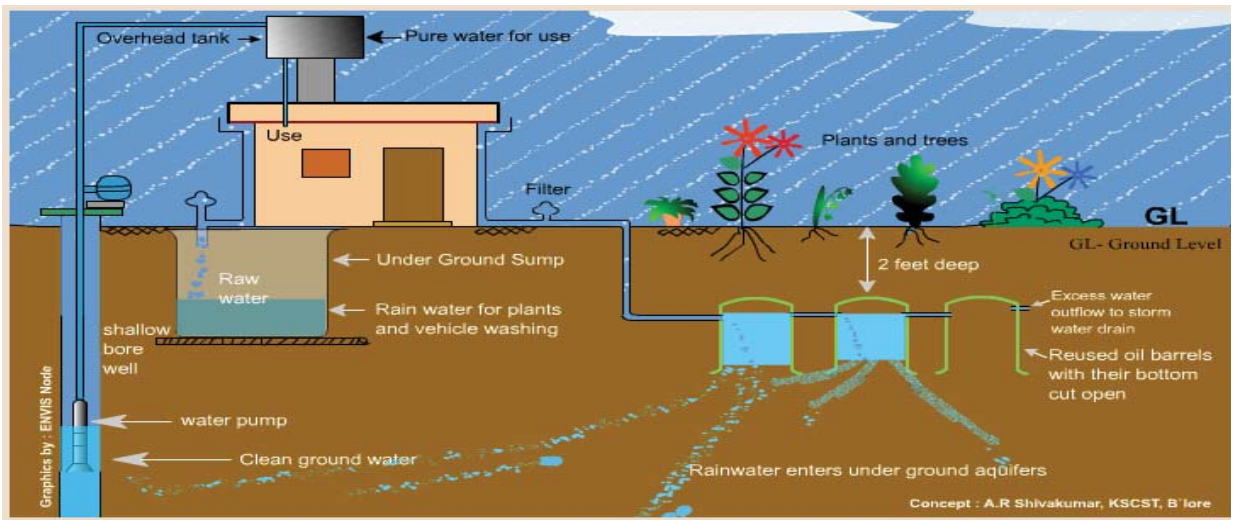
c) Bathing

d) Washing -(Vehicles, Utensils, Clothes, Floor cleaning)

e) Gardening

f) Flushing in toilets

Fig 5



For washing, gardening and flushing toilets, relatively less clean water can be used (secondary use). Water requirement in a house is throughout the year. However, rainwater availability without having facilities to store is limited to number of rainy days and the quantity of rainwater available during the rainy days. Several interventions can be made to enhance the number of days of use of rainwater from number of rainy days to 365 days a year. Parameters, which support rainwater harvesting, are availability of space, willingness to invest, technical suitability of soil structure and geological parameters.

Rainwater harvesting for rooftops

Roof top rainwater harvesting

In urban areas, building are usually constructed with rooftops of reinforced cement concrete (RCC), mangalore tiles, asbestos/galvanized iron/zinc sheets etc. Construction of buildings with the above mentioned material requires roof top rainwater to be removed from building tops and currently been let off into storm water drains outside the plot area (which eventually goes away from the city).

The rooftops being built significantly with hard material, large quantities of rainwater runoff and loss due to evaporation and percolation are very minimal. Thus, rooftop rainwater harvesting can be put to good use by storing rooftop water on (a) roof itself (b) ground level (c) below the ground, by using storage devices like masonry tanks/ferro cement tanks/plastic or metal containers.

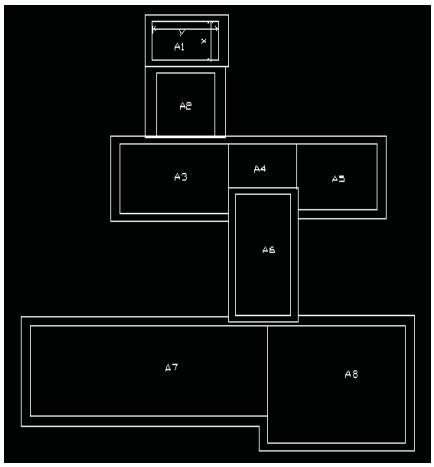
1 Roof area calculation

Roofs are of broadly two categories-flat roofs and sloping roofs.

Flat roofs when made with reinforced cement concrete normally have waterproofing course on the surface as a finish. The waterproof course is done with a small

slope towards the down take pipes. Usual practice is to use lime surkhi, in recent times a rich cement mortar is used ("muddy" in local parlance), weather proof tiles are also laid on cement mortar. These types of roofs are ideal for rooftop rainwater harvesting. (Fig 6)

Fig 6



Effective roof area for rainwater harvesting

Flat roof:

Calculation of effective roof area into grids

Divide the roof area into convenient grids and calculate the area of each grid.

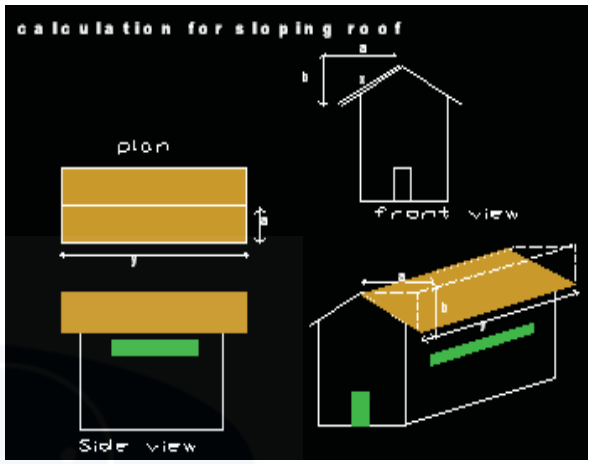
Example A1 = X x Y where A1 is the area, X is the length and Y is the width of one portion of the roof)

Add the individual grid area to get the total roof area.

i.e. A1+A2+A3+A4+A5+A6+A7+A8.... = A (total area).

