Types of Joints in Concrete Constructions

1. Construction Joints

Construction joint is placed when the mass concreting works are done and cannot be completed on a single stretch. The interface of the past day's hard concrete and present days fresh concrete is to be properly done so as the bonding should be perfect for load transferring and avoiding water leakage. This interface joint is known as Construction Joint or Daywork Joint.

Construction joints must allow horizontal displacement right-angled to the joint surface that is normally caused by thermal and shrinkage movement. At the same time they must not allow vertical or rotational displacements. Fig.1 summarizes which displacement must be allowed or not allowed by a construction joint.

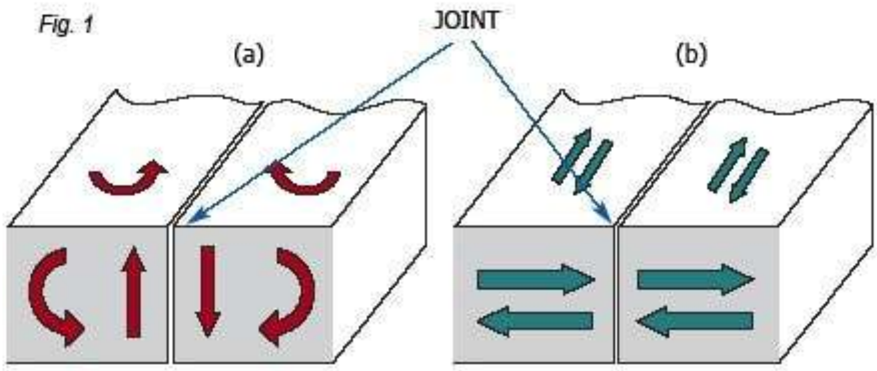


Figure 1 – Relative movements which must be (b) allowed and (a) not allowed by a con-struction joint for concrete slabs

POSITION OF CONSTRUCTION JOINTS

The number of construction joints in concrete structures should be minimized. If construction joints are necessary to facilitate construction, it is normally aligned perpendicular to the direction of the member.

For beams and slabs, construction joints are preferably located at about one-third of the span length. The choice of this location is based on the consideration of low bending moment anticipated with relatively low shear force.

However, location of one-third span is not applicable to simply supported beams and slabs because this location is expected to have considerable shear forces and bending moment when subjected to design loads. Sometimes, engineers may tend to select the end supports as locations for construction joints just to simplify construction.

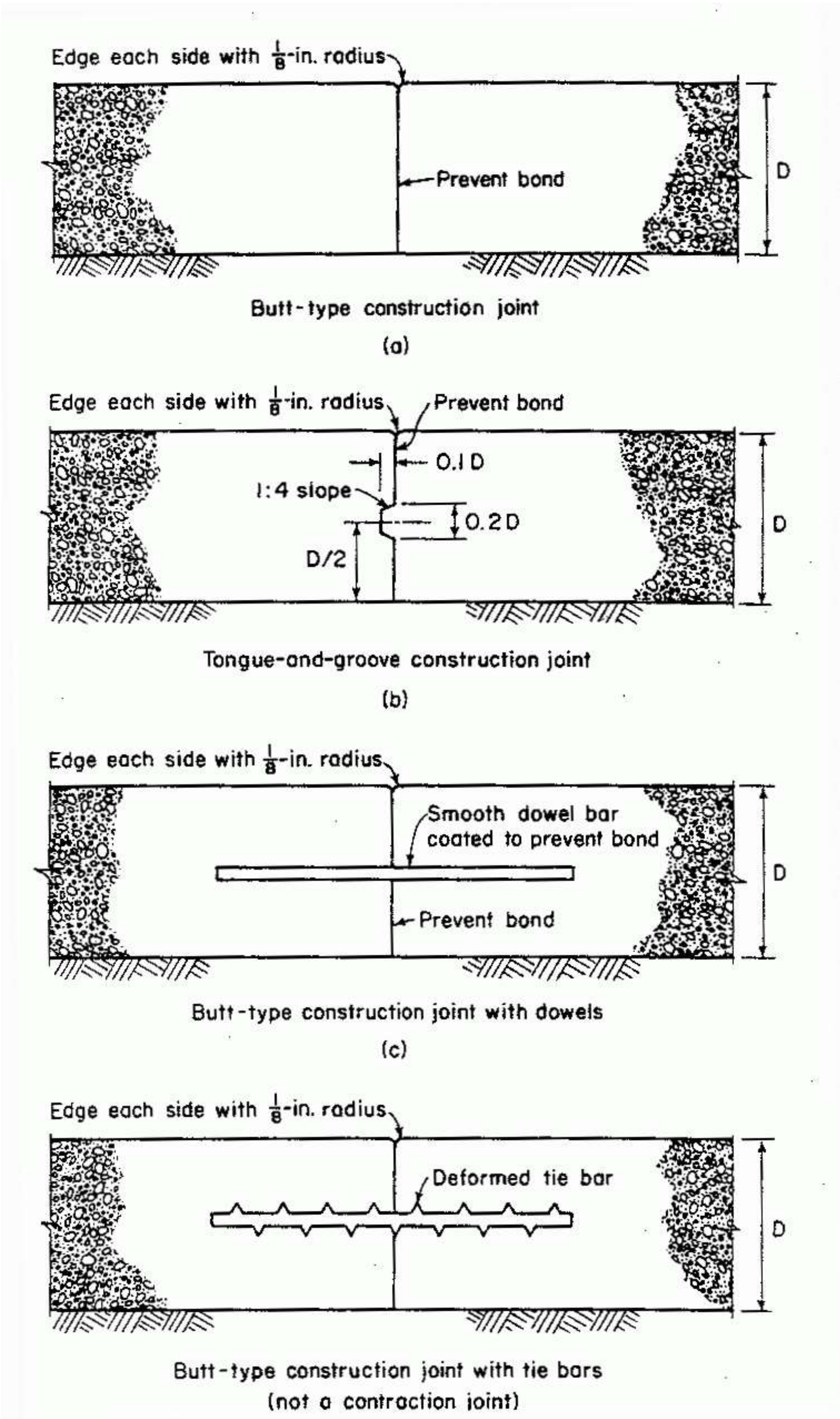


Fig.2: Types of Construction Joints in Concrete Structures

2. Expansion joints

Expansion joints are placed in concrete to prevent expansive cracks formed due to temperature change. Concrete undergoes expansion due to high temperature when in a confined boundary which leads to cracks.

Expansion joints are provided in slabs, pavements, buildings, bridges, sidewalks, railway tracks, piping systems, ships, and other structures.

Fig2: Cracks developed due to expansion of concrete.

NEED OF EXPANSION JOINTS

- If not provided the structure shall be subjected to internal compressive stresses and these stresses may be so high that structure may fail.
- The amount of expansion as already stated depends upon the extent of change of temperature, the extent of the structure, and on the coefficient of linear expansion of the material.
- But of these three parameters changes in temperature and coefficient of linear expansion cannot be controlled.
- It is only the extent of the structure which can be reduced to limit the expansion the structure within specified limits.
- Based on these concepts it is seen that the structure 30 meters long when subjected to temperature change of 50 degrees F expands about 10 mm.
- Small buildings usually do not require any expansion joint, but if the continuous length of the structure exceeds 45 meters expansion joint should be provided.

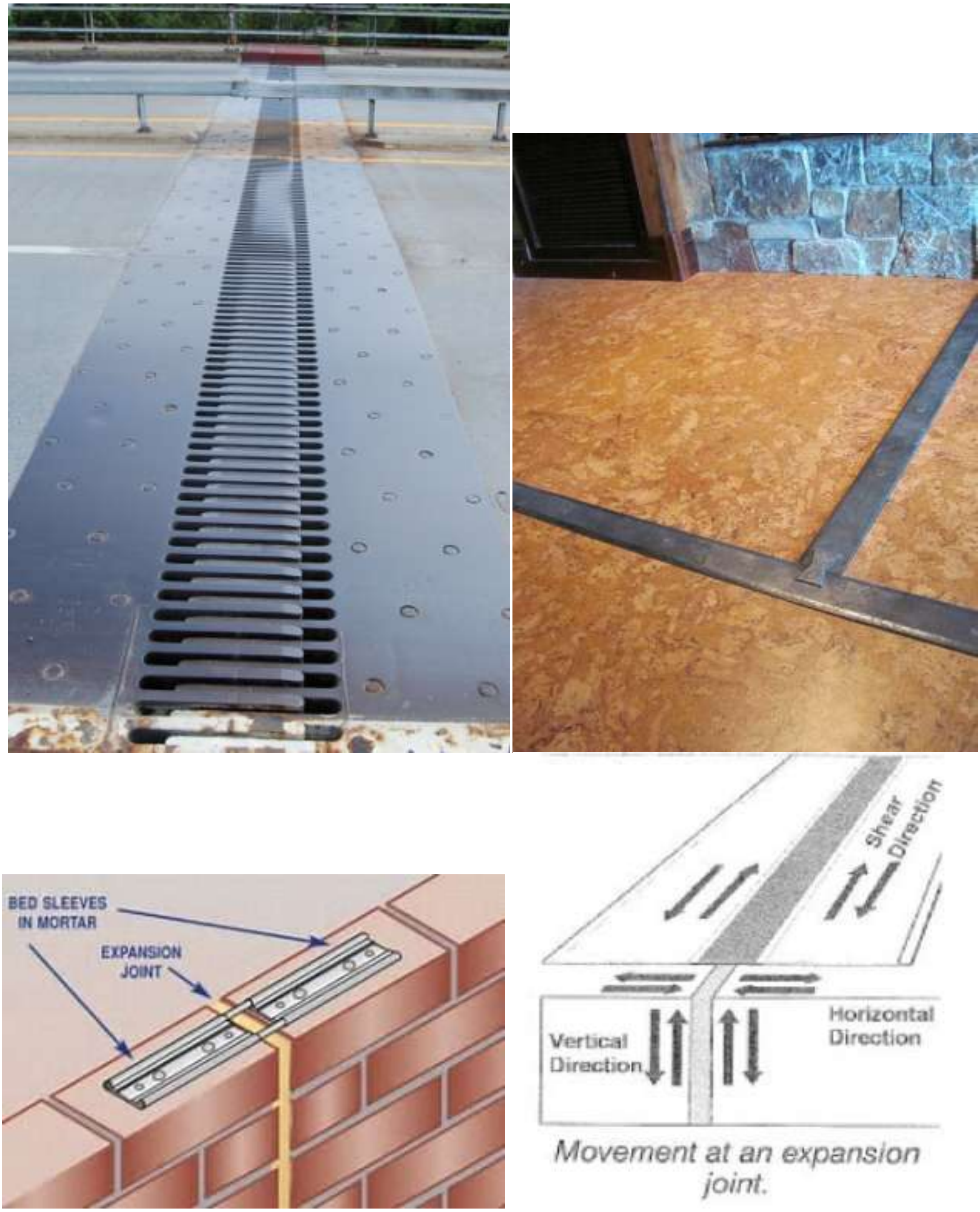


Fig.3: Expansion joints

CONSTRUCTION OF EXPANSION JOINT

`The expansion joint is to be provided from the foundation to the top floor of the building. The one side of the expansion joint is first constructed to desired level, then the Fiberboard is placed where Expansion joint is to be provided then the other side is constructed. The fiberboard is sealed with sealing compounds. Thus the whole construction of the building is done.

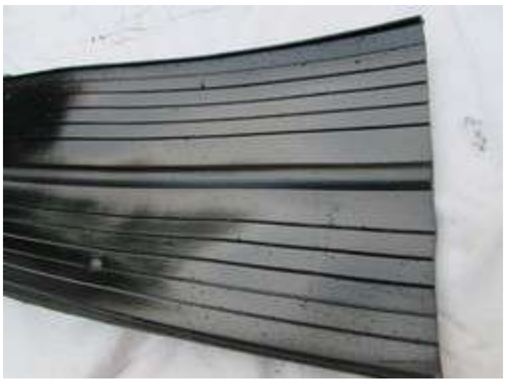
MATERIAL & TECHNIQUES

The gap of expansion joints is never left open. It is filled with a compressible material so as to make it water tight. The following materials are required to render the expansion joint watertight.

- **Joint filler**: Bitumen, bitumen containing cellular materials, cork strips, rubber, mineral fiber, expanded plastic, pith, coconut, etc. are the usual joint filler materials. Joint filler should be compressible material tightly fitted in the gap. Being compressible, they readily allow free expansion of adjacent parts. It should regain 75% of its original thickness when external pressure is removed from it. They should be rigid, durable and resistant to decay.

- **Sealing compound**: its function is to seal the joint against passage of moisture and to prevent the ingress of dust, grit or other foreign matter into the joint. It should be tint less, non-toxic, insoluble and readily workable. Mastic or Hot-applied bituminous sealing compound is mostly used for the purpose.

- **Water bars:** the function bars are to seal the joints against passage of water. Water bars may be made of rubber, P.V.C., G.I. sheet, copper, or aluminum sheets. G.I. Water bar should not be used under corrosive conditions. Width of water bar may be varied from the 15cm. to 20cm.and thickness should not be less than 0.56 mm. they are given U or V fold to allow expansion and contraction at the joints.



SPACING OF EXPANSION JOINTS

Sl.No	Description of elements	c/c spacing
1	Walls i) Load bearing walls one brick and more in thickness and having cross-walls at intervals	30m
	ii) Load bearing walls without any cross walls	30m If wall acts as panel walls between columns spaced not more than 9 m c/c no joints are required. Control joints may be given over the center of openings at half the spacing of expansion joint.
2	Roofs i) Ordinary roof slabs of RCC on unframed construction protected by mud phuska.	20 m to 30 m interval and at all changes of direction points of structure.
	ii) Thin unprotected RCC slabs.	15 m
3	Chhajjas, balconies and parapets. Copings	6 to 12 m. Corresponding to joints in the roof slabs.
4	Framed structures	At 30 m intervals and at corners or change of direction points.

TREATMENT METHODS FOR EXPANSION JOINTS IN VARIOUS ELEMENTS

1) Walls: The joints in the wall are not left exposed. They are covered with covering sheets which may be of aluminum, hard board, AC sheet or timber plank. Normally A.C. sheet is used to cover the joint. The covering sheet is fixed to the wall on one side of the joint with screws and on the other side by screws through oval shaped slots. The oval slots permit movement at the joint without causing any damage to the covering sheet.

Expansion joint in the roof shall invariably be provided with joint filler and water bar.

