GUIDELINES AND SPECIFICATIONS FOR EXPANSION JOINTS

(*First Revision*)

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1 INTRODUCTION

1.1 The Bearings, Joints and Appurtenances Committee (B-6) of the Indian Roads Congress was constituted in 2009 with the following personnel:

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1.2 The Guidelines and Specifications for expansion joints were published in 2005. Subsequently, comments were received from the members of the Committee as well as from the professionals working in this field suggesting modifications in the documents. The Committee B-6 constituted a Sub-group to prepare a draft document taking note of the suggestions received for consideration of the Committee B-6. The Sub-group had the following members:

Banerjee, A.K.	Convenor
Majumdar, Santanu	Member
Gaharwar, Dr. S.S.	Member

1.3 Sub-group prepared a draft which was discussed in the meetings of the B-6 Committee and the draft 'Guidelines and Specification for Expansion Jonts' were finalized. The darft was approved by the Bridge Specifications and Standards Committee in its meeting held on 25th October, 2010. Subsequently, the draft was approved by the Executive Committee on 27th October, 2010. The document was considered by the IRC Council in its 192nd meeting held on 11th November, 2010 at Nagpur (Maharashtra) and approved the docoment.

2 SCOPE AND OBJECTIVE

This document deals with the functions and requirements of expansion joints for all types of bridges, various types of movements and rotations for which these joints are to be designed, guidelines on selection of a type of expansion joint depending on the magnitude and nature of movements of the deck in a specific situation, general and material specifications, testing and acceptance standards, guidelines on installation, inspection and maintenance, handling and storage, and the replacement of the joints.

The provisions of these guidelines are meant to serve as a guide to both design and construction engineers, but mere compliance with the provisions stipulated herein will not relieve them in anyway of their responsibility for the functional performance of the joint designed and erected. These guidelines limits itself to areas of direct relevance to the correctiveness needed in the basic approach to the problems and practice relating to expansion joints.

Various sketches given in the guidelines are indicative. Actual arrangement of the proprietary items depends upon the patented design and specifications of manufacturers.

In case of expansion joints for submersible bridges, special attention needs to be paid to durability under submerged conditions.

Users are requested to report the performance of different types of expansion joints to Indian Roads Congress so as to enable periodic review and updation of these guidelines.

3 FUNCTIONS

The first and foremost requirement of an adequate joint design is that the joint should be capable of accommodating all movements of the deck viz. translation and rotation. In the process, it must not cause unacceptable stresses either in the joint itself or in the structure by the way of restraint. A further requirement is a low noise level especially in an urban environment. The replacement of an expansion joint is always combined with a traffic interruption – at least on the affected lane. Therefore, expansion joints should be robust and suitable for all loads and local actions under all weather conditions. The replacement of all wearing parts should be possible in a simple way. In general, the expansion joints should perform the following basic functions:

i) Should permit the expansion/contraction of the span/spans to which it is fixed without causing any distress or vibration to the structure.

ii) Cause no inconvenience/hazard to the road user and offer good riding comfort.

iii) Should be capable of withstanding the traffic loads including dynamic effects.

iv) Be watertight and be capable of expelling debris without clogging/ without imparting higher force on the structure than what it is designed for. For this, it is desirable to have expansion joint extending for full width including the kerb as well as in footpath portion. However, specifications of joints provided in footpath and kerb may be different than that provided in the main carriageway portion.

v) Surface exposed to traffic should be skid free and resistant to polishing.

vi) Ensure accessibility for inspections and easy maintenance with all parts vulnerable to wear being easily replaceable.

vii) Any other function assigned to the expansion joint as per the specific requirements of the structural systems.

4 MOVEMENTS AND ROTATIONS

4.1 The prime functional requirement of a joint is to cater for movements with very low resistance or with no resistance at all. Estimation of the joint movement, is therefore, the first design step. The most familiar and by far the biggest movement that the joint has to cater for is linear translation marked by opening and closing of the joint. Often the joint suffers rotational as well as transverse movement and out of plane vertical movement as shown in **Fig. 4.a and 4.b**.