Effective roof area is excluding the peripheral wall thickness and any other opening. (Fig 7)

Fig 7



Example:

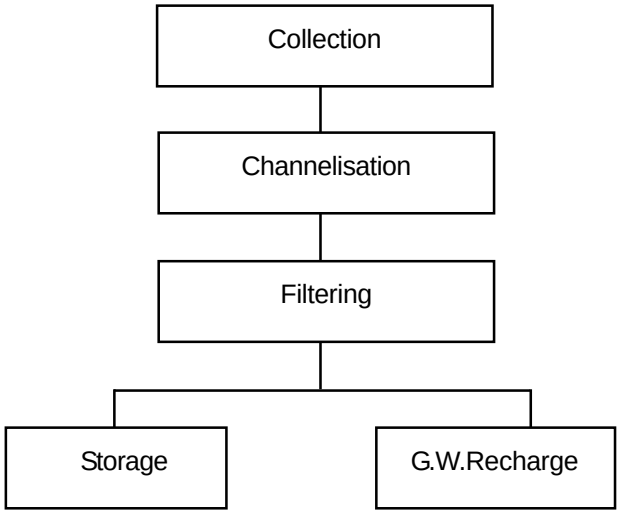
(A1) Area of one part of the roof = a x y

(A2)Area of other part of the roof = a x y

Total area = 2 x a x y

Calculation of effective roof area sloping roof

Various stages of rainwater harvesting



2 Channelisation

Down water pipes made out of PVC, HDPE or cement pipes can be used for tranporting rainwater collected from roofs to the filtration system before storing. The size of the down take pipe varies depending on the roof area, which is connected to the down pipe.

3 Filtration

Rainwater collected on the roof is very pure and clean. However, there are many substances, which get mixed up with this pure water on the roof (leaves, bird droppings, dust etc.). These contaminants need to be filtered before the rainwater is stored. There are many filtration systems.

a) Sand bed filter

b) Popup filter

c) Stabilization tank

a) Sand bed filter

Sand bed filter is the traditional method where coarse riverbed sand, pebbles and aggregates are filled as layers one above the other in a confined masonry structure. Rainwater is allowed at the top from one end and filtered water is drawn from the other side. (Fig 8 & Fig 9)

Fig 8

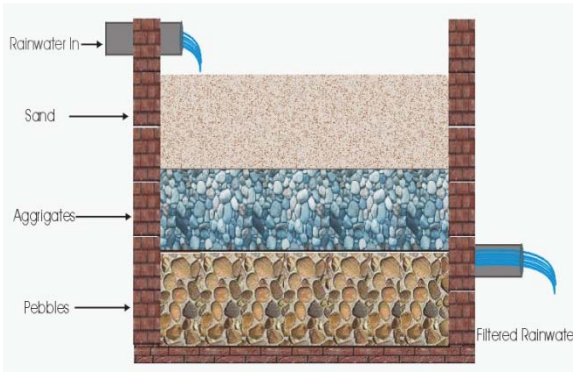
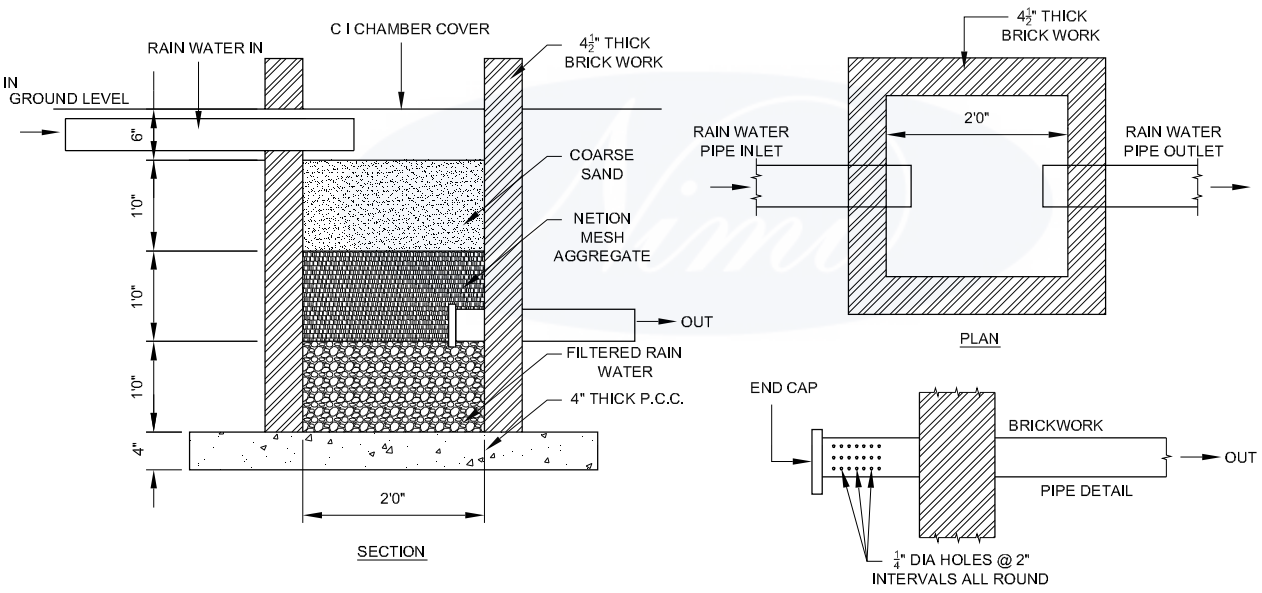