Joint in floor shall be invariably sealed to prevent accumulation of dirt, dust, therein.

The joints in the wall are not left exposed. They are covered with covering sheets which may be of aluminum, hard board, AC sheet or timber plank. Normally A.C. sheet is used to cover the joint. The covering sheet is fixed to the wall on one side of the joint with screws and on the other side by screws through oval shaped slots.

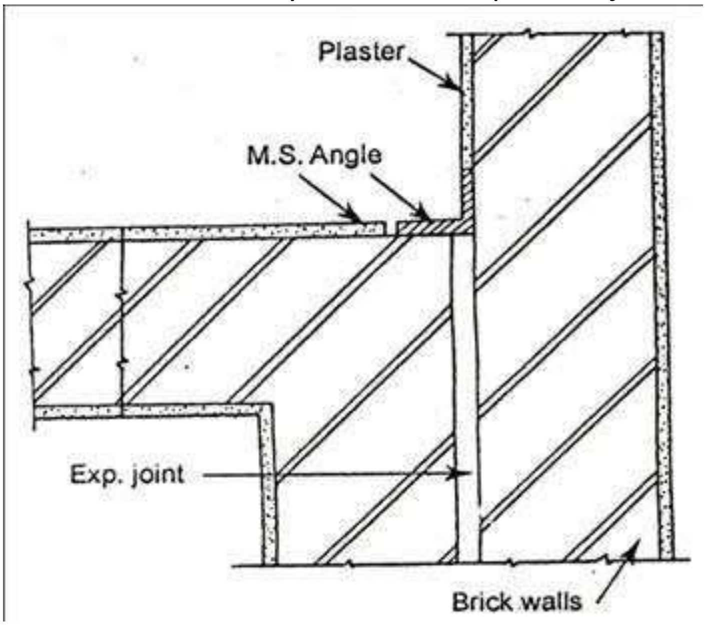
The oval slots permit movement at the joint without causing any damage to the covering sheet.

Expansion joint in the roof shall invariably be provided with joint filler and water bar.

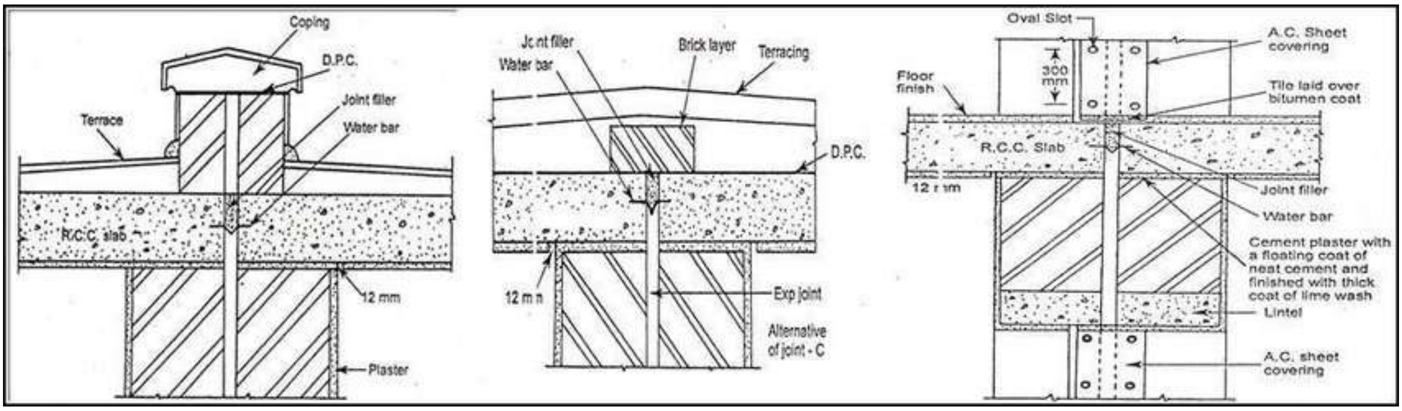
Joint in floor shall be invariably sealed to prevent accumulation of dirt, dust, therein.

2) Framed Walls: In case of framed structure, it is necessary to provide two frames, one on either side of the expansion joint. The treatment of joints is similar to those given to the masonry wall expansion joint.

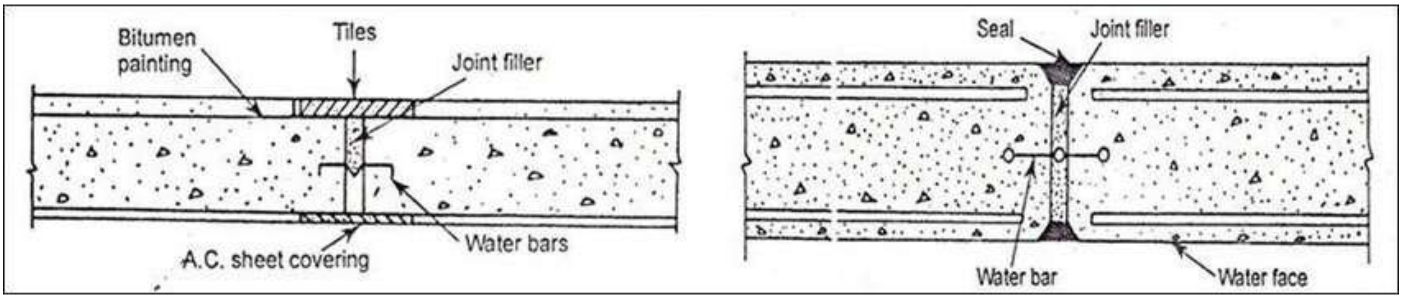
3) Roofing Slab: The gap of the joint should be sealed with a water bar and sealing compound. In order to prevent cracks in the masonry above or below the expansion joint R.C.C or plain concrete bed blocks should be provided in the masonry below the expansion joint in the slab.



Expansion Joint treatment in walls



Expansion Joint treatment in Framed walls



Expansion Joint treatment in Roofing Slab

3. Contraction Joints

A contraction joint is a sawed, formed, or tooled groove in a concrete slab that creates a weakened vertical plane. It regulates the location of the cracking caused by dimensional changes in the slab.

Unregulated cracks can grow and result in an unacceptably rough surface as well as water infiltration into the base, subbase and subgrade, which can enable other types of pavement distress.

Contraction joints are the most common type of joint in concrete pavements, thus the generic term “joint” generally refers to a contraction joint. Contraction joints are chiefly defined by their spacing and their method of load transfer. They are generally between 1/4 – 1/3 the depth of the slab and typically spaced every 3.1 – 15 m

4. Isolation Joints

Joints that isolate the slab from a wall, column or drainpipe

Isolation joints have one very simple purpose—they completely isolate the slab from something else. That something else can be a wall or a column or a drain pipe. Here are a few things to consider with isolation joints:

Walls and columns, which are on their own footings that are deeper than the slab subgrade, are not going to move the same way a slab does as it shrinks or expands from drying or temperature changes or as the subgrade compresses a little.

Even wooden columns should be isolated from the slab.

If slabs are connected to walls or columns or pipes, as they contract or settle there will be restraint, which usually cracks the slab—although it could also damage pipes (standpipes or floor drains).

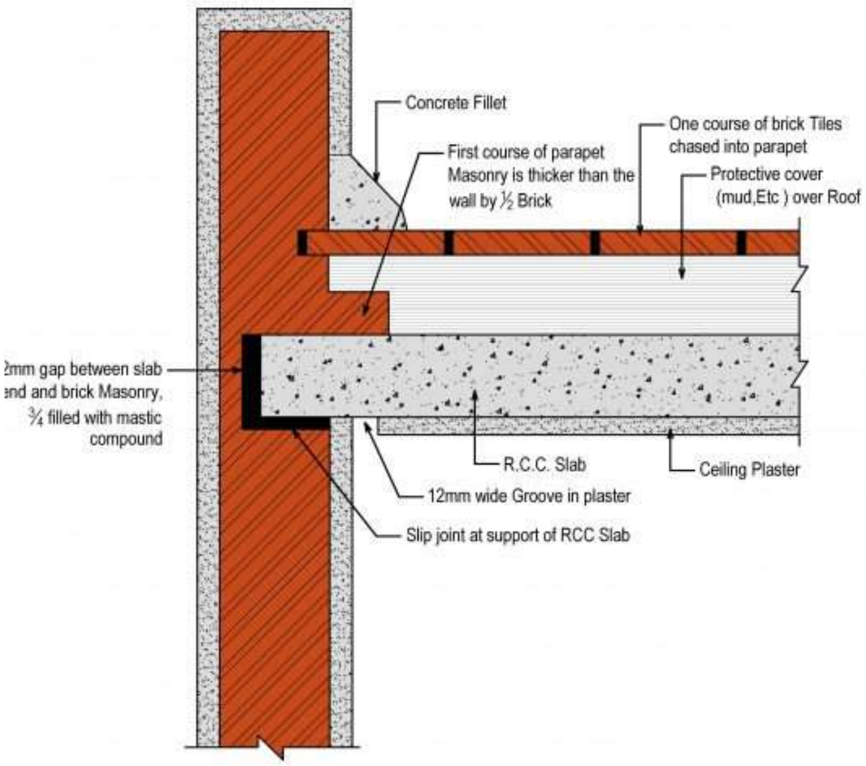
Blowups, from expansion of concrete due to hot weather and sun, are more commonly caused by contraction joints that are not sealed and that then fill up with non-compressible materials (rocks, dirt). They can also be due to very long unjointed sections.

Very long unjointed sections can expand enough from the hot sun to cause blow ups, but this is rare.

Isolation joints are formed by placing preformed joint material next to the column or wall or standpipe prior to pouring the slab. Isolation joint material is typically asphalt-impregnated fiberboard, although plastic, cork, rubber, and neoprene are also available.

Isolation joint material should go all the way through the slab, starting at the subbase, but should not extend above the top. For a cleaner looking isolation joint, the top part of the preformed filler can be cut off and the space filled with elastomeric sealant. Some proprietary joints come with removable caps to form this sealant reservoir.

SLIP JOINTS

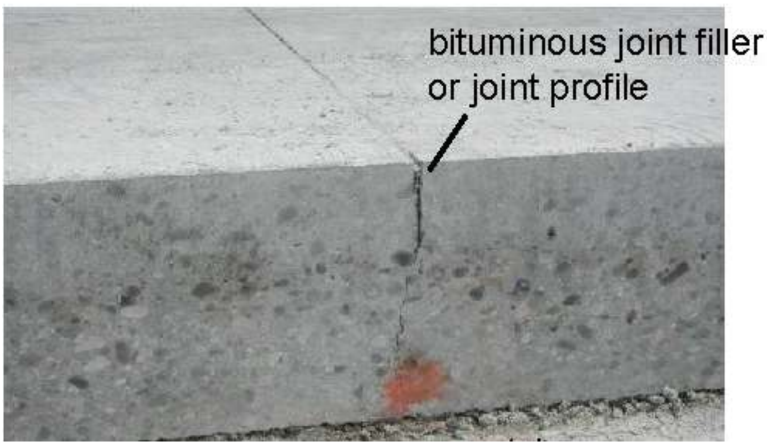


Slip joints are joints in construction which provide sliding movement of one component over another with the minimum of restraint at the interface of the two components. These are usually provided to work as a movement joint and to mitigate the sliding movement at the joints of RCC slab and top of supporting walls.

DUMMY JOINT

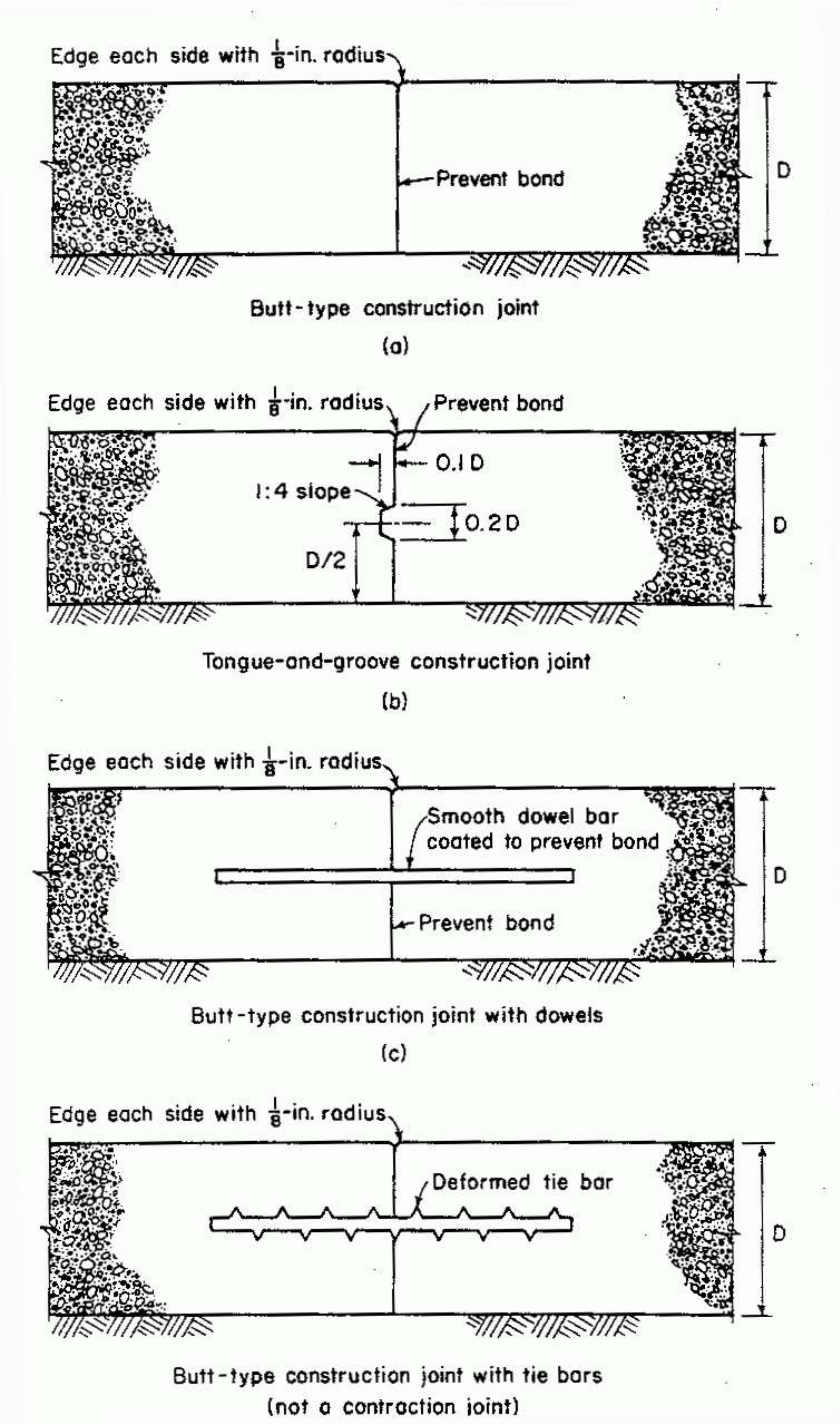
A groove cut into the top half of a concrete slab, sometimes packed with filler, to form a line wher e the slab can crack with only minimum damage.