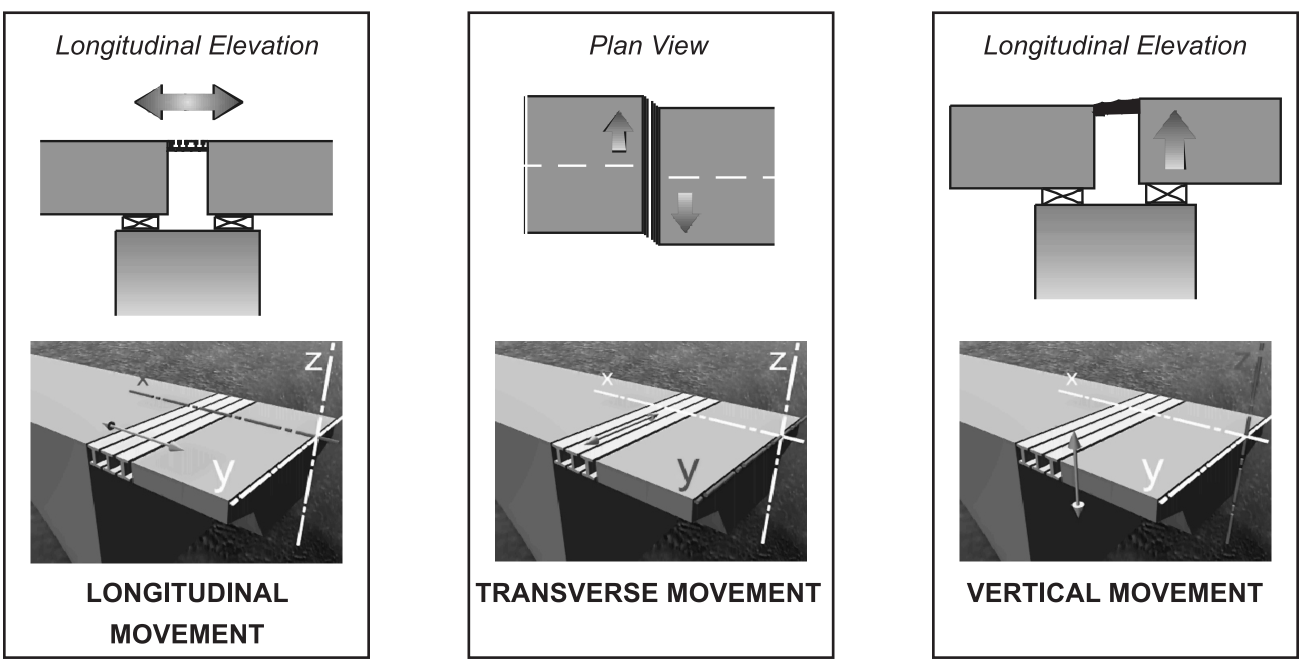

Fig. 4.a

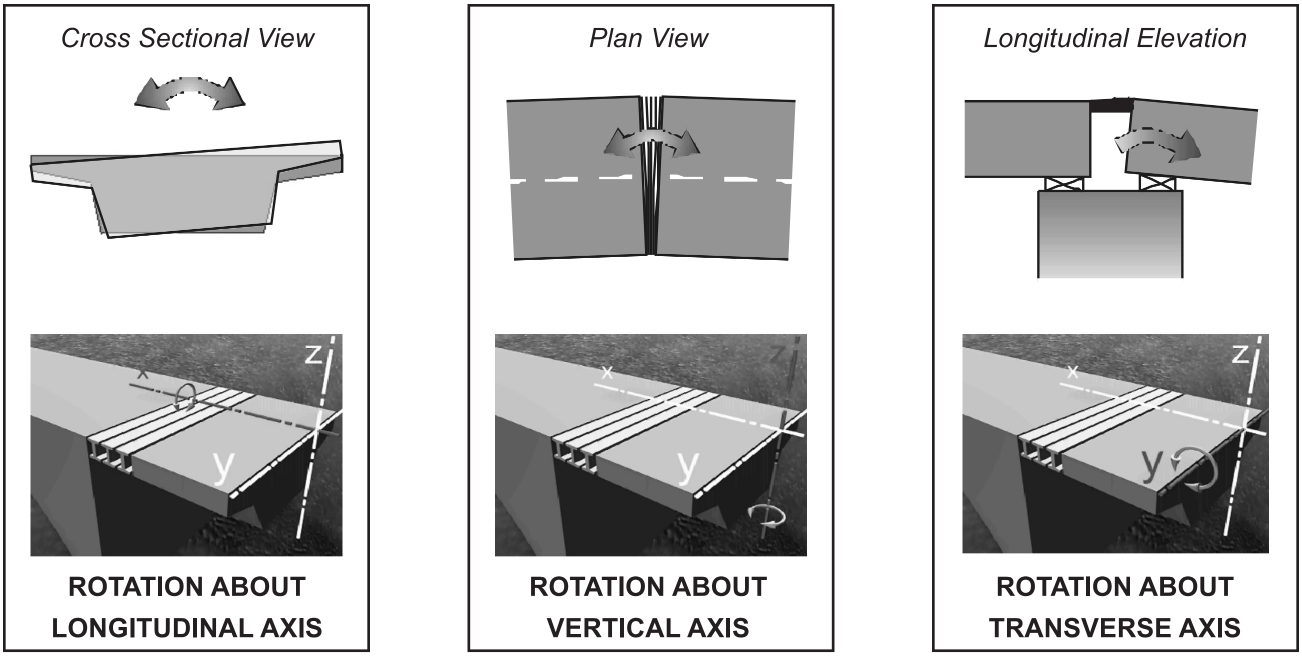

Fig. 4.b

4.2 The design of deck joint is to be viewed as an integral part of structural design process. The estimation of deck joint movement, its magnitude and direction is determined by the design of supporting system. The plan geometry of the structure is obviously the most important factor in determining the horizontal movement at different points of the structure viz., at points of bearing support as also for deck joints. It is necessary to consider all translations and rotations to ensure that the displacements will not exceed the permissible design limits of the joint construction. Salient sources of joint movements may be broadly grouped into external load induced movements and internal volume changes of deck as given in **Table 4.1**.

Table 4.1 Salient Sources of Joint Movement

Sources of External load induced movements	Sources of Internal volume changes of deck
Horizontal loads transmitted to deck (traffic loads/climatic loads)	Ambient temperature
Displacement/rotation of deck edges induced by vertical traffic loads	Creep of concrete deck
Foundation/substructure movement (soil deformation, earth pressure etc.)	Shrinkage of concrete deck

4.3 External load induced movements are transmitted to deck joint through rocking, sliding, rotation and elastic restraint of bearing and structure. When caused by transient traffic load these comprise low amplitude high frequency translation, rotation and vertical displacements. Traffic load induced movements are influenced by:

- Deck rigidity, geometry and statical system
- Traffic loading, Bearing type, location and behaviour
- Structural restraint of particular relevance to design and articulation system

In addition to traffic loads, external load induced movements may be caused due to exceptional loads like wind, earthquake, accidental structural damage, displacement etc.

4.3.1 In the case of an elastic zero movement point, there are additional movements at expansion joints due to acceleration and braking forces. For decks supported on free elastomeric bearings at both end, the zero movement point is elastic (see **Fig. 4.3.1.a**). The zero movement point may also be elastic due to flexibility of pier. Moreover the actual rigidity of piers can differ from the planned rigidity. If a zero movement point is located on a tall substructure, the additional movements due to pier deformation must be considered in the structural analysis (see **Fig. 4.3.1.b**). If the bridge is fixed on more than one support, the position of the zero movement point may differ from the planned position.