Fig 9



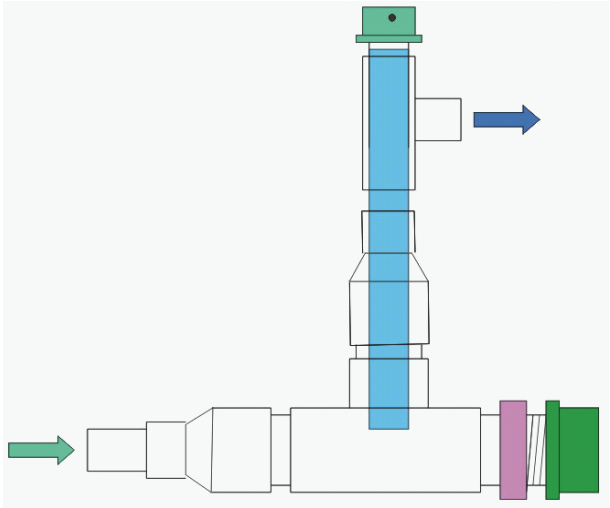
SAND BED FILTER FOR FILTERING RAINWATER

b) Popup filter

The "popup filter" has three components (rainwater receptor, flush valve and filter element) rainwater receptor where the rainwater is allowed to flow from down pipes and a flush valve is provided to flush the first flow of the rainwater along with leaves, dust etc. Water received in the receptor flows upwards against gravity through a filter element to filter most of the floating elements and allow water to stabilize in this filtration zone. Rainwater passing through this filter element (which is relatively cleaner), flows out through an outlet, which can be led to storage device. Filter element is mounted on a vertical stabilizer pipe with a friction fit. In the normal course, rainwater gets filtered and flows through outlet into the storage device. Filter element needs to be cleaned periodically during the rainy season to remove the filtered material and to keep the filtration system clean. In the event where the filter is not cleaned and the filter element is getting clogged, the "popup filter" has a built-in safety feature it to push out the filter element from the stabilizer pipe and allow the water to flow out freely. This safety feature will avoid flooding of the rooftop because of clogged filter. The first indication of the filter getting clogged is rainwater flowing out of a vent hole provided on the top of the filter element.(Fig 10)

These popup filters are simple in design and are very flexible to install in verifying field conditions.

Fig 10

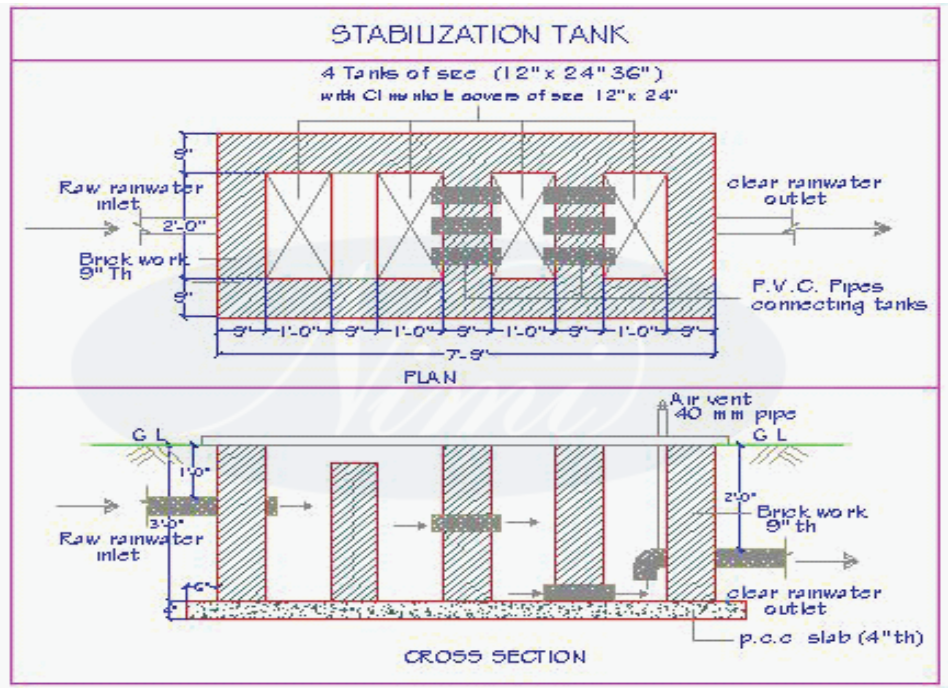


An important feature in filtering is the separation of first flush of rainwater from relatively cleaner and purer subsequent rain.

c) Stabilization tank:

For large volume of rainwater a unique design has been developed by the author to trap light and heavy impurities without having any filter media. Rainwater is allowed to flow through a series of small tanks and by providing an entry and exit for water at strategic positions, impurities can be trapped in the stabilization tanks for subsequent cleaning. Heavier impurities will get trapped in the first two tanks as the water flows out at the higher level. Lighter and floating impurities get trapped in the third and fourth tanks as the water flows out at the bottom or lower level. Periodic cleaning of these tanks is required to remove the impurities. (Fig 11)

Fig 11



4 Storage

Storage of harvested rainwater is possible at various levels.

The storage structures may vary from permanent masonry tanks, ferro-cement tanks to plastic or metal tanks. The capacity of storage device can be decided by considering parameters such as roof area, water usage and space availability. Water consumption in a house is throughout the year and water availability from rainfall is for a limited period restricted to number of rainy days in a year. To make rainwater available in non rainy days, storage device need to be designed with an optimum capacity to suit the need/requirement. In rainwater harvesting system, storage device is the single most expensive component. Optimum size of the storage device and cost effective methods to store water are the key issues for a viable roof top rainwater harvesting system. (Fig 12)