dummy joint-cut (to prevent wild cracks)

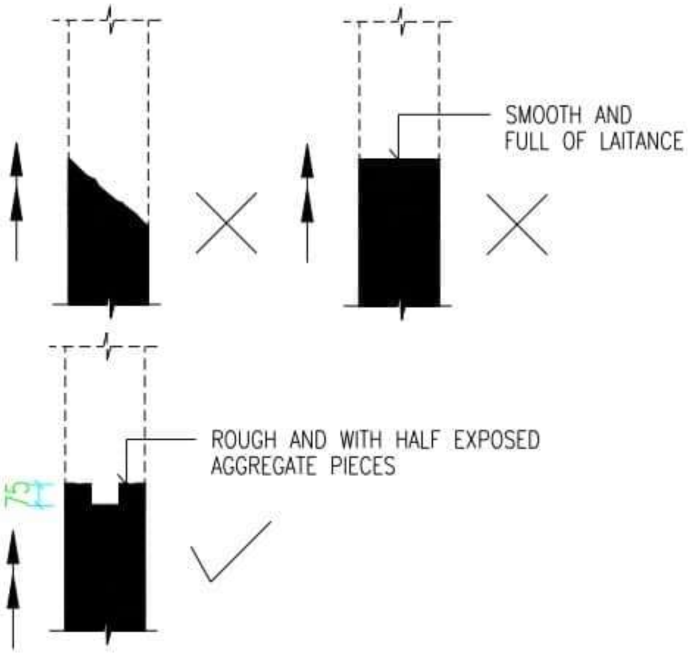


EX.NO: 14 DRAW JOINTS IN STRUCTURES

14.1 LOCATION OF CONSTRUCTION JOINTS FOR DIFFERENT MEMBERS

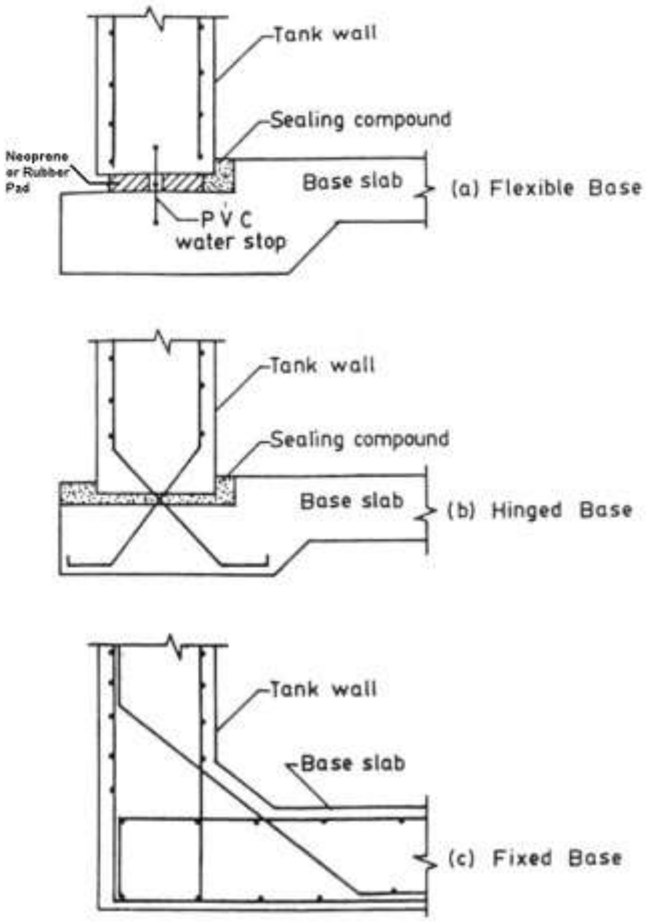


14.1. (a) CONSTRUCTION JOINT INSTALLATIONS AT SLABS AND BEAMS

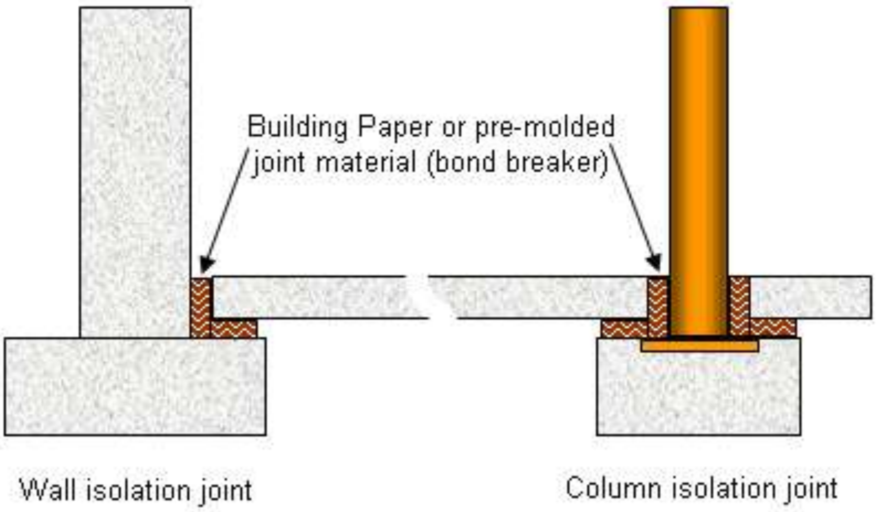


14.1. (b) CONSTRUCTION JOINT INSTALLATIONS AT C OLUMNS

14.2 DRAW DETAILS OF PROVISION OF JOINTS AT JUNCTION BETWEEN WALL AND FLOOR OF A RESERVOIR



EX.NO: 14.3 DRAW DETAILS OF DIFFERENT TYPES OF JOINTS IN STRUCTURE



(A) ISOLATION JOINT DETAIL

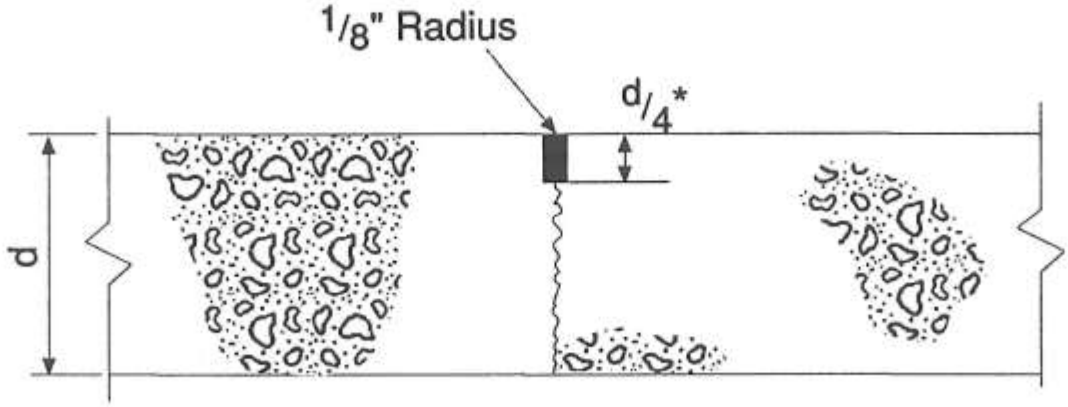


Fig. 4a. Undoweled contraction joint

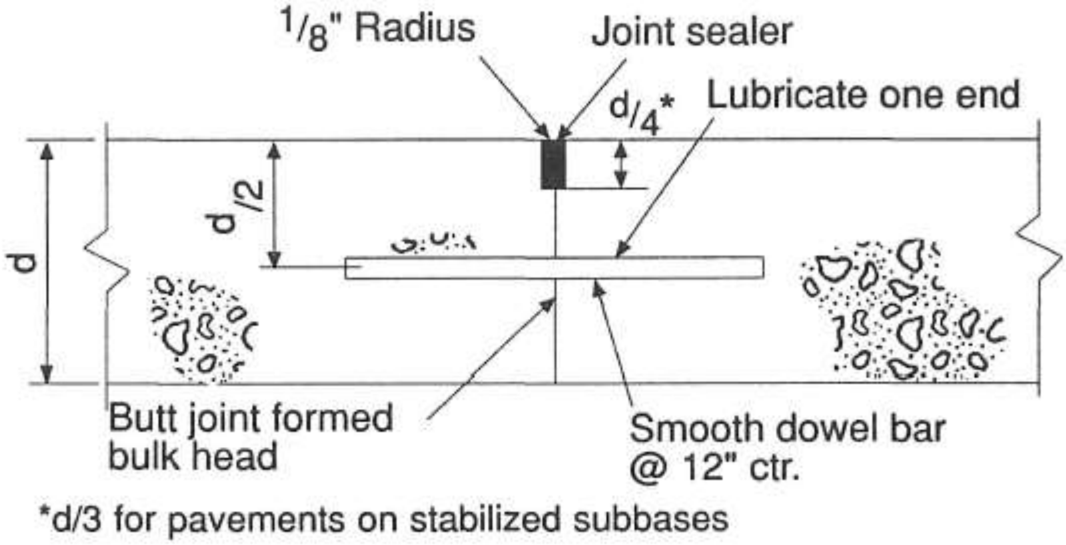
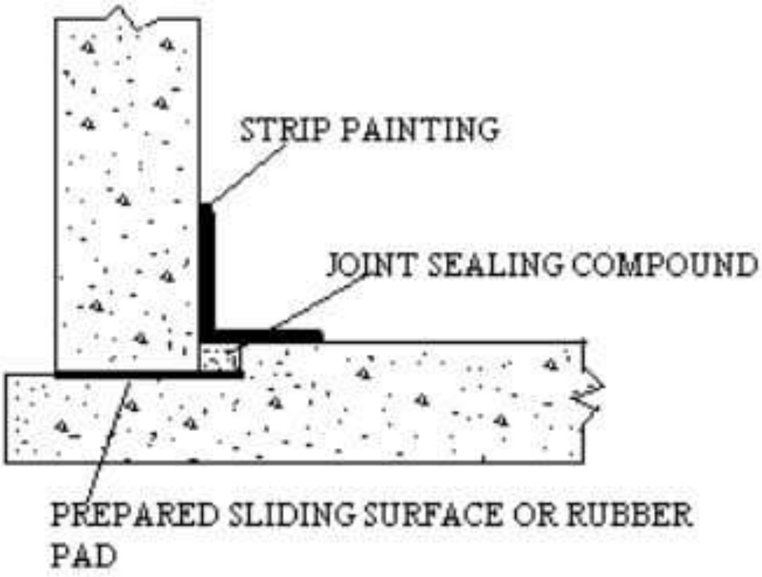


Fig. 4b. Doweled contraction joint

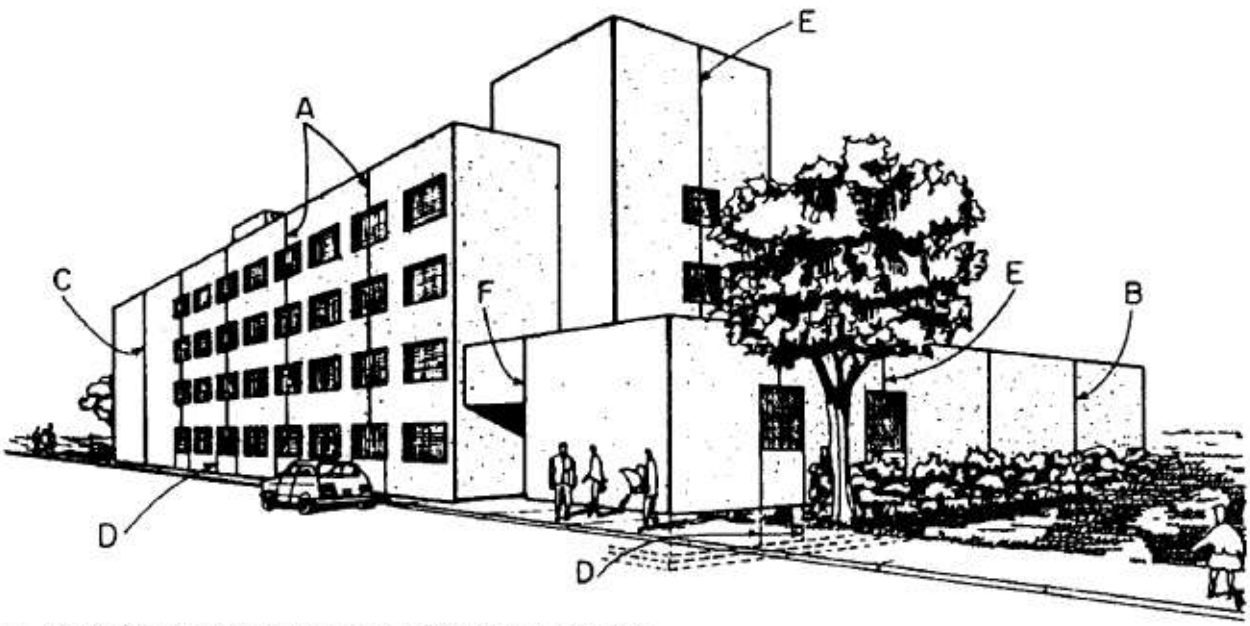
(B) CONTRACTION JOINT



(c) SLIDING JOINT

EX.NO: 14.4 DRAW PLAN SHOWING LOCATIONS OF CONTRACTION AND ISOLATION JOINTS

JOINTS IN CONCRETE CONSTRUCTION (ACI 224.3R-95)



A. 20 ft (6m) apart in walls with frequent openings.
B. Never more than 20 ft (6m) apart, walls with no openings.
C. Within 10 to 15 ft (3 to 5m) of a corner, if possible.
D. In line with each jamb at first-story level.
E. Above first story at centerline of opening
F. Jamb lines are preferable.