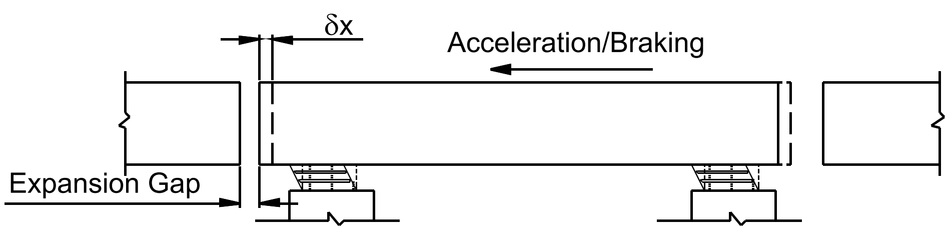

Fig. 4.3.1.a

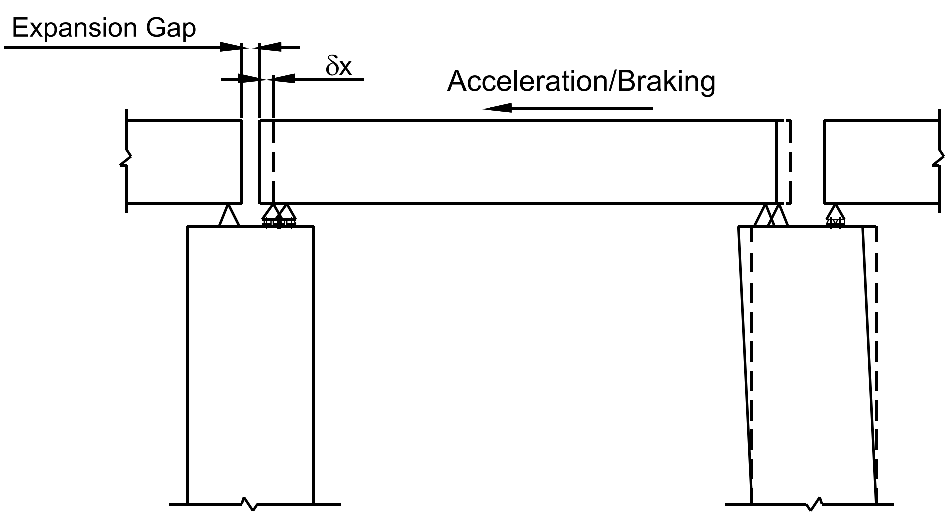

Fig. 4.3.1.b

4.3.2 The support rotation of deck under the influence of traffic loads may cause movements and rotation at the expansion joint. The point of rotation of deck at support depends on the type of bearing on which it is supported. The vertical distance of the point of rotation from the plane of expansion joint and the magnitude of rotation are the factors influencing movements and rotation at the expansion joint (see **Fig. 4.3.2**).

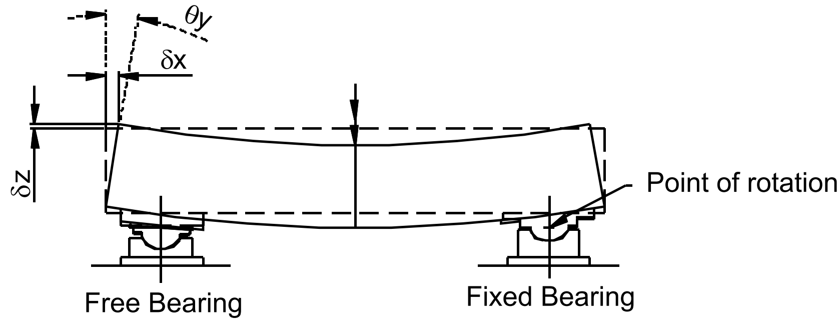

Fig. 4.3.2

4.3.3 Movement of substructure under the influence of traffic load due to sway effect etc. may cause movement and rotation at the expansion joints (see **Fig. 4.3.3**).

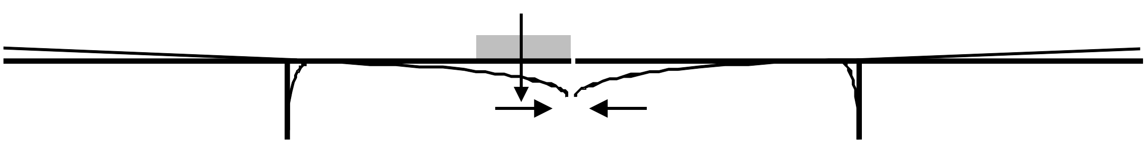

Fig. 4.3.3

4.3.4 **Fig. 4.3.4** shows a wall-type abutment on piling. For such a structure, it is generally assumed that the loads and forces above Plane A-A are resisted by piling below Plane A-A. Occasionally, passive earth pressure in the soil at the toe of the footing above Plane A-A is included in the analysis as providing resistance to the horizontal forces above Plane A-A. Accordingly, it is generally considered that Plane A-A is an absolutely rigid plane and the movement of the abutment with respect to Plane A-A due to loads and forces above Plane A-A is ignored. Moreover when sizing bridge deck joints, the abutments are considered as rigid substructures and the bridge seats and back walls as immovable surfaces. As a result of this simplified assumption, the bearings and deck joints are sized based only on the joint movements produced by superstructure length changes. Depending on the characteristics of the bearings, deck joints in such a structure should also take into account the anticipated abutment movements, which may occur early in the life of the structure.

4.3.5 Movement may also be caused from the lateral and rotational movement of the abutment due to consolidation of the backfill, surcharge effect and active pressure exerted by the backfill soil.

4.4 The sources of deck movement due to internal volume changes of deck are environment related. The low frequency, high amplitude movements are mainly translatory and predominate deck and joint movement.

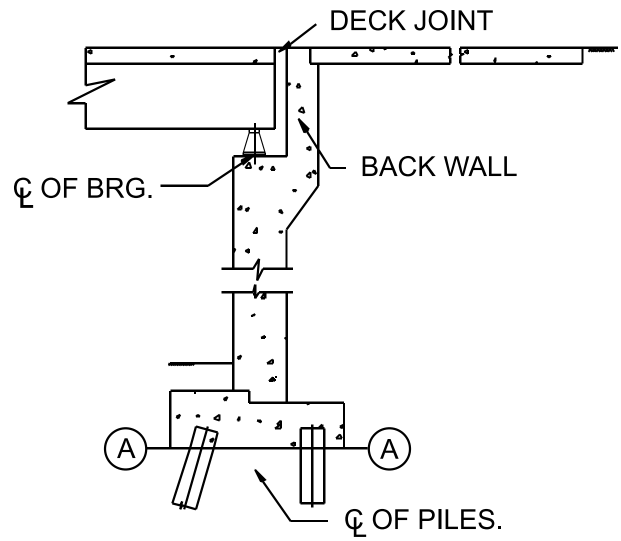

Fig. 4.3.4

4.4.1 It is also necessary, particularly for longer spans, to make a reliable judgement of bridge temperature during installation of joint and preset the joint accordingly to ensure as closely as possible to the condition that in the long run, at mean average temperature, the joint remains at its nominal state. The age of deck concrete from casting and/or pre-stressing is also required to be considered for calculating the remnant creep and shrinkage and to apply necessary preset to the joint accordingly.

4.5 The simplest plan geometry catered for and common is two-lane narrow straight deck. It will have movement parallel to longitudinal centreline. To determine the actual movement possible, the stationary point or the zero movement point has to be identified. The zero movement point will depend on structure geometry, location and type of bearings and piers as well as their stiffness. In general, the zero movement point is located on the centreline of straight deck by symmetry in such cases.