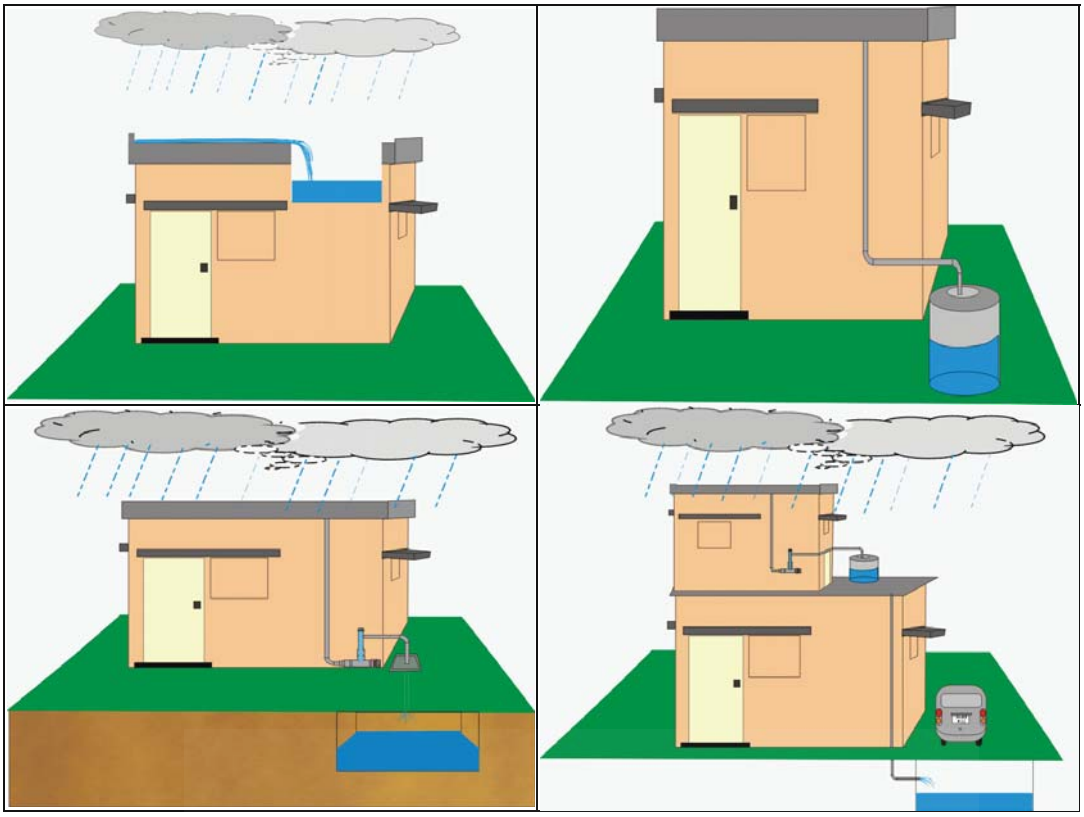
Collection surface

Larger the roof area available for rainwater collection higher is the quantity of rainwater collected. Cleaner and better the quality of rooftop, cleaner and better will be the rainwater collected. Maintenance of the roof surface and keeping it clean has a direct bearing on the quality of water collected.

Rainwater harvesting storage facility and capacity

Rainwater collected on the roof and guided through the down water pipes gets filtered in the filtration system and is available for direct use. Rainwater coming out of the filter may be guided to a storage device for future use. Positioning, size and capacity of the storage container may be decided considering the roof area and the requirement of raw-water. Higher the storage capacity more will be the rainwater availability during the non rainy days. In urban areas, like Bangalore, total rainwater storage capacity of around 8,000 to 15,000 its would

Fig 12



suffice for the requirement of secondary usage (gardening, vehicle washing, cleaning etc.).

Roof yield or potential rainwater from a roof

Roof yield or the potential rainwater from a roof is normally referred to the annual yield from a given roof area. Annual yield is the quantity of water in liters collected from a given roof over a period of one year covering all the rainy days.

It is the product of roof area and the annual rainfall.

Example:

a Roof area of 100 sq. meters with annual rainfall of 1000 mm (milimeters)

Roof yield = 100 x 1000 = 1,00,000 liters/year

b Roof area of 1000 sq. feet with annual rainfall of 40 inches

Roof yield = 1000 x 40 x 2.36 (constant) = 9

Cost of rainwater harvesting: Examples to illustrate, rainwater harvesting can be many and the cost involved also vary from case to case. The parameters that influence the cost of rainwater harvesting are:

1 How much rainwater to collect

2 Type of surface from where rainwater is collected

3 Existing structure and fittings for rainwater collection and flow

4 Type and capacity of harvested water storage device

5 Method and system of rainwater retrieval system for use from storage device

Considering the above facts, rainwater harvesting can cost as little as Rs. 1000/- and may go up to Rs. 50,000/- for a residential building.

Rainwater harvesting for those who does not have proper roof can also be harvested by those who does not have proper roof by creating temporary collection surface by using a clean cloth piece (Sari or Doti or Panche)

Four corners of the cloth piece may be tied with separate threads and stretched three feet above the ground and tied tightly to four supports (poles/supports/walls etc.) during a rainy day. As the rainwater falls on the outstretched cloth depressions in the middle will be formed and all the water will get collected at the center. Since the cloth is pours water will start getting filtered through the cloth and starts dripping/flowing down at the center. A vessel or a can be placed to collect this pure rainwater for further storage in an enclosed tank or a larger container for future use.

Divide the roof area into convenient grids and calculate each grid area by taking projected length & breadth. Actual surface area i.e. x x y is not considered for the calculation of roof area but the projected area i.e. a x y is considered.

Ground water recharge

Underground water is one of the important sources of water in urban areas. With increasing urbanization, underground water has been indiscriminately exploited causing depletion in water table and water availability. It is very evident from the number of failing bore wells/open wells that it is unsustainable to pump out water from wells without recharging the same from the rainwater. To reverse the trend or to reduce the effect of over exploitation, ground

water recharge needs to be taken up in large scale at residential and institutional buildings.