Fig. 3.1—Locations for contraction joints in buildings as recommended by the Portland Cement Association (1982).

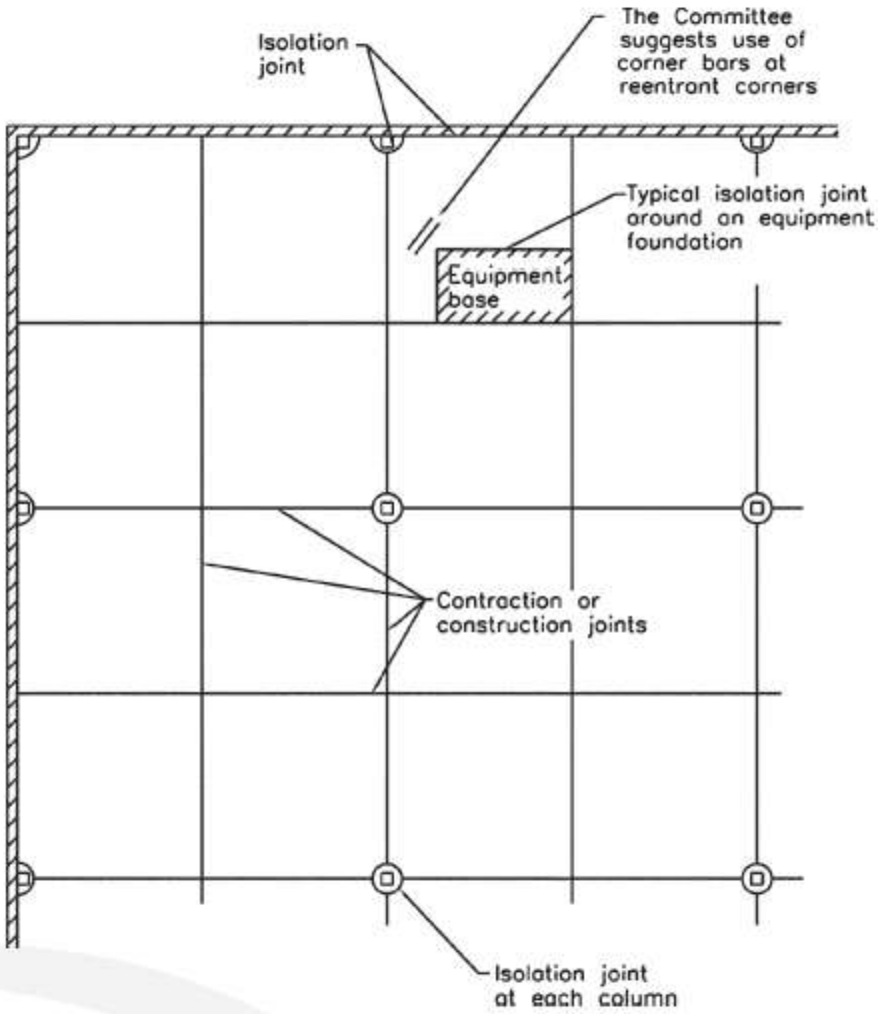


Fig. 5.2.9—Appropriate locations for joints.

JOINTS IN CONCRETE CONSTRUCTION (ACI 224.3R-95)

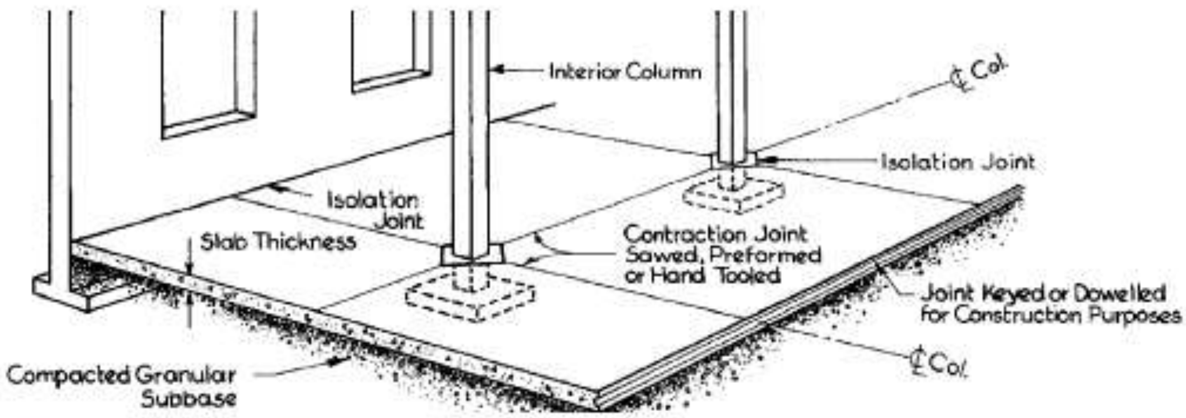


Fig. 5.1—Location and types of joints (ACI 302.1R).

EX.NO:14.5 ILLUSTRATE EXPANSION JOINTS IN WALLS AND ROOFS

1.Many designers consider it good practice to place expansion joints where walls change direction as in L- T- Y-, and U-shaped structures, and where different cross sections develop.

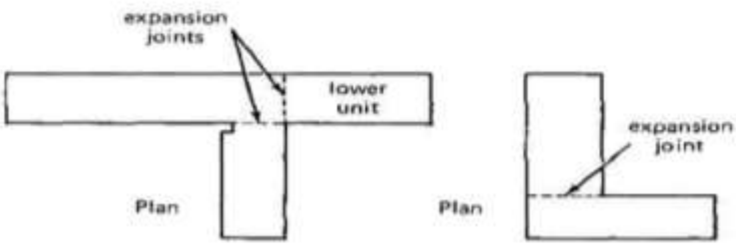


Figure 3 :Joints related to shapes of Building

2. Expansion joints may be necessary at the junction of tall and short buildings (Fig.4) to avoid distress due to differential settlements

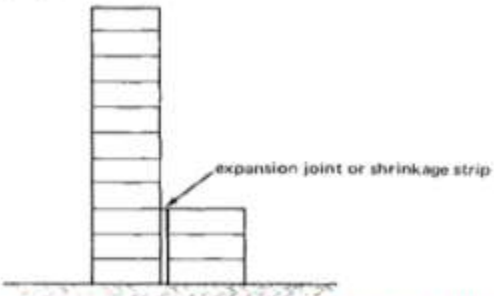


Figure 4 :Joints related to shapes of Building

3. When expansion joints are required in nonrectangular structures, they should always be located at places where the plan or elevation dimensions change radically.

4. The simplest expansion joint is one on a column line with double columns.

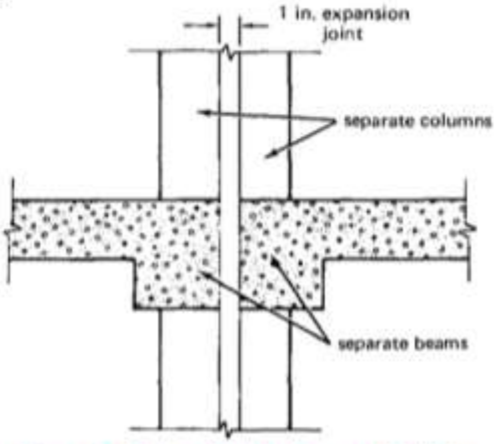


Figure 5 :Joints related to shapes of Building

5.Expansion joints without a double column may be used by introducing them in the third or quarter point in the slab as in fig 6.

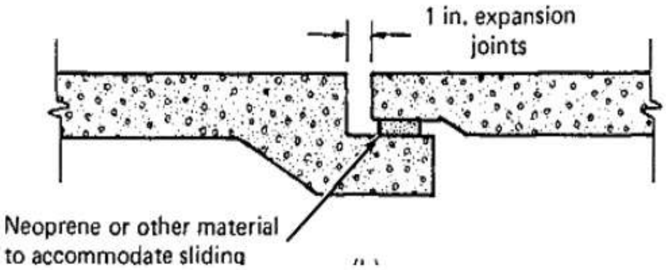
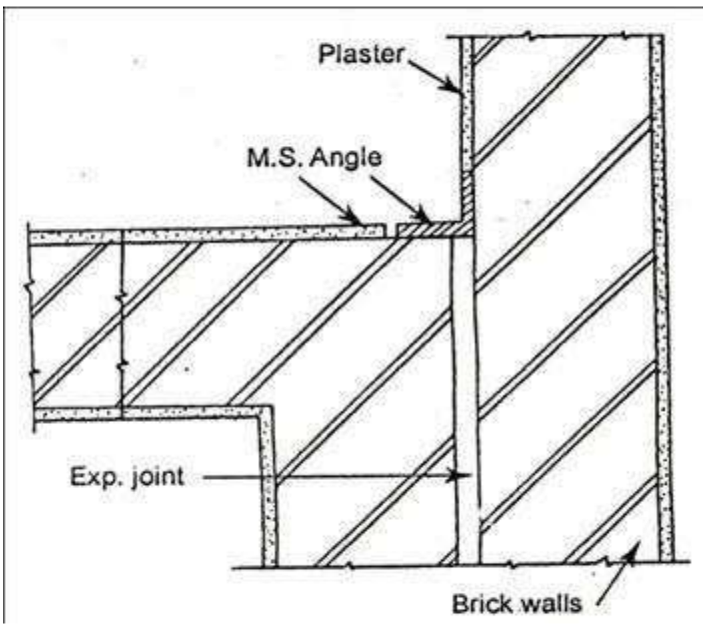
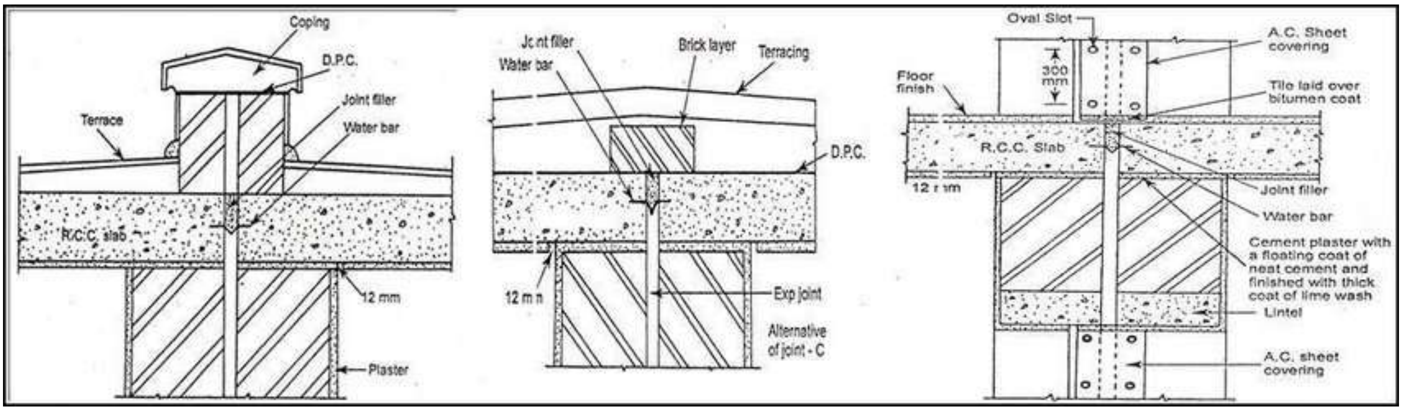


Figure 6 :Joints related to shapes of Building

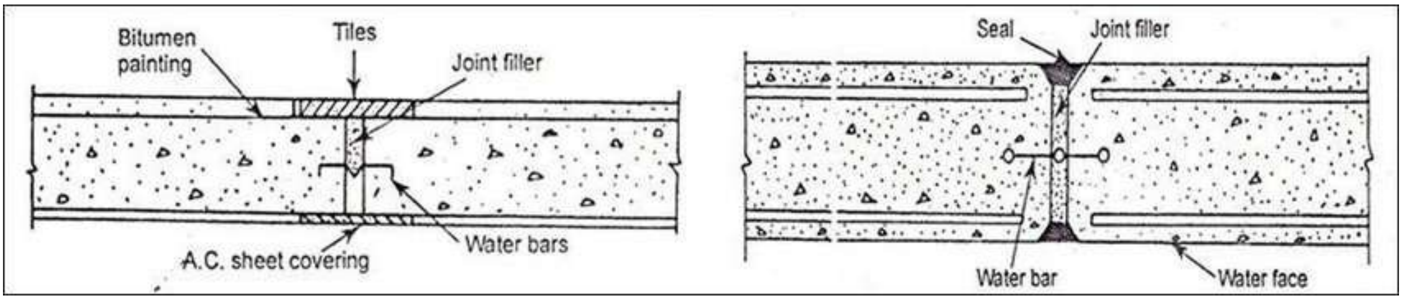
6. Joints should extend through foundation walls, but column footings need not be cut at a joint unless the columns are short and rigid. No reinforcement should pass through these joints; it should terminate 2 in. from the face of the joint. Dowels with bond breaker may be used to maintain plane.