4.6 In case of a curved bridge, the zero movement point may even fall outside the plan area. The location of the zero movement point determines the magnitude and direction of movement. As such a detailed analysis is necessary (see **Fig. 4.6**).

4.7 Skew and curved wide bridges are common in modern highway system. Bridges curved in plan and skew are likely to have both longitudinal and transverse movement (**Fig. 4.7.a** and **Fig. 4.7.b**). Wide bridges may also tend to move transversely. This can lead to twisting of expansion joints and some transverse force on the joint and structure needing attention.

4.8 Vertical translations can be caused by the geometrical conditions on the abutment, e.g. for bridge with longitudinal gradient and horizontal bearing seating (**Fig. 4.8.a**) for bridges with considerable cantilevering of deck over bearing at abutments (**Fig. 4.8.b**).

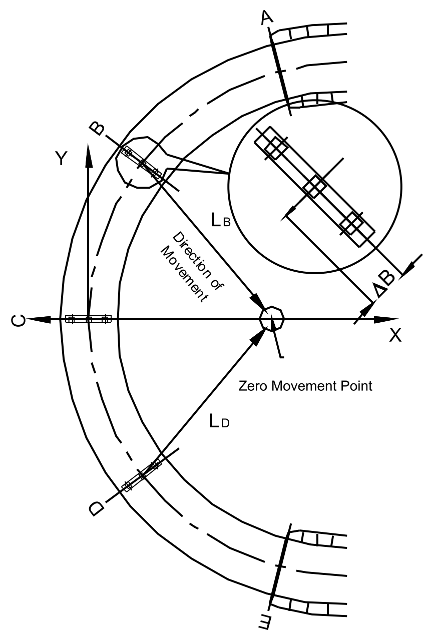

Fig. 4.6

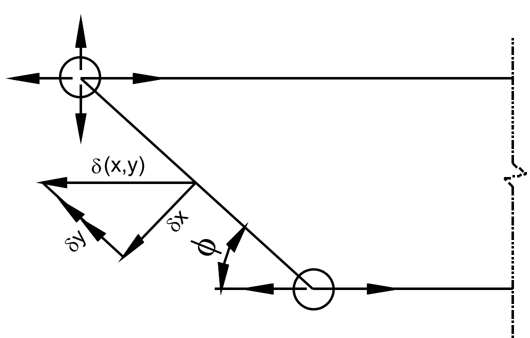

Fig. 4.7.a

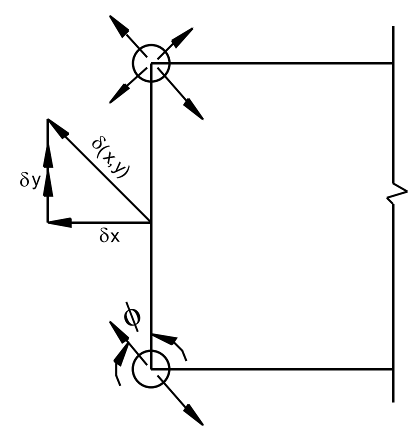

Fig. 4.7.b

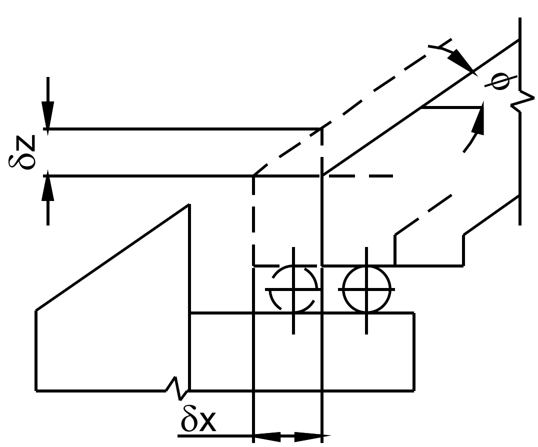

Fig. 4.8.a

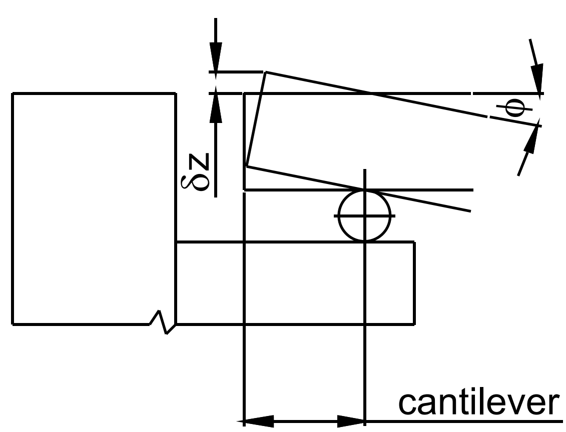

Fig. 4.8.b

4.9 Vertical translations can be caused during replacement of bearing (**Fig. 4.9.a**). Also, in the case of replacement of one single bearing on one side, a rotation will occur about longitudinal axis of the bridge (**Fig. 4.9.b**). However, it is possible to avoid this movement by uniform lifting over the cross-section.

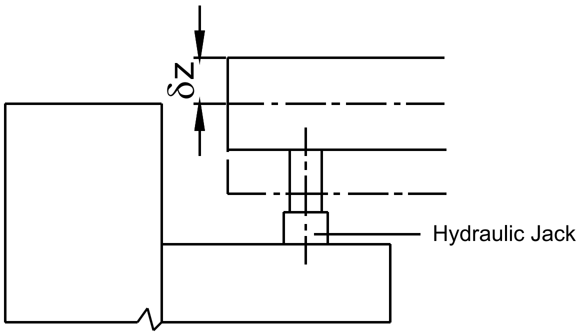

Fig. 4.9.a

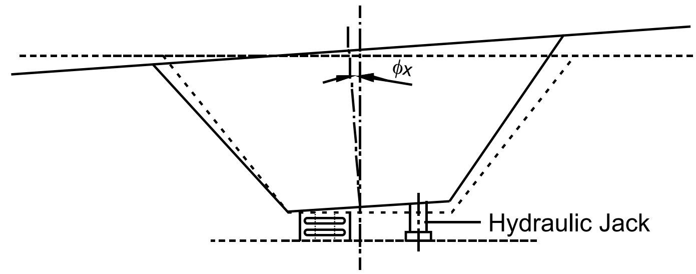

Fig. 4.9.b

4.10 The following factors shall be considered in determining force effects and movements. The design movement for expansion joint however need not cater for Earthquake and Dynamic effects since the expansion joint is a replaceable item and design life for expansion joint is much lower than the return period of earthquake forces:

i) Structural material properties, including co-efficient of thermal expansion, shrinkage, creep etc.

ii) Effective temperature range, installation datum temperature and extremes.

iii) Articulation system details including bearing, pier stiffness etc.

iv) Method and sequence of construction.

v) Tilt, probable settlement and movement of supports.

vi) Construction tolerances.

vii) Live load, wind and earthquake.

viii) Dynamic structural response, structural restraints.

ix) Provisions for future construction/rehabilitation work particularly for lifting of superstructure for replacement/resetting of bearings.