There are many methods of ground water recharge. Following are few methods for recharging ground water using rainwater from rooftops of buildings. (Fig 13)

a) Reused plastic barrels method

b) Direct recharge through open wells and bore wells

c) Infiltration gallery for large building

d) How to build and infiltration gallery?

e) Roads/Trenches

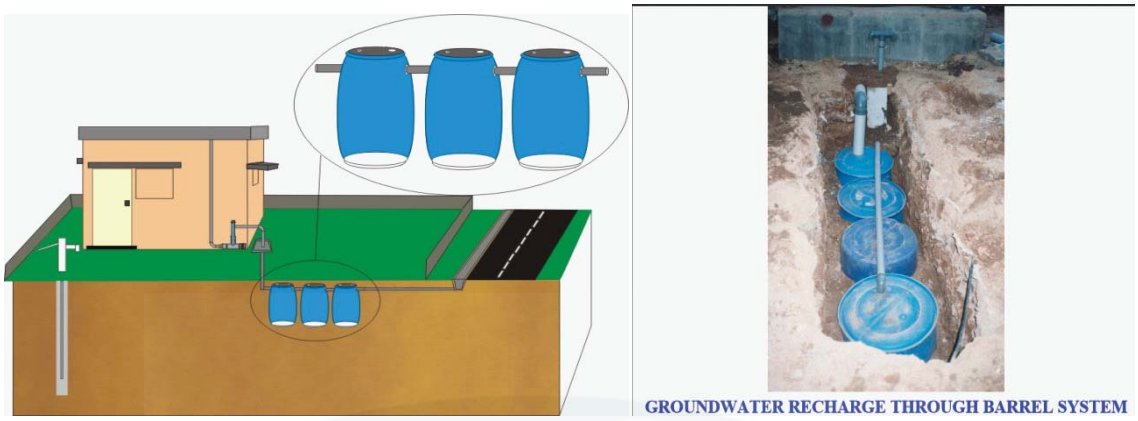
f) Parks and open spaces

g) Layouts

a) Reused plastic barrels method

This cost effective and simple method has been developed by A.R. Shivakumar. In this method, overflow or rainwater from the storage structure and water from the roof other than the roof connected to the storage structure may be allowed to flow through a popup filter. This filter will filter floating elements and to some extent the silt coming in the water. Relatively cleaner water comes out of the filter and is allowed to flow into ground water recharge gallery. (Fig 13)

Fig 13



GROUNDWATER RECHARGE THROUGH BARREL SYSTEM

The ground water recharge gallery is created by using reused plastic oil/chemicals barrels (blue colored drums sold on the road side for construction activities etc.).

These barrels are of around 200 to 220lts. Capacity each and are quite strong in their construction. One side of the barrel (top or bottom), which is circular in shape, is cut open.

Depending on the total roof area connected to this infiltration gallery, more number of barrels are used for ground water recharge. The barrels are buried underground with their sides cut open facing down wards.

These empty barrels are buried without filling anything into them. The top of the barrel, which is intact, should be two feet below the ground level. These barrels are placed one beside other and they are connected to each other at the top by a pipe. By doing so, these barrels are placed upside down under the ground at a depth of two feet from the surface. Outflow of the popup filter is connected to the first barrel in the row by a pipeline.

Rainwater flowing from the filter flows into the first barrel, which is underground and its bottom cut open. Since the ground below the barrel is porous, water flowing into it infiltrates into the ground.

During heavy rainfall, more water stores temporarily in the first barrel and over flows in to the next and later to subsequent barrels. As the height of the water increases in the barrels, percolation level also increase because of water head inside the barrels. In a system of barrels, first barrel in the row receives water and subsequent barrels are interconnected at the top to receive excess rainwater. Last barrel carries the overflow (if it happens) through a pipe into the storm water drain outside the plot. To facilitate the air trapped in the barrels to escape out, an air vent is provided at the last barrel by fixing a vent pipe (Overflow pipe can also act as an air vent).

In the normal situation, where house is not located in low-lying area, (water stagnation during rainy season), one barrel is required to percolate water from a roof area of around 400 sq.ft. However, the percolation from each barrel depends on many other parameters like water table, soil structure, rainfall in the site etc.

Process: Identify an open space around a building to create barrel system of infiltration gallery. Excavate earth to a depth of 6ft. from the ground level. The width of excavated pit must be slightly more than the diameter of the plastic reused oil barrel (around 1 ft. or 21 inches).

Length of the excavated pit must be equal to number of barrels used multiplied by diameter. For example a four barrels infiltration gallery will have excavated pit of 21 inch x 4 no. = 84 inch or 7 ft. length.

Take required number of plastic barrels (each of around 200lts.) and cut open one side of all the barrels.

Drill two holes at the bottom end on opposite sides with diameter slightly more than that of rainwater down pipe (4 or 5 inch as the case may be). Install empty barrels so prepared in the excavated pit with their cut open side facing downwards. Align all the barrels in one line with the side holes facing each other. Insert a pipe of 12 inch length to interconnect two neighboring barrels.

Guide the rainwater pipe connected to the outlet of the popup filter to the first barrel. Connect a similar pipe as overflow to the last barrel and leave the outlet of this pipe to the drain outside the building. Make sure a cap with perforations is fitted to prevent rats or insects from entering the overflow pipe at the drain. Also make sure that the over flow pipe end is at a level above the normal water flow level in the drain.

Fill up the excavated pit with soil leaving the barrels and the connecting pipes undisturbed. Once the soil over these barrels stabilizes, activities like gardening, cement flooring, light vehicle parking etc. Can be taken up.

Rainwater flowing from the popup filter flows in to these barrel system of infiltration gallery and recharges ground water.