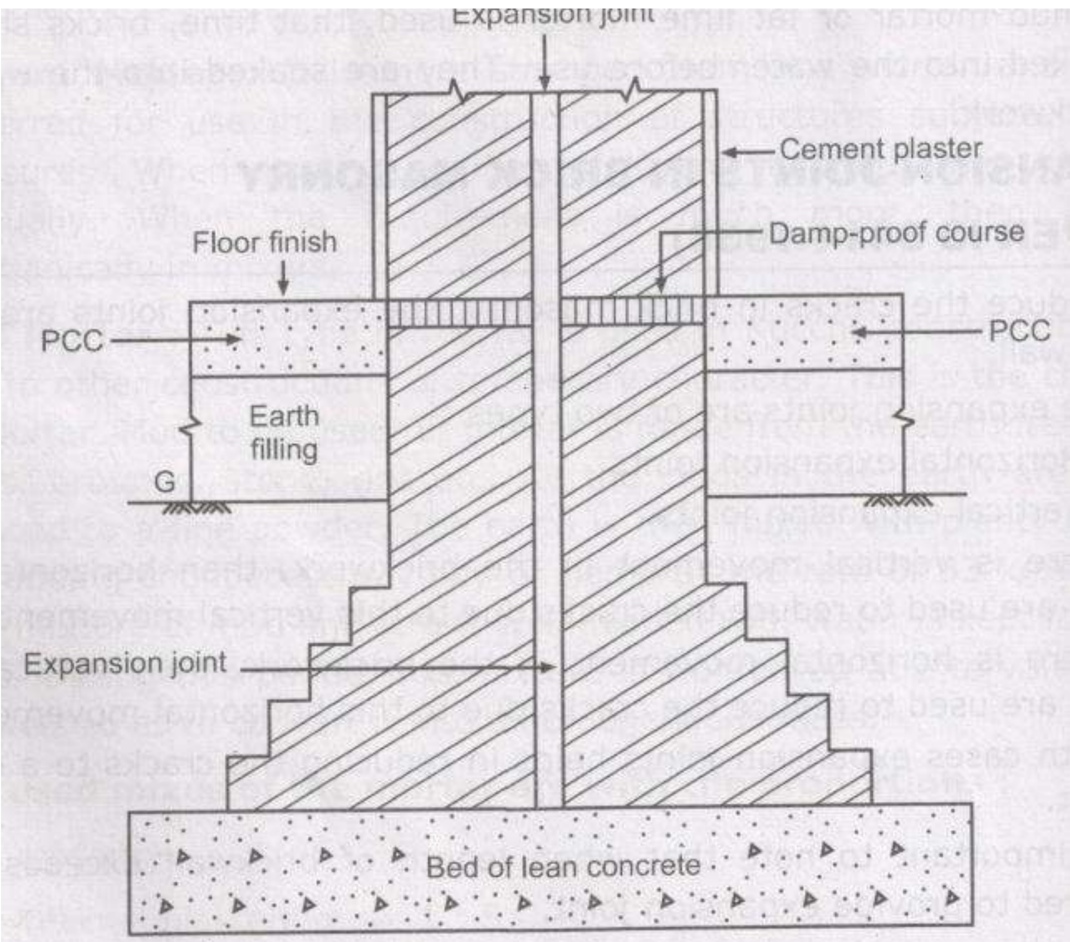
Expansion Joint treatment in walls



Expansion Joint treatment in Framed walls



Expansion Joint treatment in Roofing Slab



Expansion joint at foundation level

IS 3414 (1968): Code of Practice for Design and Installation of Joints in Buildings [CED 13: Building Construction Practices including Painting, Varnishing and Allied Finishing]

BLANK PAGE

IS : 3414 - 1968
(Reaffirmed 2000)

Indian Standard

CODE OF PRACTICE FOR DESIGN AND INSTALLATION OF JOINTS IN BUILDINGS

(Second Reprint APRIL 1978)

UDC 693·224 : 69·001·3

INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Price Rs 12·00

April 1969

Indian Standard

CODE OF PRACTICE FOR DESIGN AND INSTALLATION OF JOINTS IN BUILDINGS

Building Construction Practices Sectional Committee, BDC 13

Chairman	*Representing*
SHRI M. L. NANDA	Central Public Works Department
Members	
SHRI B. D. AHUJA	National Buildings Organization (Ministry of Works, Housing & Supply)
SHRI P. C. JAIN (*Alternate*)	
SHRI B. V. APTE	Builder's Association of India, Bombay
SHRI K. J. SAPRA (*Alternate*)	
CHIEF ARCHITECT	Central Public Works Department (Architectural Wing)
CHIEF ENGINEER	National Buildings Construction Corporation Ltd, New Delhi
CHIEF ENGINEER (B & R)	Public Works Department, Government of Rajasthan
EXECUTIVE ENGINEER (DESIGN & SPECIFIC DIVISION) (*Alternate*)	
SHRI B. K. CHOKSI	In personal capacity (*M 60 Cusrow Bag, Bombay 1*)
SHRI J. DATT	Concrete Association of India, Bombay
SHRI K. C. PRINJA (*Alternate*)	
SHRI V. S. DEVDHAR	Institute of Surveyors, New Delhi
PROF DINESH MOHAN	Central Building Research Institute (CSIR), Roorkee
DIRECTOR	Engineering Research Department, Government of Andhra Pradesh
SHRI C. M. GOVEAS	Atomic Energy Commission, Bombay
SHRI HARISH CHANDRA	Central Public Works Department
SHRI S. B. JOSHI	S. B. Joshi & Co Ltd, Bombay
SHRI R. N. JOSHI (*Alternate*)	
SHRI V. S. KAMAT	Hindustan Construction Co Ltd, Bombay
SHRI KEWAL KRISHAN	Public Works Department, Government of Punjab
SHRI N. J. MASANI	Forest Research Institute and Colleges, Dehra Dun
SHRI T. R. MEHANDRU	Institution of Engineers (India), Calcutta
COL O. P. NARULA	Engineer-in-Chief's Branch, Army Headquarters
SHRI K. P. GHOSH (*Alternate*)	
SHRI D. J. PATEL	Hindustan Housing Factory Ltd, New Delhi
SENIOR ARCHITECT (B I), CENTRAL PUBLIC WORKS DEPARTMENT	Indian Institute of Architects, Bombay
SHRI J. D. SHASTRI	Directorate General of Health Services, New Delhi
SHRI T. N. SUBBARAO	Gammon India Ltd, Bombay
SHRI P. M. APTE (*Alternate*)	

(*Continued on page 2*)

INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

(*Continued from page* 1)

Members	*Representing*
SUPERINTENDING ENGINEER (CALCUTTA CENTRAL CIRCLE No. 1)	Central Public Works Department
SUPERINTENDING ENGINEER (PLANNING AND DESIGNS)	Public Works Department, Government of Madras
EXECUTIVE ENGINEER (BUILDING CENTRE DIVISION) (*Alternate*)	
SHRI L. G. TOYE	Research, Designs and Standards Organization (Ministry of Railway)
SHRI N. V. SHASTRI (*Alternate*)	
SHRI R. NAGARAJAN, Director (Civ Engg)	Director General, ISI (*Ex-officio Member*)

Secretary

SHRI C. K. BEBARTA
Assistant Director (Civ Engg), ISI

Joints in Structures Subcommittee, BDC 13 : 14

Convener	
SHRI C. B. PATEL	Central Public Works Department
Members	
SHRI A. P. BAGCHI	Sahu Cement Service, New Delhi
SHRI AKSHOY BOSE	Ballardie Thompson & Mathews, Calcutta
SHRI K. P. GHOSH	Engineer-in-Chief's Branch, Army Headquarters
SHRI C. L. N. IYENGAR	Concrete Association of India, Bombay
SHRI E. T. ANTIA (*Alternate*)	
SHRI B. C. PATEL	M. N. Dastur & Co Private Ltd, Calcutta
SHRI P. B. PATEL	Gammon India Ltd, Bombay
SHRI J. S. SHARMA	Central Building Research Institute (CSIR), Roorkee
SHRI S. M. SINGH (*Alternate*)	
SURVEYOR OF WORKS III (OFFICE OF SSW I, ZONE 1)	Central Public Works Department

Indian Standard

CODE OF PRACTICE FOR DESIGN AND INSTALLATION OF JOINTS IN BUILDINGS

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 23 July 1968, after the draft finalized by the Building Construction Practices Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 When a material is stressed beyond its tensile or shear strength it cracks. The stresses may be due to external loads or due to restraint impressed against dimensional changes. Moisture movement and temperature variations cause such stresses which are restrained by the building elements. All building materials expand or contract with change in temperature and variation of moisture content. The magnitude of these changes vary with the type of materials used. Most building materials expand when wetted and shrink while drying. Some materials which contain considerable moisture at the time of construction dry out subsequently. Such materials are stone, brick and concrete and major dimensional changes are caused by their contraction.

0.3 If the resulting expansion and contraction movements are restricted partly or wholly by any means, for example, by restraining effect of cross and end walls in large buildings, internal stresses, like tension during contraction and compression during expansion, occur in the structure and their magnitude depends on:

a) the extent to which such free movement has been prevented due to connection of the element to other structural elements,

b) the extent to which the movement would have taken place if there were no restraint,

c) the extent to which the material creeps and flows under stress, and

d) the extent to which the elastic deformation takes place.

These four factors are interdependent and the movement which actually occurs depends on the restraint to these movements as well as on creep. Hence to minimize cracking in buildings, it would be necessary to avoid materials which expand or contract considerably due to thermal and moisture movements and design the structure so as to minimize restraint to contraction or expansion of the material. Use of materials having maximum extensibility, that is, total creep and elastic deformation before cracking and reducing the range of variation in temperature and moisture movement also helps in minimizing the cracking in buildings.

0.4 In a tropical country like India, occurance of large variations in the atmospheric temperature and humidity are to be expected and the problems of crack prevention assumes greater importance. The larger the structure or the number of storeys it has, the greater the extent to which such movements take place.

0.5 There are two ways of dealing with expansion and contraction of structures. The structures may be monolithic and heavy reinforcement may link each section so that all stresses formed may be accommodated without fracture. Alternatively the structure may be provided with a number of joints which relieve the stresses by allowing pre-determined sections of the structure to move. In the first method accurate assessment shall be made of all the conditions which are likely to induce stresses in the structure. This is not always possible but never the less the method is followed in cases like shell structures and certain rigid frames where provision of the joints will interfere with the rigidity of the structure. In the second method where joints are provided reasonable care has to be exercised for the design, location, detailing of joints and selecting materials, such as for joint fillers and water-bars, so that large movements may be accommodated without structural failure, disfiguring cracks or penetration of moisture. This standard is intended mainly to provide guidance in location, design and construction of various types of joints in buildings.

0.6 This code of practice represents a standard of good practice and, therefore, takes the form of recommendations.

0.7 In the formulation of this standard due weightage has been given to international coordination among the standards and practices prevailing in different countries in addition to relating it to the practices in this field in this country. This has been done by deriving assistance from the following publications:

INDIA. MINISTRY OF WORKS, HOUSING AND SUPPLY. Handbook of building engineers in metric system. 1966. National Buildings Organization, New Delhi.

INDIA. UTTAR PRADESH PUBLIC WORKS DEPARTMENT. A report on problem of cracks in buildings due to temperature variations, 1962, issued by the Chief Engineer.

CRITCHELL (PETER L.). Joints and cracks in concrete. 1958. Contractors Record Ltd, London (Now Maclaren and Sons Ltd, London).

UNITED KINGDOM. Department of Scientific and Industrial Research (Building & Research Station). Principles of Modern Building Vol I. 1959. Third edition.

0.8 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard deals with the design and installation of joints in masonry and concrete in buildings.

1.2 This standard does not cover the design and installation of joints in heavy-duty floors and pavements, water retaining structures and power house structures.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Expansion Joints — Joints provided to accommodate the expansion of adjacent building parts and relieve compressive stresses that may otherwise develop. Expansion joints essentially provide a space between the parts and may sometimes be provided with the load transmitting devices between the parts and generally filled with expansion joint filler which is compressible enough to accommodate the expansion of adjacent parts, and having ability to regain 75 percent of the original thickness, when pressure is released.

2.2 Construction Joint — Joint installed at location where construction stops for any reason and when the location of stoppage does not coincide with the planned location of an expansion joint or contraction joint.

2.3 Contraction Joints — These are essentially separations or planes of weakness introduced in concrete structures to localize shrinkage movements which would otherwise lead to unsightly cracks. They may be of any of the following types:

a) *Complete Contraction Joint* — In this type of joint the bond between adjacent sections of a structure may be broken completely by painting one face with a bituminous material or by setting a layer of waterproof paper or roofing felt against the face of the section before casting the next section up to it.

b) *Partial Contraction Joint* — When structural stability is required between sections of a reinforced concrete structure separated by a contraction joint it is sometimes convenient to continue the reinforcement across the joint. Due to presence of reinforcement the movement at these partial contraction joints is usually very small.

*Rules for rounding off numerical values (*revised*).

c) *Dummy Joints* — Dummy type contraction joints are used more particularly in thin sections of concrete. In these joints a plane of weakness is created by forming a groove in either or each of the surfaces of the concrete, the total depth of the groove being one-third to one-fifth of the thickness of the section.

2.4 Sliding Joints — When variations in temperature, moisture content or loading result in tendency for one part of a structure to move in a plane at right angles to the plane of another part it is necessary to provide a slip plane between the two parts thus enabling freedom of movement in both planes. Sliding joints are usually formed by applying a layer of plaster to one of the surfaces and finishing it smooth before the other is cast on it or by any other approved suitable method.

2.5 Joint Filler — A strip of compressible material used to form and fill the expansion joints in structure.

2.6 Sealing Compound — A material of plastic consistency applied to the joint in the form of liquid or paste. The function of the sealing compound is to prevent the ingress of water or foreign matter.

2.7 Waterbar — A strip which is placed across the joint during construction so as to form an impervious diaphragm.

3. NECESSARY INFORMATION

3.1 For the design and detailing of buildings the following information is necessary:

a) Local temperature, humidity and other climatic data;

b) Complete plan, elevation and details of the buildings; and

c) Special requirements for waterproofing particularly at locations where joints are intended to be provided. In the case of basements or building parts in contact with water, the pressure of water to which the joints will be subjected to shall be indicated.

4. DESIGN CONSIDERATIONS

4.1 General — The design of joints will depend upon the type of structure, the method of construction and the jointing materials available. All building materials undergo not only elastic and permanent deformation due to load, but also changes in length may be caused by variation in temperature or moisture content. The provision of joints shall be adequate to accommodate these dimensional changes unless the additional stresses that would develop in the absence of joints are considered for in the design.

4.2 Evaluation of Dimensional Changes

4.2.1 *Temperature Variations* — Spacing of expansion joints is determined in relation to the movement which will occur due to temperature changes.

In estimating these movements the temperature at the time of construction may be considered. If concrete is laid in summer the main movement will be contraction and in such cases the expansion joints may be further placed apart provided the design takes care of the tensile stresses caused by contraction. If construction is in winter the expansion joints may be nearer to avoid excessive compressive stresses.