4.11 Calculation of rotations and movements shall be done as per relevant IRC Codes and sound engineering practices.

5 BASIS FOR SELECTION OF TYPE OF JOINTS

The prime functional requirement of a joint is to cater to the maximum movement, from extreme positions of contraction and expansion, which is normally the longitudinal movement of the deck.

The maximum opening of a joint will be determined by adding the maximum movement requirement to the minimum opening of joint in extreme closed condition.

Brief description of different types of joints with limitations of each type have been included in this section along with maximum opening capacity and rating of movement and rotation of each type to facilitate selection of the joints by the designer.

5.1 Joints for Small Openings (Movement upto 25 mm)

Brief description of different types of joints for small movements (upto 25 mm), along with their limitations, are given below:

5.1.1 *Buried joint (movement upto 10 mm)*

Burried joint consists of continuously laid bituminous/asphaltic surfacing over the joint gap bridged by a steel plate resting freely over the top surface of the deck concrete. The joint is suitable for short span structure. Typical buried joint is shown in **Fig. 5.1.1**.

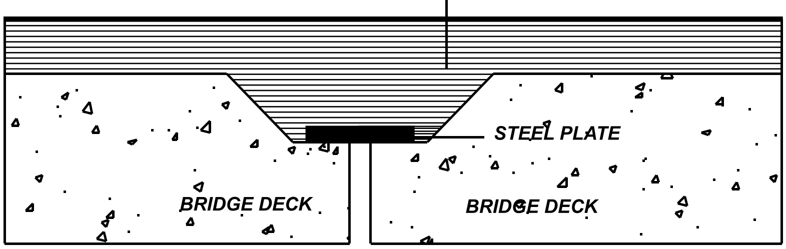

Fig. 5.1.1 Buried Joint

Limitations of Buried Joint are:

- Prone to deterioration due to cracking and squeezing of bituminous surfacing and consequent bad riding quality.
- The road surfacing at joint location is required to be renewed frequently.
- Gradual rusting and deterioration of supporting steel plate because of its inaccessibility for maintenance.

5.1.2 *Filler joint (movement upto 10 mm)*

The components of Filler joint shall be at least 2 mm thick corrugated copper plate placed slightly below the wearing coat, 20 mm thick compressible fibre board to protect the edges, 20 mm thick pre-moulded joint filler, sealed with a joint sealing compound, filling the gap up to the top level of the wearing coat. Typical filler joint is shown in **Fig. 5.1.2**.

Limitations of Filler Joint are:

- Life of the joint is short. Compressibility of filler gets reduced with age and thus needs to be replaced soon.

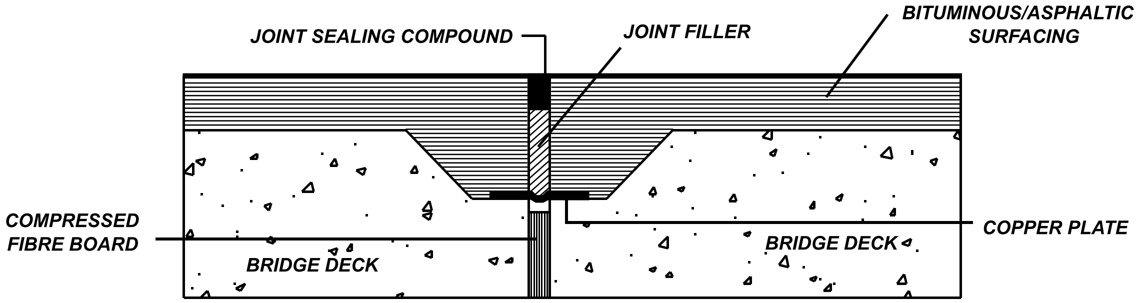

Fig. 5.1.2 Filler Joint

5.1.3 *Asphaltic plug joint (movement up to 25 mm)*

Asphaltic plug joints consists of a modified bitumen binder carefully selected single size aggregate, closure/bridging metallic plate and heat resistant foam caulking/backer rod. This joint is especially suitable for rehabilitation works. Typical asphaltic plug joint is shown in **Fig. 5.1.3**.

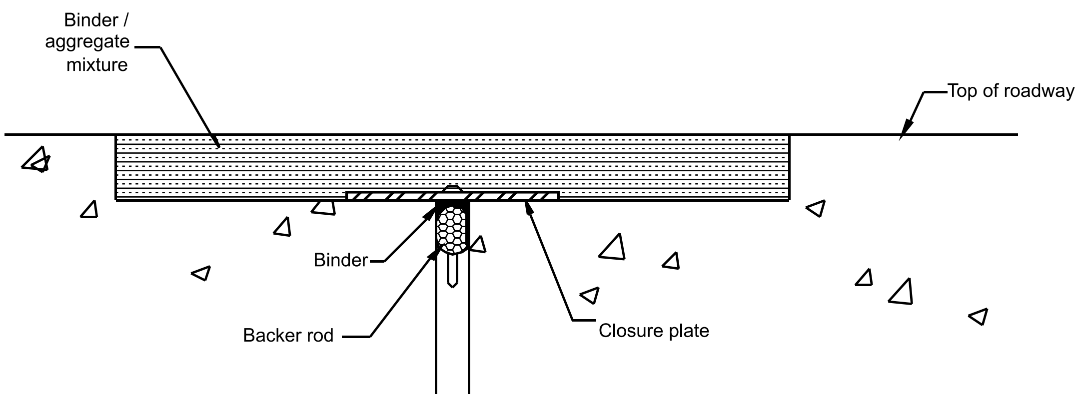

Fig. 5.1.3 Asphaltic Plug Joint

Limitations of Asphaltic Plug Joint are:

- Prone to deterioration due to flow of material in wheel path in high ambient temperature.
- The aggregate may get de-bonded from the bitumen matrix in winter with subsequent potholing under traffic.
- Possibility of de-bonding of the plug from the adjoining asphalt surface.
- Reliable indigenous source for binder etc. yet to be established.
- Incorrect placement of materials results in tearing of the adjacent carriageway pavement.
- Yielding of asphaltic material under the wheels of standing vehicles, brake and acceleration forces combined with high environmental temperatures and the development of rutting

5.2 Joints for Medium Openings (Movement over 25 mm and upto 80 mm)

The absorption of medium openings requires an elastic expansion element or an expansion gap across the carriageway surface. For traffic safety, gaps in deck slab below 5 mm or over 65 mm are not recommended. Thus, the expansion movement of a simple gap construction is limited to 60 mm. Expansion joints for medium openings consists of a sealing element, edge elements and fixing elements.