Direct recharge through open wells and bore wells

Rainwater from the roof may be allowed to flow through PopUp filter and recharge ground water from an existing open well or a bore well. In case of an open well, filtered rainwater may be directly let in to the well through pipe from any one side of the well. Make sure the water pipe is slightly projected in to the well and a bend at the end of the pipe will guide the water downwards. This arrangement will avoid the water flowing on the wall of the well and subsequent damage to the wall. During heavy rainfall water level in the well raises and subsequently descends to maintain the ground water level. Wells can be built by digging the ground to the required depth (15 to 30 feet) and building the retaining wall around (preferably round) or by inserting cement rings to avoid caving in of the sidewall. It is advised not to allow the filtered rainwater from the PopUp filters in to the bore well (live or failed). Fine silt or dust from the roof may pass through the filter and block the micro pores or aquifers in the bore well causing permanent damage to the bore well. Rainwater from the filters may be allowed to stabilize in a storage facility or an infiltration gallery specially designed to inject rainwater in to the bore well. Infiltration gallery may be built next to the bore well, as explained in the section "Infiltration gallery for large buildings". The size of infiltration gallery can vary from 300 cft. to 800 cft. Depending on the roof area. A perforated pipe needs to be installed in the second layer from the bottom from one end to the other. Farther end of the perforated pipe needs to be blocked with an end cap and the other end of the pipe is inserted in to the bore well by drilling the casing pipe of the bore well to the outside diameter of the perforated pipe. Make sure the perforated pipe is not projecting too much in to the bore well which will cause hindrance to install pump in to the bore well. At the same time if the pipe is not properly and firmly fixed to the casing pipe chances of silt/sand or other material may get an entry into the bore well. Size of this pipe can be of 40 mm or 1.5 diameter having 6 mm holes (at an interval of 150 mm or 6) all along the bottom side of the pipe. It is important to have holes only at the bottom side of the pipe as shown in the figure to avoid fine silt entering the bore well. (Fig 14, Fig 15 & Fig 16)

Fig 14

Fig 5

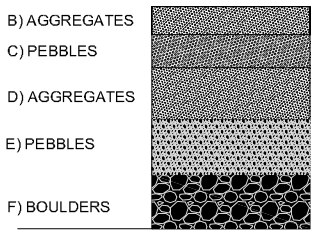


Fig 6

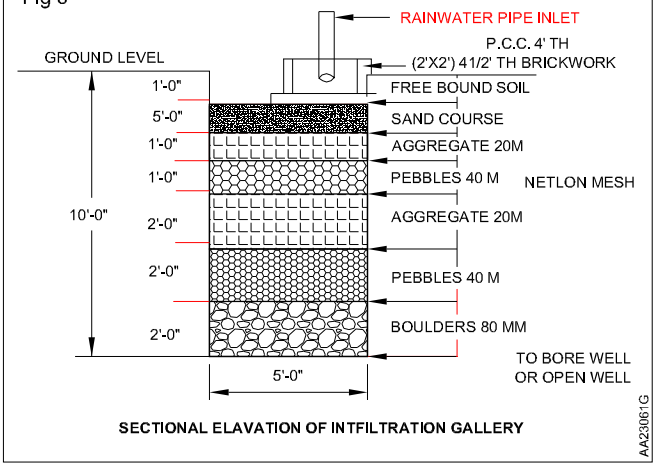
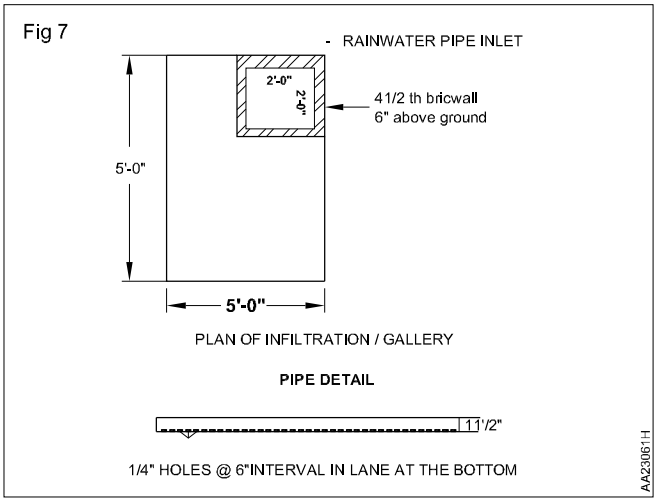


Fig 7



How does the direct injection of rainwater works?

As the rainwater descends in the infiltration gallery, most of it gets in to the subsoil and recharges ground water. During heavy rainfall, rate of infiltration will be slower than the inflow of rainwater and the rainwater starts accumulating in the gallery. As the level of water increases in the gallery and rises above the perforated pipe level, clear and stabilized water enters the pipe from the small holes provided at the bottom of the pipe to reach the bore well. In this process fine silt, which escapes PopUp filters and sand bed at the top of infiltration gallery descends to the bottom of the infiltration gallery and settles down permanently. Clear and safe rainwater recharges the bore well aquifers to increase the yield and availability. It is advised to consult a professional before attempting to inject rainwater into bore wells.

Infiltration gallery for large buildings

Infiltration gallery is to store rainwater temporarily and allow the stored water to infiltrate into underground aquifers. When the rainwater from the roof is allowed to flow on the ground infiltration (water percolating into the ground) is less, causing more of runoff, thereby majority of rainwater quickly reaches drains or storm water drains or streets and flows away from the building. To artificially increase infiltration, two parameters are important:

(a) Increasing the surface area of the soil/earth in contact

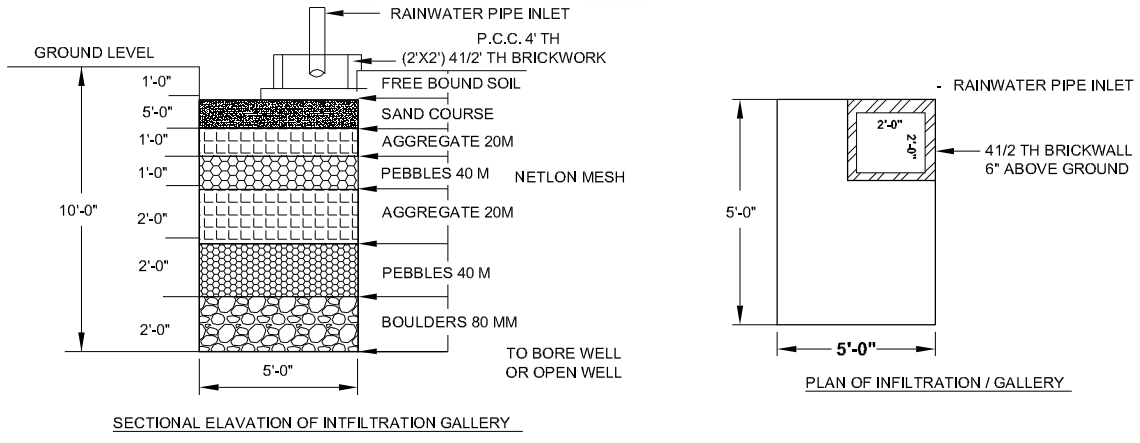
(b) Creating water head on the soil/earth