4.2.1.1 The coefficient of thermal expansion of some of the common building materials are given in Table 1 for guidance.

TABLE 1 COEFFICIENTS OF THERMAL EXPANSION OF VARIOUS BUILDING MATERIALS WITHIN RANGE OF 1° – 100°C

Sl No.	Material	Coefficient
a)	*Bricks and Brickwork*	5 to 7 × 10^{-6} per °C
b)	*Cement Mortars and Concrete*	10 to 14 × 10^{-6} per °C
c)	*Stones*	
	1) Igneous rocks (granites etc)	8 to 10 × 10^{-6} per °C
	2) Limestones	2·4 to 9 × 10^{-6} per °C
	3) Marbles	1·4 to 11 × 10^{-6} per °C
	4) Sandstones	7 to 16 × 10^{-6} per °C
	5) Slates	6 to 10 × 10^{-6} per °C
d)	*Metals*	
	1) Aluminium	25 × 10^{-6} per °C
	2) Bronze	17·6 × 10^{-6} per °C
	3) Copper	17·3 × 10^{-6} per °C
	4) Lead	29 × 10^{-6} per °C
	5) Steel and iron	7 to 13 × 10^{-6} per °C

NOTE — Because of moisture movements, range of temperature experienced and variations between natural and artifical materials, coefficients of thermal expansion for the materials cannot be specified accurately. This table, therefore, gives only very rough data, however, they are accurate enough for any calculation that can be usefully made by the designer of a building.

4.2.2 *Variations in Moisture Content* — Brickwork and concrete contract on drying out and expand when wetted again, and the process of contraction may continue even for a long time after construction, depending upon external humidity conditions. The degree of moisture immediately after the setting or hardening of the mortar or concrete may also vary from part to part during construction.

4.2.2.1 For dense concretes, contraction due to drying shrinkage may vary from 0·2 to 0·5 mm/m; for lightweight concrete blocks the shrinkage may be larger varying from 0·5 to 0·8 mm/m; for non-autoclaved aerated concrete still greater shrinkage of the order of 3 mm/m may be allowed for. However, if care is taken to allow non-autoclaved aerated concrete, specially precast blocks to dry and thus contract before use, the shrinkage values may be considerably reduced and a value of 0·6 mm/m may be allowed.

4.3 Deformation may also be caused as a result of loading. Allowance for movement in joint shall be provided for to accommodate deformation with loading particularly to allow for the following factors:

a) The difference in the compressibility of the various materials used in the individual sections of the building;

b) The unequal loading of the individual parts of a building, for example; as a result of differences in height when constructing sections in parts or in the final stage; and

c) Differential settlement due to unequal loading, variable load-bearing capacity of the soil and on account of constructing a building partly on old foundations; due to the overlapping of the load distribution with that of adjacent foundations or due to the variation in moisture conditions in the subsoil.

4.4 Generally the spacing for expansion joints shall be according to the recommendations given in Table 2.

NOTE — The rules for spacing of expansion joints and their width will generally depend mainly on the local experience gained from observations of structures earlier constructed. The precise determination of the amount of movement occuring in building to ascertain the spacing and width of joints is very complicated owing to numerious factors involved and may not be necessary in normal circumstances.

4.4.1 In case of masonry walls the vertical control joints (expansion joints) shall be provided from top of the wall to the top of the concrete foundations. The vertical control joint shall not be taken through the foundation concrete. Reinforcement shall not pass through the joint.

4.4.2 In case of masonry walls resting on pile foundation the vertical control joint shall be taken up to the top of the grade beam over the piles. Reinforcement shall not pass through the joint.

4.4.3 In case of reinforced concrete framed structures, the vertical control joint between two columns shall extend from top of the column to the top of the pedestal provided over the RCC footing.

4.5 In addition to provision of joints as covered in this code, measures may also be taken to reduce or prevent damage due to thermal effects as indicated below:

a) Choosing texture and colour for the exposed surface such that of the solar radiation is reflected and the minimum is absorbed; white wash finish for roofing would be advantageous,

b) Providing insulating surfaces on the top of structural slabs to reduce and delay the penetration of heat into the structure, such insulating slabs being provided with expansion joints at suitable intervals.

TABLE 2 RECOMMENDATIONS FOR SPACING OF EXPANSION JOINTS

(*Clause* 4.4)

Sl No.	Item and Description	Spacing of Joints
(1)	(2)	(3)
i) *Walls*		
	1) Load bearing walls with cross walls at intervals. Traditional type of one-brick thick or more	30 m intervals
	2) Walls of warehouse type construction (without cross-walls)	Expansion joints in walls at 30 m maximum intervals. (If the walls are panel walls between columns at not more than 9 m centres no joints are necessary.) Control joints over centre of openings may be given at half the spacing of expansion joints.
ii) *Chajjas, balconies and parapets*		6 to 12 m intervals
iii) *Roofs*		
	1) Ordinary roof slabs of RCC protected by layers of mud phuska or other insulating media in unframed construction	20 to 30 m intervals, and at changes in directions as in L,T,H and V shaped structures
	2) Thin unprotected slabs	15 m intervals
iv) *Frames*		
	Joint in structure through slabs, beams, columns, etc, dividing the building into two independent structural units	Corners of L,H,T and C shaped structures and at 30 m intervals in long uniform structures
v) *Coping*		Corresponding to joints in the roof slabs

4.6 Many defects other than expansion may also lead to development of cracks, and such cracks may not be related to the defective provision of expansion joints, for example, surface shrinkage cracks, stress concentration in reinforcement due to corrosion of reinforcements and effect of frost action.

5. MATERIAL

5.1 Joint Filler

5.1.1 The joint filler is a strip of compressible material used to form and fill the expansion joints in structures. The main functions of the joint filler are to permit the components of the joint to expand without developing compressive stresses as a result of thermal or other changes and also to support the sealing compound.

5.1.2 The joint filler shall satisfy the following performance requirements:

a) Compressibility without extrusion, that is, it must be cellular;

b) Ability to recover as early as possible 75 percent of its original thickness when pressure is released;

c) Durability and resistance to decay due to termite and weathering; and

d) Sufficient rigidity during handling and placing to permit the formation of straight joints.

5.1.3 Joint filler may be produced from a variety of materials, such as bitumen, bitumen containing cellular materials, cork strips or granules, natural or cellular rubber, expanded plastics, mineral fibre, polythene foam and coconut pith and cashewnut shell liquid resin.

5.1.4 For garage and factory floors the joint filler shall have high resistance to ingress of foreign matter. Resistance to chemicals, amount of extensibility, etc, will depend upon the nature of exposure, therefore, the joint filler shall be specially designed for the purpose.

5.1.5 For external joints in buildings, the joint filler shall have excellent resistance to weathering and also resistance to flow, adhesion and extensibility; for internal joints resistance to weathering may not be necessary. Resistance to chemical fumes, oils, fats, fuel gases may be necessary for internal or external joints depending on exposure conditions.

5.1.6 Bituminous joint filler shall conform to IS : 1838-1961*.

5.2 Sealing Compound

5.2.1 The sealing compound shall satisfy the following requirements:

a) To seal the joint against the passage of water,

b) To prevent the ingress of grit or other foreign matter, and

c) To provide protection to the joint filler where necessary.

The various characteristics properties of the sealing compound those require consideration are adhesion, good extensibility, resistance to flow, resistance to ingress of foreign matter, resistance to weathering and resistance to oil, fuel and fat.

5.2.2 Hot applied bituminous sealing compound shall conform to IS : 1834-1961†.

---

*Specification for preformed fillers for expansion joint in concrete, non-extruding and resilient type (bitumen-impregnated fibre).

†Specification for hot applied sealing compounds for joints in concrete.

5.3 Waterbar

5.3.1 The function of waterbar is to seal the joint against water penetration. Waterbars may be necessary where the joint is subject to groundwater pressure or where the method of construction makes it difficult the accurate sealing of surface cavity, and where it is very essential that there shall not be any risk of penetration of water.

5.3.2 Waterbars which have to rely on adhesion on length of path for its proper functioning shall not be used in structures of dubious bearing properties. Waterbars to be used in such structures shall have good flexibility, large width and low modulus of elasticity.

5.3.3 Waterbars may be of natural and synthetic rubber, polyvinylchloride (PVC) or metal. The most common shapes of PVC and rubber waterbars are shown in Fig. 1 and 2 and of metallic waterbars are shown in Fig. 3.

5.3.4 *Metallic Sheet Waterbar* — The metallic sheet for use as waterbar in joints shall conform to the requirements given in **5.3.4.1** to **5.3.4.3**.

5.3.4.1 Of the metals available copper is most suitable for use as waterbar as regards ductility and resistance to corrosion in air, water and concrete. It may, however, be attacked by some wastes. If sheet lead or aluminium are used, they shall be insulated from concrete by a good coat of bitumen. Galvanized steel sheets may also be used with specific permission of engineer-in-charge provided the liquid stored or the atmosphere around the liquid retaining structure is not exactly corrosive, for example, sewage.

5.3.4.2 The thickness of metallic sheet shall correspond to not less than 0·56 mm Indian Standard gauge sheets.

5.3.4.3 The strips shall be supplied in uniform lengths of 2·5 to 3·5 m at the option of the manufacturer, unless otherwise ordered.

6. INSTALLATION OF JOINTS

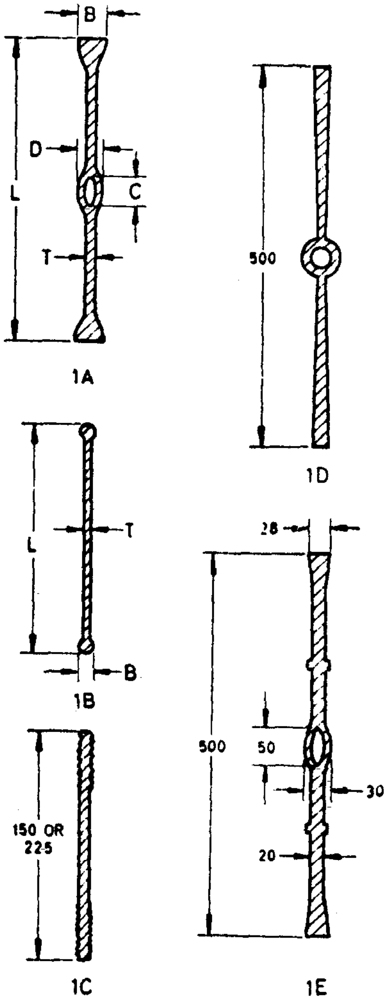
6.1 General

6.1.1 The finish of joint shall be such as to provide a neat appearance. It is very important that formwork is accurately constructed and the concrete mix is sufficiently workable to permit thorough compaction.

6.1.2 In many cases expansion joints will have to be incorporated as architectural features and the choice of joint filler, the pattern of joint.

L	*D*	*C*	*B*	*T*
60	10	10	10	3
100	8	10	10	3
150	13	11	13	5
200	18	21	20	6
250	18	20	20	5
350	18	20	20	5
450	18	20	20	5

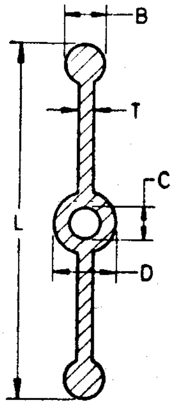
L	*B*	*T*
100	10	5
150	10	5
225	20	5



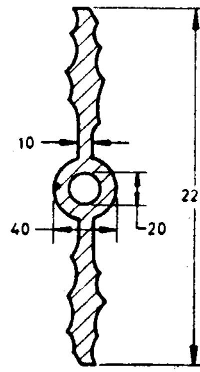
All dimensions in millimetres.

FIG. 1 TYPICAL DESIGNS OF VALVE TYPE PVC WATERBARS

L	*D*	*C*	*B*	*T*
225	40	20	25	10
175	40	20	25	10
150	30	20	15	5
125	30	20	15	5

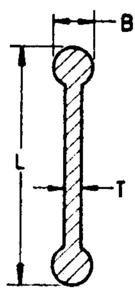


2A

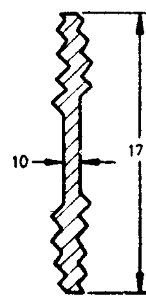


2B

L	*B*	*T*
225	20	5
150	10	5
150	25	10
100	10	5



2C



2D

All dimensions in millimetres.

FIG. 2 TYPICAL DESIGNS OF NATURAL RUBBER WATERBARS

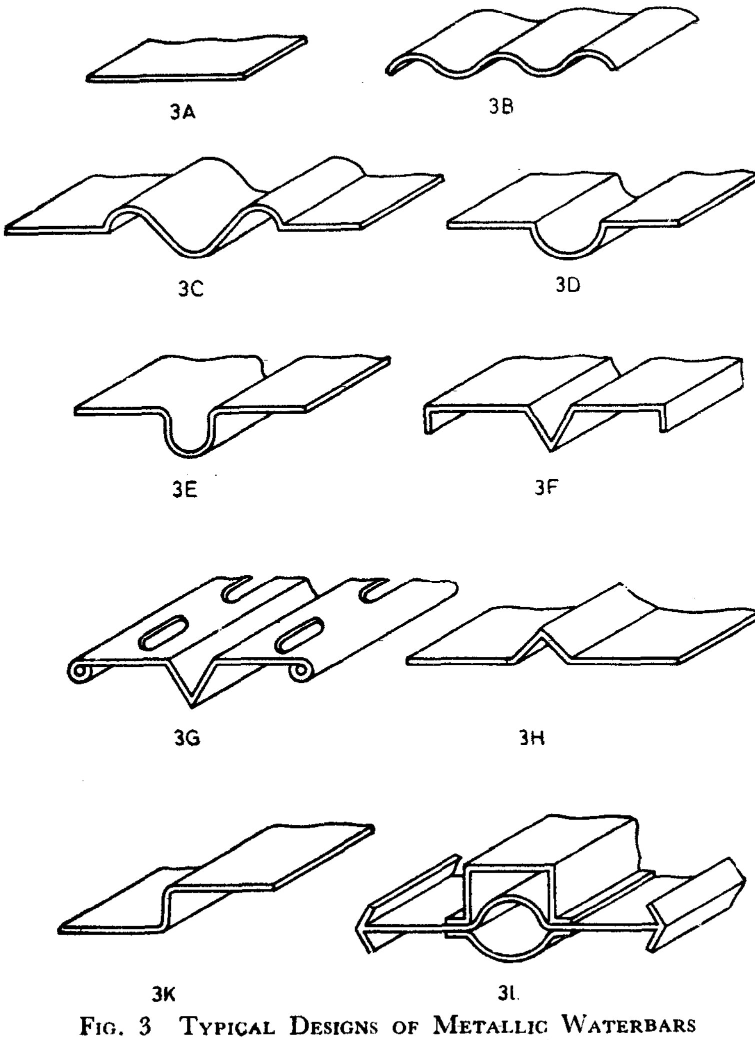


Fig. 3 Typical Designs of Metallic Waterbars

and further finishes to mask the joint, if necessary, would depend on architectural considerations. Expansion joints may advantageously be located in corners where they will be hidden from view. The joints in floors may best be located at or near the junction between the wall and the floor.