5.2.1 *Compression seal joint (movement upto 40 mm)*

Compression seal joint consists of steel armoured nosing at two edges of the joint gap suitably anchored to the deck concrete and a preformed chloroprene elastomer/closed cell foam joint sealer compressed and fixed into the joint gap with special adhesive binder. The seal is supposed to remain in continual compression due to pressing of the seal wall against joint faces throughout the service life to ensure that the joint remains water tight and capable of repelling debris. Typical compression seal joint is shown in **Fig. 5.2.1**.

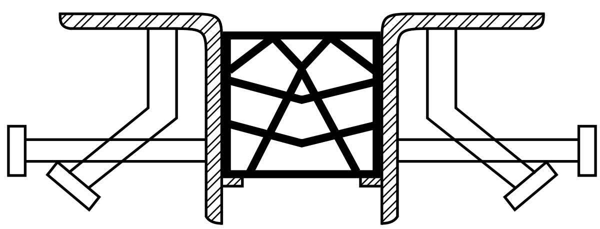

Fig. 5.2.1 Compression Seal Joint

Limitations of Compression Seal Joint are:

- Contact pressure of seal with steel nosing, which is the key to effective sealing mechanism, decay considerably with age. Hence more safeguards are required during installation for desired level of compression in the seal.
- Susceptible to detachment of seals from nosing due to debris accumulation and dynamic vehicular impact on nosing.
- More susceptible to vandalism.

5.2.2 *Single strip/box seal joint (movement up to 80 mm)*

Single strip/box seal expansion joint consists of two edge beams with anchorages and an elastomeric sealing element held firmly in the housings of edge beams that guarantee the water tightness of the joint. The maximum gap between the edge beams at road surface when the joint fully opens due to maximum contraction of deck shall be limited to 80 mm for comfortable passage of the traffic. The edge beams protect the adjacent bridge deck concrete from damage due to vehicular impact and also transfer the vehicular load to the deck structure through robust anchorage system Typical single strip seal joint is shown in **Fig. 5.2.2.1**.

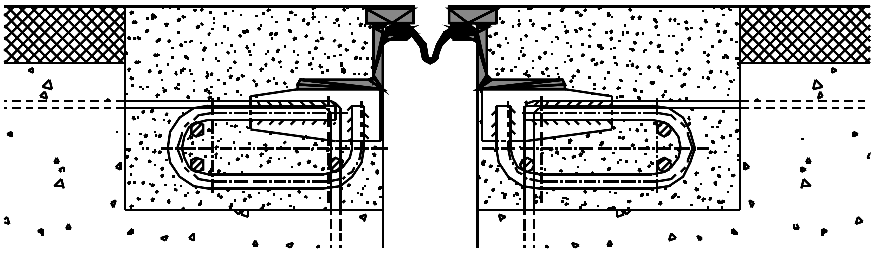

Fig. 5.2.2.1

Seals of expansion gaps can be constructed as V-shaped sections (**Fig. 5.2.2.2**) or hollow sections (**Fig. 5.2.2.3**). Movements are absorbed by the opening/closing of these elements. Both shear headed stud type and loop type anchorage may be used.

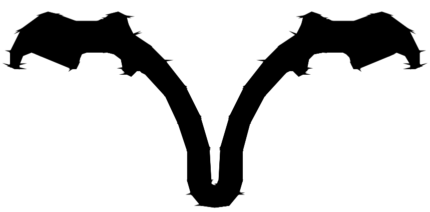

Fig. 5.2.2.2 V Shaped Sealing

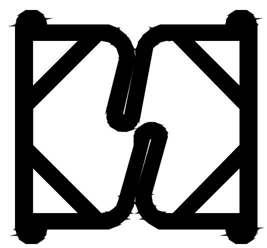

Fig. 5.2.2.3 Box Seals

Limitations of Single Strip Seal Joint are:

- Open surface gap tends to accumulate too much of debris on the strip seal element particularly near footpath and kerb.
- Noise generation during passage of vehicle over the open surface gap.
- Blocking of open surface gap by entrapped stones or hard pieces may generate locked-in condition restraining free movement of structure.

5.2.3 *Reinforced elastomeric joints (movement upto 80 mm)*

This type of joint consists of reinforced elastomeric pads connected to a supporting steel structure which itself is cast into the concrete structure of the bridge. The joint accommodates movement by shear deformation of elastomer and opening and closing of grooves at upper and lower surface. The maximum movement is limited by the gap width. Typical reinforced elastomeric joint is shown in **Fig. 5.2.3**.

Limitations of Reinforced Elastomeric Joints are:

- In high volume and high-speed traffic areas the rubber surface of the bearing plate is susceptible to excessive wear which lowers the skid resistance.

- Since the reinforced elastomeric pads of most of the elastomeric joints are manufactured in 1 m to 1.5 m sections, there is a potential for water leakage at the tongue and groove splicing of the elastomeric pads in the case of improper installation.
- Additional water seal below the elastomeric seal is required for making it waterproof.
- Horizontal force offered by the joint and transmitted to the bridge structure may be considerable due to the high resistance of the elastomeric elements.