Increase in any of the above or both will influence greater infiltration of rainwater into ground. The level of infiltration also depends on the structure of the soil.

How to build an infiltration gallery?

Identify an open area around the building, and excavate earth to the required size, the excavated pit can be of rectangular or circular in shape. To support better infiltration and for convenience of excavation, the infiltration gallery can be of minimum 5 ft. and maximum 10 ft. depth and of similar width. Length of the infiltration gallery can vary to accommodate runoff water from the roof during heavy intensity rains. The excavated pit has to be filled layer by layer with material like pebbles, gravel, sand etc. These layers of different material will allow the rainwater to flow gently without much of turbulence and accommodate storing of rainwater temporarily. (Fig 17)

Fig 8



The sand layer will arrest silt coming in along with rainwater. To have a greater effect of the layers of different material, fill the excavated pit with soling or aggregate of large size to a depth of two feet. Fill the second layer with 40 mm aggregate to a depth of one foot and the third layer with 20 mm aggregate to a depth of one foot. Repeat the combination of 40 mm and 20 mm aggregate till 2ft. Short of ground level (leaving 2ft.depth of pit empty from the top). Over the layer of the aggregate, spread a sheet of plastic/ nylon mesh or net (mosquito net). Fill the balance of the infiltration gallery (top 2ft.) with coarse river sand. Build a boundary rim around the infiltration gallery with brick and

cement masonry structure. This will avoid flow of water from the surrounding along with other impurities directly entering into infiltration gallery.

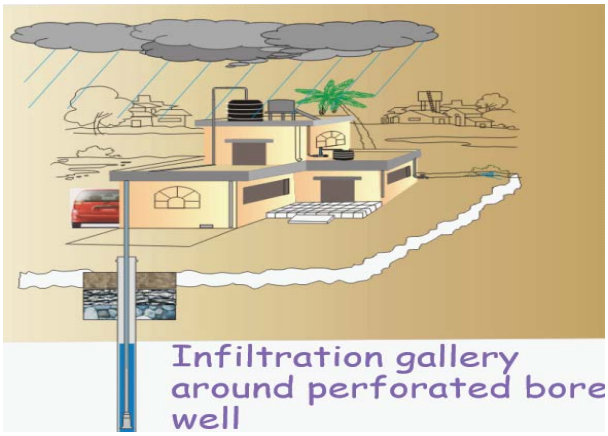
Important

- All the material used in infiltration gallery like aggregate and sand need to be thoroughly washed to remove all silt and finer particles before filling into the infiltration gallery.
- Infiltration gallery created underground should not be lined with plastic or brick and cement masonry or any other material, which will block the rainwater entering into underground aquifer.
- The bottom of the infiltration gallery should not be lined or rammed to create hard surface. All these attempts will block the rainwater entering into underground aquifer.

Process

The rainwater flowing from the building roof will be filtered in popup filter and canalized through pipes or cement lined channels to reach infiltration gallery. At the point of enter of rainwater in the infiltration gallery, splash pad may be laid to avoid splashing of water. Splash pad may be of rubber or plastic with perforation to hold water from flowing directly into sand. Water entering the infiltration gallery through sand bed will reach different layers of aggregates and start infiltrating into ground. The popup filter on the down comer pipe will arrest most of the impurities. The sand layer in infiltration gallery will arrest finer silt or dust coming along with rainwater. Different layers of material in the infiltration gallery will facilitate flow of rainwater gently into infiltration gallery without having much turbulence. During heavy rainfall, water flowing into infiltration gallery will be more than the water infiltration into the ground, thereby the water temporarily gets stored and the level of water in the infiltration gallery rises. With increase in the water head percolation level also increases. (Fig 18)

Fig 18



Rainwater harvesting from roads

In the recent past, rapid growth in the urban areas has led to asphalted roads and stone slabs or pavers for footpaths. This accounts for nearly 10% of the total area of Bangalore. Consequent to this, the rainwater run-off has increased and ground water recharge has declined.

As the roads are built sloped towards the sides, rainwater falling on the road is guided to the side drains. When it rains, water flows from the apex to the sides and collects in the sidewalk area and subsequently flows to the storm water drains. (Fig 19 & Fig 20)

To increase ground water recharge by percolation and decrease the flooding of storm water drains, an infiltration trench could be built by the side of the drain all along the road, wherever possible. The infiltration trench can be 2 feet wide and 2 feet deep and filled with pebbles or aggregates with a top layer of coarse river sand.