6.1.3 Defects may arise in expansion joints due to inadequate joint spacing or incorrect location and size of joints or due to incorrect construction procedure, such as discontinuous joints, badly formed sealing cavities, poor compaction and misalignment of waterbars. Also defective choice of joining material will result in defects like loss of adhesion of sealing compound, fracture of the sealing compound, flow of the sealing compound, cavitation, bubbling, spalling, oxidation of joint filler, etc.

6.1.4 *Inspection* — Some of the important aspects which require supervision while installing joints are cleanliness of cavity, thorough application of the mortar or concrete around the cavity and its thorough compaction, accurate location of waterbar and cupious oiling of the fillet for forming of the sealing cavity, accuracy and smoothness of the joint, continuity of the joints, and accurate cutting and fitting of the joint filler. If more than one piece is used for joint filler, pieces should be closely butted together tightly in order to prevent concrete bridging across the cavity.

6.2 Application of Sealing Compound -- For application of the sealing compounds the concrete or masonry shall be in dry condition. The subsequent climatic conditions after construction shall also be considered in selection of proper sealing compounds and its application so that the sealing compound is able to withstand the stress and maintain its adhesive bond with the masonry or concrete. After allowing the concrete to dry, the sealing cavity shall be cleaned and exposed to atmosphere for some time till it is dry. For vertical control joints in masonry, no sealing compound may be provided.

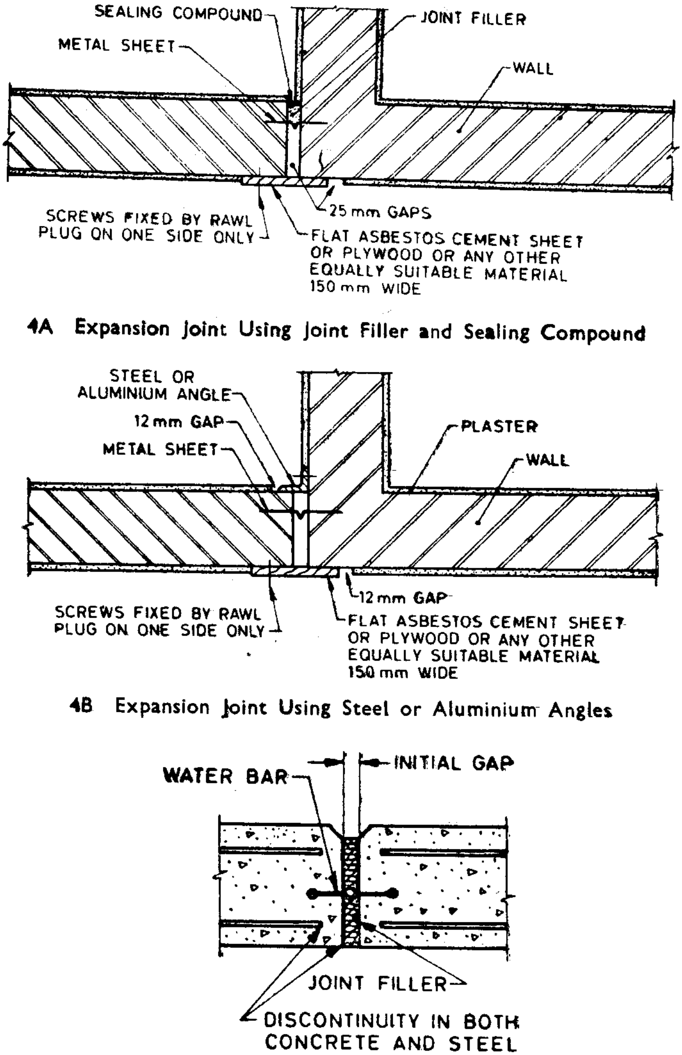
6.2.1 While applying compounds, the manufacturer's advice may be followed with regard to application of primer, if necessary. The application of primer shall be such as to cover the sealing cavity to the full depth. No excess primer shall be applied. Sufficient time shall be allowed after the application of primer so that it dries completely before the application of sealing compound. Hot applied sealing compound shall be heated to the correct temperature as recommended by manufacturer. Building mastics may be applied with trowel or by means of a gun for application.

6.3 Installation of Expansion Joint in Walls

6.3.1 In brick or stone masonry expansion joints normally need not be necessary, except in the case of long walls exceeding 30 m in length; in such long walls the expansion joints shall be not less than 15 mm wide and shall be spaced not more than 30 m apart.

6.3.2 In the case of walls above ground level where the width of the joint is less than 15 mm, use of sealing compound will suffice, but for wider joints, a joint filler shall be used. The installation of joint with joint filler and sealing compound shall be as shown in Fig. 4A and with angle irons shall be as shown in Fig. 4B.

6.3.3 For walls below ground level or for walls subject to water pressure, use of an efficient waterbar is essential in the expansion joints. The water-bar shall be installed as shown in Fig. 4C.



4A Expansion Joint Using Joint Filler and Sealing Compound

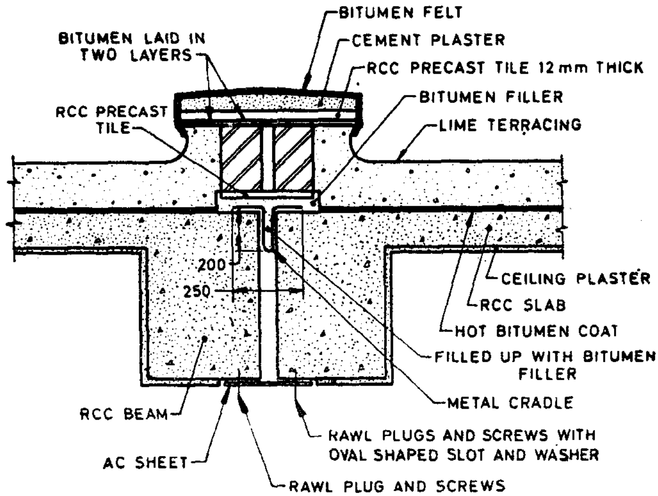
4B Expansion Joint Using Steel or Aluminium Angles

4C Expansion Joint Subject to Water Pressure

FIG. 4 TYPICAL DETAILS OF EXPANSION JOINTS IN WALLS

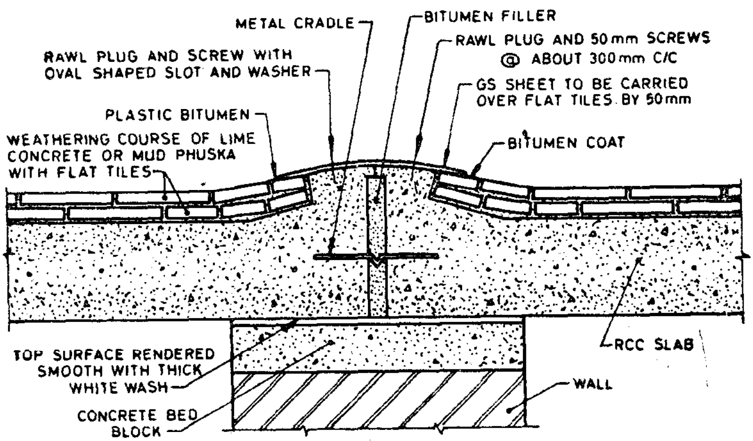
6.4 Installation of Expansion Joints in Roofs, Floors

6.4.1 The expansion joints used in roofs shall be finished such as to obtain an effective seal against penetration of water. A waterbar shall be installed in the expansion joint. The joint and the cover slabs shall be suitably treated for waterproofing. Typical sketches of expansion joints in roofs are shown in Fig. 5 and 6.

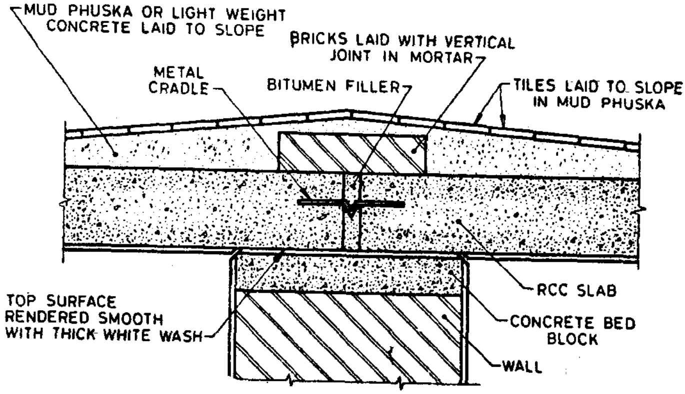


All dimensions in millimetres.

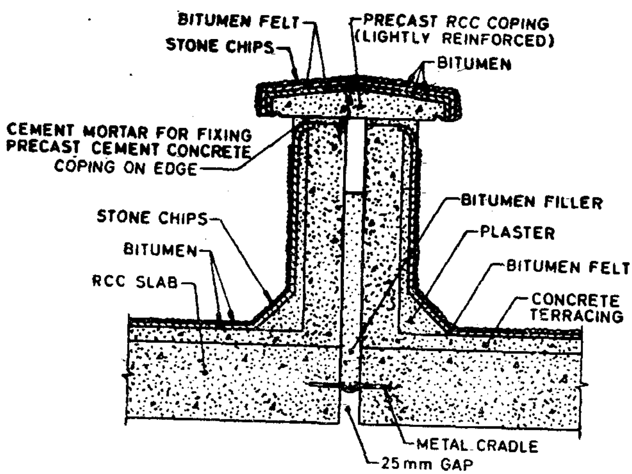
5A Expansion Joint Using RCC Precast Tiles Over Joint



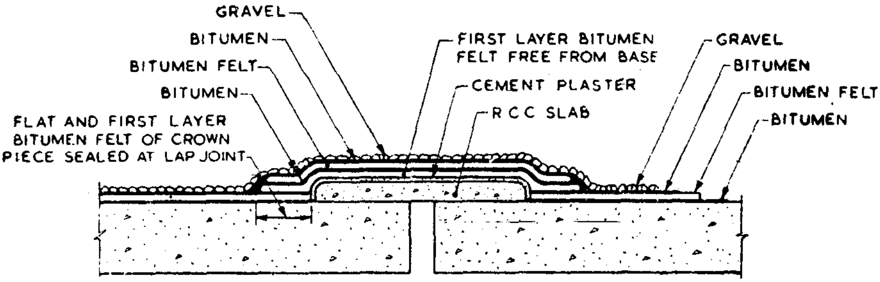
5B Expansion Joint Where Flat Tiles Laid Over Roof



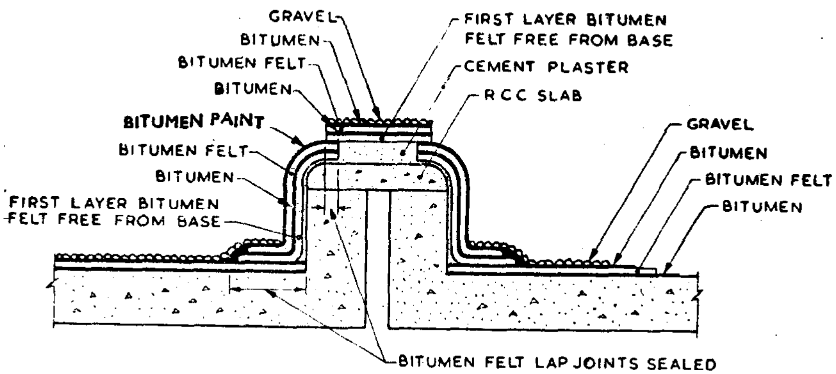
5C Expansion Joint Where Flat Tiles Laid Over Roof and Brick Layer Over Joint



5D Raised Type Expansion Joint with Coping



5E Expansion Joint with RCC Slab Covered over Joint



5F Raised Type Expansion Joint Without Coping

All dimensions in millimetres.

FIG. 5 TYPICAL DETAILS OF TREATMENT FOR EXPANSION JOINTS AT ROOFS

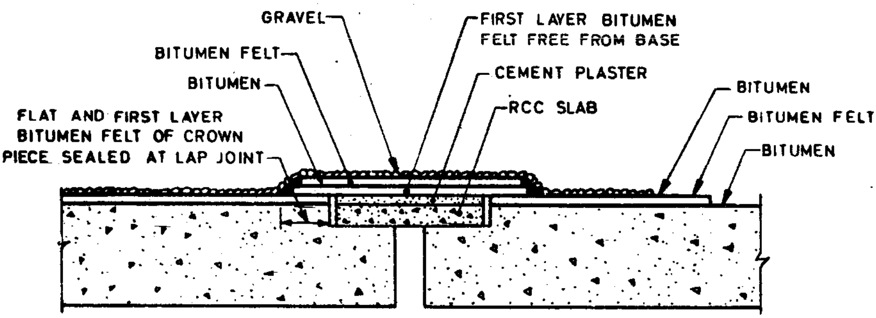


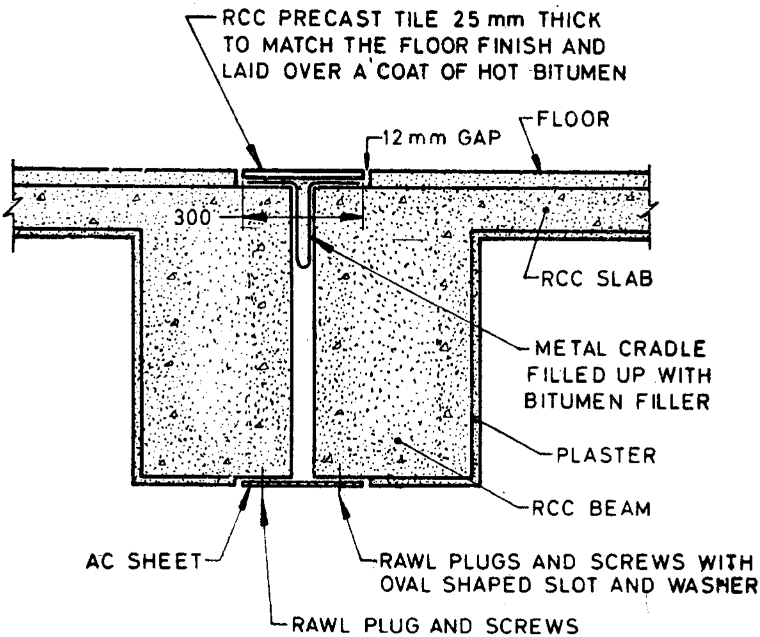
Fig. 6 Typical Details of Expansion Joint in Level with Roof Surface

6.4.2 In the case of expansion joints in floors, provision of waterbar may not be necessary. Where the lower part of the joint is left open chamfering shall be provided on either side of the joint to improve appearance. If an open joint is not acceptable, a cover plate fixed to one side and free to slide over the concrete on the other side may be provided (*see* Fig. 7).