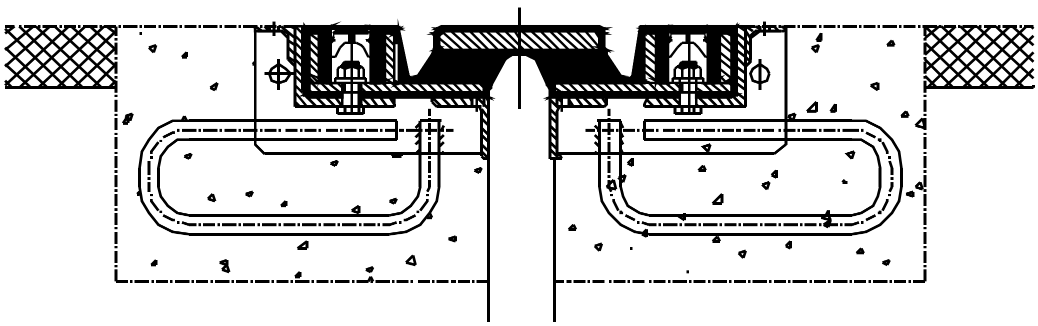

Fig. 5.2.3 Reinforced Elastomeric Joint

5.3 Joints for Large Openings (Movement over 80 mm)

5.3.1 *Modular strip/box seal joint*

The modular strip/box seal expansion joint divides the total movement capacity into several smaller gaps. The joint consists of two edge beams, one or more central/separation beams or lamellas oriented transversely to the traffic direction forming the load carrying elements, and cross beams supporting individual or multiple central beams to transfer the loads to the bridge deck through the anchorage system. Centre beams and transverse support/ cross beams are connected by resilient or shock absorption system to dampen dynamic loading, thus reducing the forces transmitted to the structure and anchorages. The shock absorption system accommodates vertical and transverse movements apart from longitudinal movement. The joint also contains gap control system, which allows closing and opening of the joint and ensures that all modules open or close equally. The joint is made watertight through mechanically locked sealing system of elastomeric strip seals connected between the lamellas. The gap width between the consecutive centre beams at the joint surface shall be limited to 80 mm when the joint opens fully due to maximum contraction of deck. Typical details of a modular strip seal expansion joint are shown in **Fig. 5.3.1**.

Limitations of Modular Strip/Box Seal Joint are:

- Numerous movable parts susceptible to fatigue and wear.
- Open surface gap tends to accumulate too much of debris on the strip seal element particularly near footpath and kerb.

- Noise generation during passage of vehicle over the open surface gap between transversely located center beams.
- Mechanically operated gap control system can lead to poor functioning of the joint, particularly when individual gaps are blocked by stones or other hard pieces.

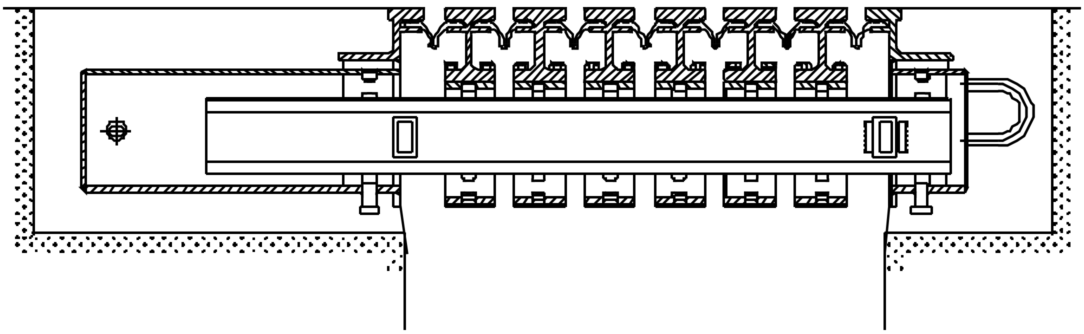

Fig. 5.3.1 Modular Strip Seal Expansion Joint

5.3.2 *Finger joints*

The cantilever-toothed joint (**Fig. 5.3.2.1**) also called finger joint, is a very robust construction but with several disadvantages. The deformation capacity in the crosswise direction is severely limited and vertical deformations of the joint can prejudice traffic safety. To accommodate small vertical deformations without hazard, the free finger ends should be rounded. Finger joints with supported fingers (**Fig. 5.3.2.2**) have proved to be not as good as with cantilever fingers.

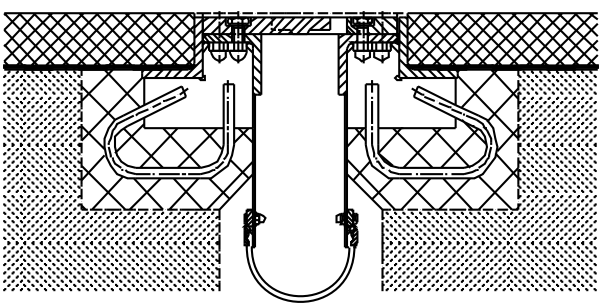

Fig. 5.3.2.1 Cantilever-Toothed Joint or Finger Joint

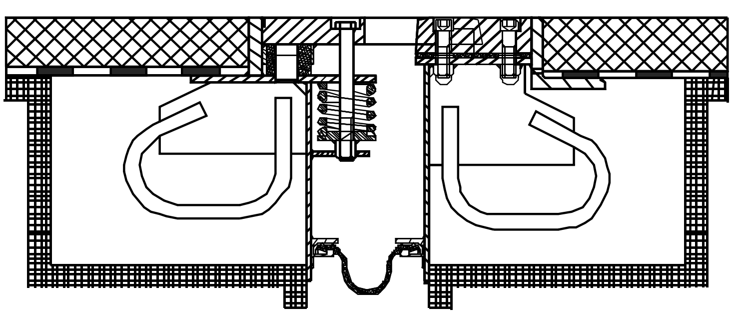

Fig. 5.3.2.2 Finger Joint with Supported Fingers

Limitations of Finger Joints:

- Additional arrangements are required for making it water-proof.
- It induces lot of noise.
- It cannot accommodate differential vertical movement and high transverse movements.

5.3.3 *Reinforced coupled elastomeric joint*

This type of joint consists of reinforced elastomeric pads connected to a supporting steel structure which itself is cast into the concrete structure of the bridge. The joint accommodates movement by shear deformation of elastomer and opening and closing of grooves at upper and lower surface. This joint can take up movement upto 230 mm. Typical Reinforced coupled elastomeric joint is shown in **Fig. 5.3.3**.