Fig 19

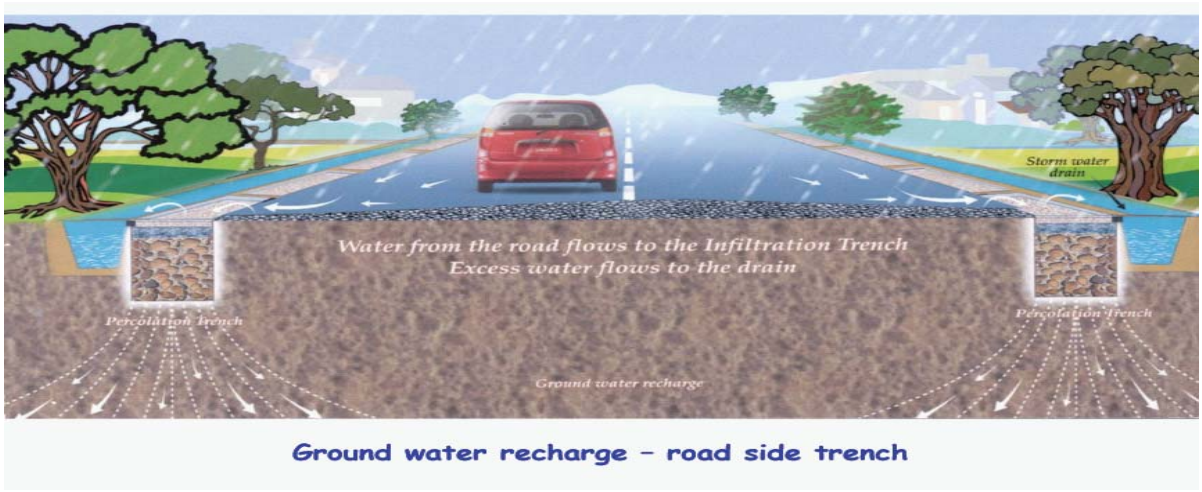
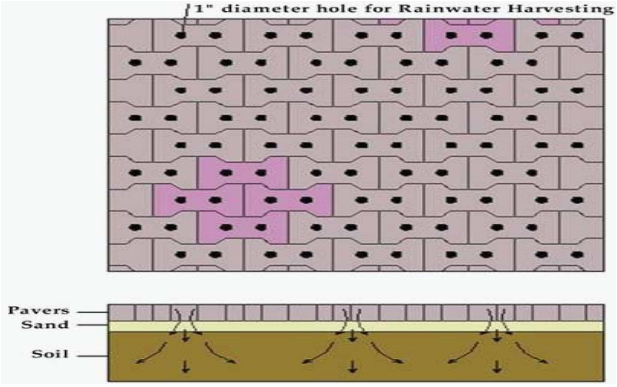


Fig 20



As the rainwater from the road flows into the infiltration trench, water percolates into the ground. During heavy rainfall, excess water spills over to the storm water drains. The infiltration trenches store water temporarily during rainfall and later for infiltration. These infiltration trenches may be exposed as walk ways or paved with inter-locking pavers, specially designed with gaps in between for water to flow into the infiltration trenches.

Parks and open spaces

1) Water harvesting methods in parks and open spaces involve micro-watershed management methods that allow rainwater infiltration and percolation into the ground. The runoff has to be minimized by providing adequate number of percolation pits and dispersion trenches. In large parks, storage of rainwater in small ponds is also possible since the ponds can be integrated with the landscape of the park. Mapping of the contours, planning for rainwater outflow in consonance with natural.

Drainage patterns, identifying appropriate areas for percolation pits/dispersion trenches will be required.

Recharge of pits or trenches

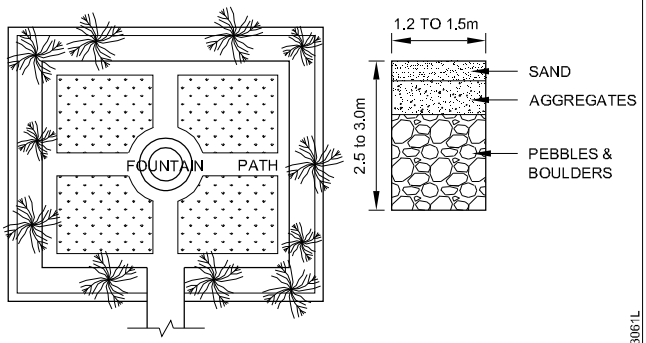
Ground water recharge in parks can be enhanced by a simple technique of providing recharge pits or a trench.

- Width of pit:1.2 to 1.5 m. Depth: 2.5 to 3.0 m.
- Material: 40-60 mm coarse gravel followed by 20 mm aggregates and 2 mm sand. Pits are conveniently made at suitable low-level micro-watershed locations as collection centers of surface runoff.
- A splash pad is provided on top of the sand layer to cut off the velocity of entry of water to the pit.
- The number of such pits is based on the park area and the small rivulets dissecting the landscapes into micro-watersheds.

Requirements

- Creation of water harvesting ponds in concave depression and low-lying areas.
- Allowing groundwater recharge by the creation of seepage pits.

Fig 21



RECHARGE PIT FOR PARKS AND OPEN SPACES

- Allowing surface runoff to enter into existing wells or artificial water bodies.

Natural flow of water

- Surface runoff water should be trapped in ponds, tanks and lakes when available, so that it can be used for maintenance during dry periods.
- This practice is similar to dry land technology of agricultural belts.
- Low-lying areas and drainage channels are earmarked and convenient micro-watersheds are prepared.
- Water harvesting is followed based on natural flow and surface accumulation of the runoff water.
- Water follows the lowest contour gradient available for that area.
- These structures not only provide water for the park, but also increase groundwater recharge.
- Providing a bore well in these areas will enhance the availability of water in its vicinity.

Rainwater run-off from open space and paved areas can be stored in underground sumps by filtering through sand-bed filters and guiding the filtered water through channels.

Layouts

Layout refers to a geographical area encompassing sites, roads, drains, civil amenities and parks. Rainwater harvesting in layouts can be done using the 'Cascade Capture Method'.

In this process, rainwater can be harvested on a plot or through recharge of ground water. The run-off from the plot could be captured by storm water drains and directed into artificial infiltration or percolation pits. The overflow from the storm water drains and infiltration system could be captured in lakes and tanks. The method of rainwater harvesting involves contour mapping, drainage pattern, determining a storage point/ground water recharge and ensuring segregation of sewage/sullage from storm water run-off.

Nimi