6.4.3 In the case of long chajjas, balconies and parapets the joints shall be at intervals of 6 to 12 m. The expansion joints shall not extend into the portion where sun shade is embedded into the masonry but shall stop short of face by 5 cm, and the distribution reinforcement in the embedded portion and in the 5 cm portion of chajja slab, where there is no expansion joint, shall be increased to 0·3 percent of the gross cross sectional area to take up temperature stresses. In case of covered verandah slabs the expansion joint spacing may be increased to 12 to 14 m and the expansion joint shall not be extended beyond the wall. The gap may be sealed by copper cradle. Aluminium cradles insulated with a thick coat of bitumen may also be used in place of copper cradles.

6.4.3.1 Where verandah slab is the extension of the floor slab, the distribution reinforcement in the portion of the slab resting on the masonry shall be increased to twice its normal amount. Reinforcement not required from structural considerations may be considered effective as distribution reinforcement for the purpose.

6.4.3.2 To prevent cracks in the masonry below or above the expansion joint in cases where it is not possible to provide a vertical joint in the masonry, RCC or plain cement concrete bed plates shall be provided on the bearing.



All dimensions in millimetres.

FIG. 7 TYPICAL DETAILS OF EXPANSION JOINT AT FLOOR

6.5 Roof or Floor to Wall Joints — The roof slab shall be free to move at the bearings on the walls and sliding joints shall be provided for at the bearings. This may be achieved by resting the slab over a smooth surface obtained by a plaster finish over the bed blocks or bearing surface of wall, giving a white wash finish will give smoother surface. A similar treatment may be given in the case of floor slabs bearing on walls (*see* Fig. 8, 9 and 10).

6.6 Installation of Expansion Joints in Framed Buildings — The details of joints between the panel wall of the frame shall be as illustrated in Fig. 11. In the case of continuous expansion joints between two parts of buildings twin columns shall be provided and the details of expansion joints between them shall be as shown in Fig. 12. In addition to the expansion joints necessary in the reinforced concrete frame, contraction joints shall be provided in the masonry in the facade. These joints may be either straight or staggered joints in the masonry and the joints finished with suitable sealing compound to match the appearance for the cladding. Resin based building mastics may be found suitable for sealing joints in the facade as they will be available in various colours. PVC cover strips may also be used. In the case of glass block partition felted mineral fibre will be particularly suitable as joint filler.

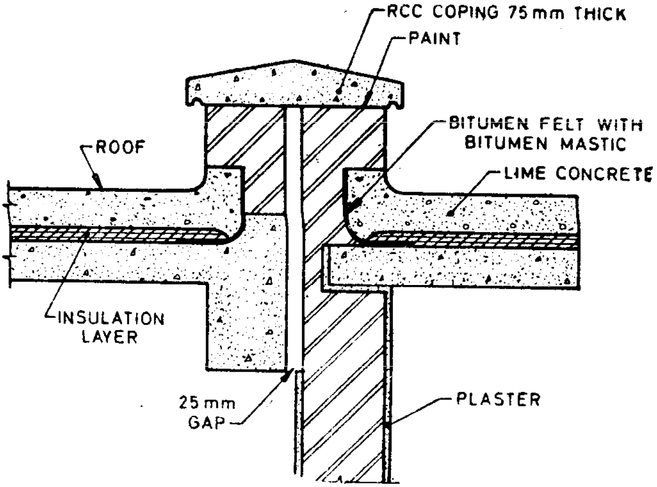
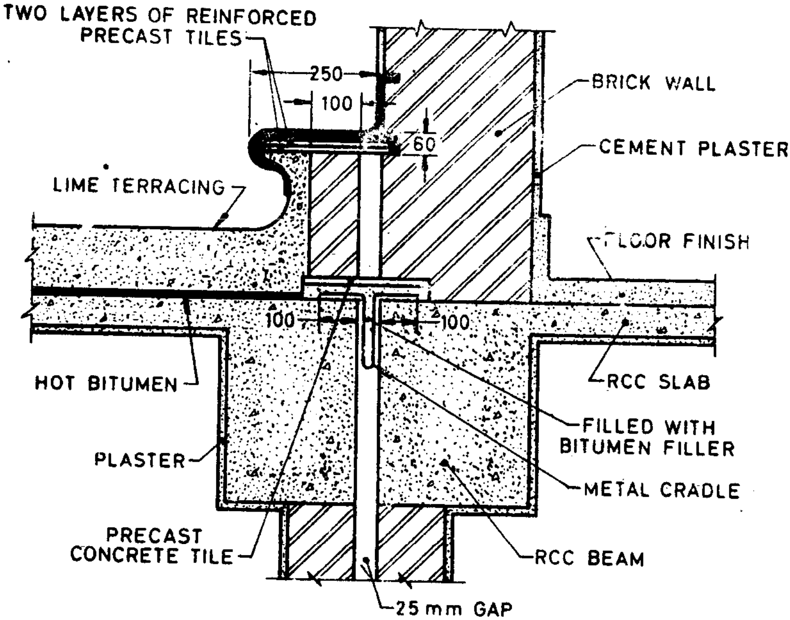


Fig. 8 Typical Details of Expansion Joint at Wall and Roof Junction



All dimensions in millimetres.

Fig. 9 Typical Details of Expansion Joint at Roof by the Side of Wall

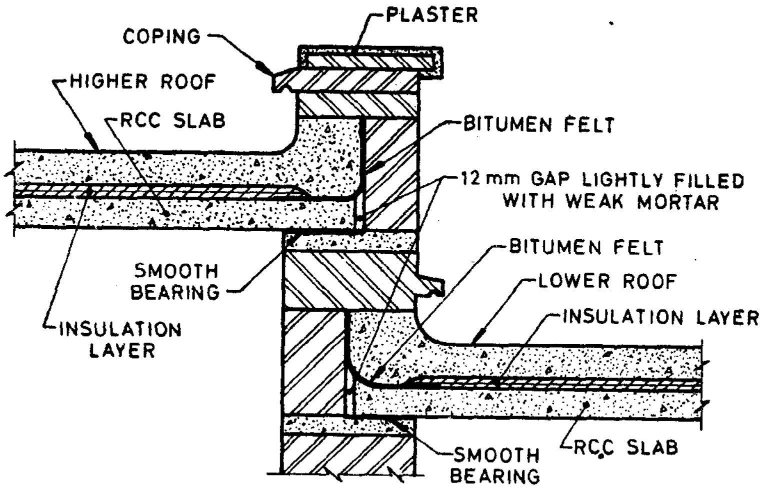


FIG. 10 TYPICAL DETAILS OF EXPANSION JOINT AT DIFFERENT FLOOR LEVELS

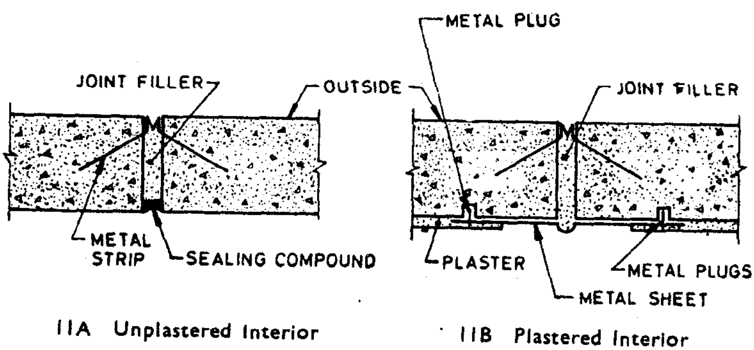
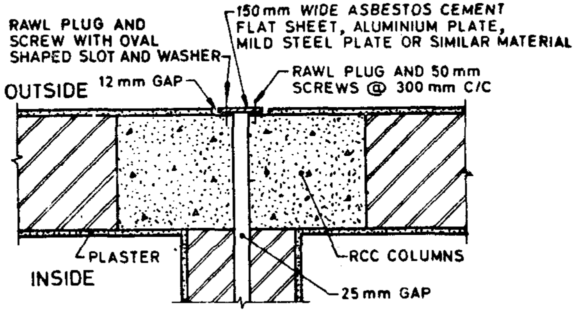
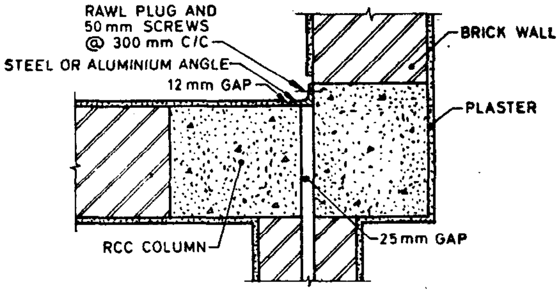


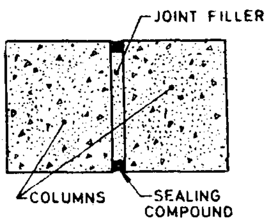
FIG. 11 TYPICAL DETAILS OF EXPANSION JOINT AT PANEL WALLS OF RCC FRAMED STRUCTURE



12A TYPICAL DETAILS OF EXPANSION JOINT ON OUTER FACE OF COLUMNS



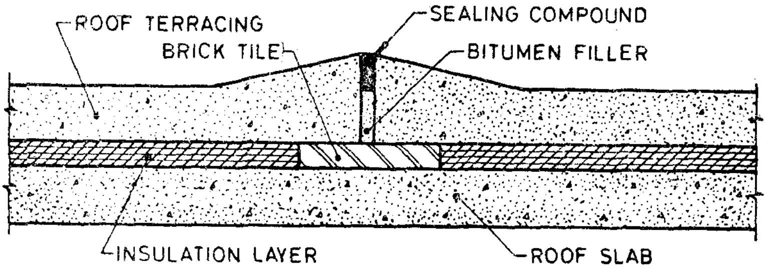
12B TYPICAL DETAILS OF EXPANSION JOINT AT CORNER COLUMNS



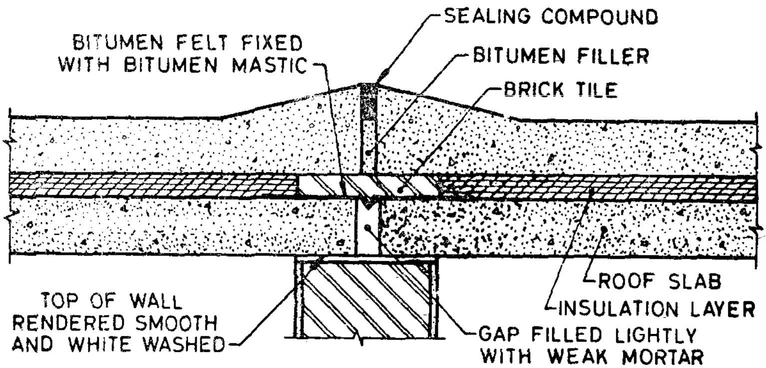
12C TYPICAL DETAILS OF EXPANSION JOINT AT ISOLATED TWIN COLUMNS

FIG. 12 TYPICAL DETAILS OF EXPANSION JOINTS AT TWIN COLUMNS OF RCC FRAMED STRUCTURES

6.7 Contraction Joints in Roofs — Contraction joints are generally of two types, namely, parapet type and lip type. Typical sketches of these types of joints are shown in Fig. 13 and 14.



13A TYPICAL DETAILS OF LIP TYPE JOINT IN ROOF TERRACING WHERE THERE IS NO JOINT IN ROOF SLAB



13B TYPICAL DETAILS OF LIP TYPE JOINT WHERE THERE IS JOINT IN ROOF SLAB OVER A WALL

FIG. 13 TYPICAL DETAILS OF LIP TYPE JOINTS IN ROOF

7. MAINTENANCE

7.1 It may be advantageous to carry out maintenance work during dry spells of weather in the spring, at which time of the year the width of th joints and the cracks will be intermediate between summer and winter conditions, and subsequent strains for the sealing compound and joint filler will be equally divided between expansion and compression.

7.2 Isolated and well-defined cracks in vertical surfaces shall be cut out to provide a substantial cavity to a width of 15 mm, and depth 15 to 20 mm, and this shall be filled with cold-applied bitumen or hot-applied mastic.

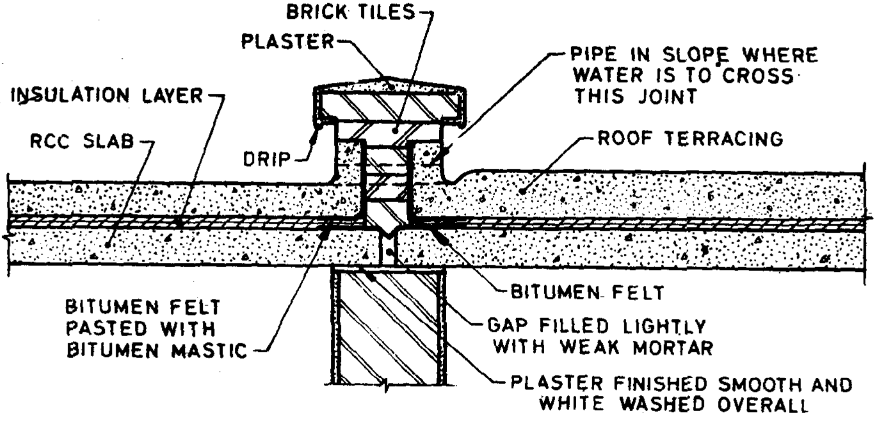


FIG. 14 TYPICAL DETAILS OF PARAPET JOINT IN ROOF TERRACING WITH OR WITHOUT WALL

7.3 For maintenance of joints, in the first stage the sealing compound and all grit which has become packed in the joint shall be removed. The walls of the sealing cavity shall be cleaned as thoroughly as possible by wire brush. If a different type of sealing compound is to be used subsequently all the traces of the old compound shall be removed. Washing with solvent containing 5 to 10 percent of suitable detergent and then hosing down with water for one or two hours and then brushing with stiff brushes will prove satisfactory. The sealing compound shall then be applied.