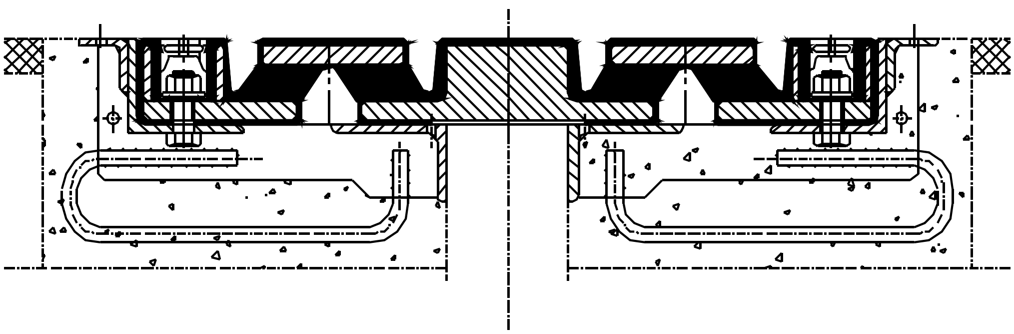

Fig. 5.3.3 Reinforced Coupled Elastomeric Joint

Limitations of Reinforced Coupled Elastomeric Joint are:

- In high volume and high speed traffic areas the rubber surface of the joint is susceptible to excessive wear, which also lowers the skid resistance.
- Since the reinforced elastomeric pads of most of the slab seal joints are manufactured in 1 m to 1.5 m sections, there is a potential for water leakage at the tongue and groove splicing of the elastomeric pads in the case of improper installation.
- Additional water seal below the elastomeric seal is required for making it water proof.
- Horizontal force offered by the joint and transmitted to the bridge structure may be considerable due to the high resistance of the elastomeric elements.

5.4 Suggested Criteria for Adoption of Different Types of Expansion Joints

Primary basis of selection of any joint shall depend on the movement capacity of that joint in relation to the specific requirement of the particular structure. Designer may select the type of joint depending on the form/movement/rotation as indicated in **Table 5.4.1**. No joint is necessary up to 6 mm movement of the joint. It is recommended that mixing of different type of joints in any particular structure should be avoided. However, single gap strip seal joint and modular strip seal joint shall be regarded as the same type.

Table 5.4.1 Criteria for Adoption of Different Types of Expansion Joints

Sl. No.	Type of Expansion joints	Recommended movement capacity & suitability for adoption	Special Consideration
1)	Buried Joint	Simply supported spans on unyielding support with movement not exceeding 10 mm.	Only for decks with bituminous/asphaltic wearing coat. Steel plate may need replacement if found corroded or distorted at the time of relaying/renewal of wearing coat.
2)	Filler Joint	Simply supported spans on unyielding support with movement not exceeding 10 mm.	The sealant and joint filler would need replacement, if found damaged.
3)	Asphaltic Plug Joint	Simply supported spans with horizontal movement not exceeding 25 mm.	Not to be used below - 5ºC and above 50ºC. Only for decks with bituminous/ asphaltic wearing coat. Not suitable for bridge with longitudinal gradient more than 2 percent and cross camber/super-elevation exceeding 3 percent. Not suitable for curved spans and spans resting on yielding supports. The joint is especially suitable for rehabilitation works.
4)	Compression Seal Joint	Simply supported or continuous spans with maximum horizontal movement not exceeding 40 mm or maximum gap not exceeding 60 mm.	Limited capacity for movement in the transverse direction. Chloroprene/Closed Cell foam seal may need replacement during service.
5)	Single Strip / Box Seal Joint	Simply supported, continuous construction for maximum horizontal movement and maximum gap opening upto 80 mm	Elastomeric seal may need replacement during service
6)	Reinforced Elastomeric Joints	Simply supported or continuous spans for maximum horizontal movement and maximum gap opening up to 80 mm	Liable to excessive wear and tear under high traffic intensity and may require frequent maintenance. Not suitable for bridges located in heavy rainfall area, spans resting on yielding support of cantilever bridges and where rotations and transverse movements are high.
7)	Modular Strip/Box Seal Joint	Large to very large movements, continuous/cantilever construction with right, skew or curved deck having horizontal movement in excess of 80 mm. Maximum gap opening shall not exceed 80 mm per module of joint	Elastomeric seals and movable parts may need replacement during service.

8)	Finger Joints	For large movements over 80 mm without significant rotation in the horizontal plane. Separate arrangement for making the joint water tight is to be ensured.	Not suitable for joints involving differential vertical movement /articulated support and high transverse movements. The joint must be anchored adequately and effectively protected against corrosion.
9)	Reinforced Coupled Elastomeric Joint	Simply supported or continuous spans for maximum horizontal movement and maximum gap opening over 80 mm but upto 230 mm.	Liable to excessive wear and tear under high traffic intensity and may require frequent maintenance. Not suitable for bridges located in heavy rainfall area, spans resting on yielding support of cantilever bridges and where rotations and transverse movements are high.

Notes : For movements larger than those indicated in the above table, reference may be made to specialized literature for the design/selection of a suitable joint which is site specific.

For skew and curved bridges and bridges having significant transverse movements of the decks, special design requirements are necessary.

6 SPECIAL TYPES OF JOINTS

This section of the guideline is aimed to provide general information to attend special requirements of very high longitudinal movement, high transverse movement, special detailing of joints for high seismic zones, special low noise modular joint system and requirement of anti-skid surface for very large modular strip seal joints. For joints for very high longitudinal and transverse movement, only specialized manufacturers having proven experience in design, manufacture and supply of such joints shall be consulted from the design stage to evolve a foolproof system design most suitable to the structure and site conditions, climatic variables and other requirements to ensure proper execution and performance of the joint.

a) **Very high longitudinal movement:** In design and construction of very large and complex bridges, expansion joints to cater for very large longitudinal movement are required. Specially designed modular strip seal/box seal expansion joint is the most suitable type for such cases.

b) **High transverse movement:** For long span bridges and/or sharply carved bridges and in high seismic zones the transverse movement may also be considerably higher. Specially designed modular strip seal/box seal expansion joint is the most suitable to cater for very high transverse movement. The requirement of high transverse movement can be met by special detailing of joints e.g. using wider and deeper control boxes to allow high transverse movement.

c) **Joints for high seismic zones:** For long span bridges in high seismic zones modular strip seal expansion joints equipped with seismic fuse box duly tested in a test laboratory may be used to isolate the joint from the structure during earth quake and thereby avoiding designing the joints for high additional movement in case of earthquake. Such isolation with seismic fuse ensures lesser damage to the joint and also the structure during earthquake. Typical detailing of seismic fuse is shown in **Fig. 6.3**.

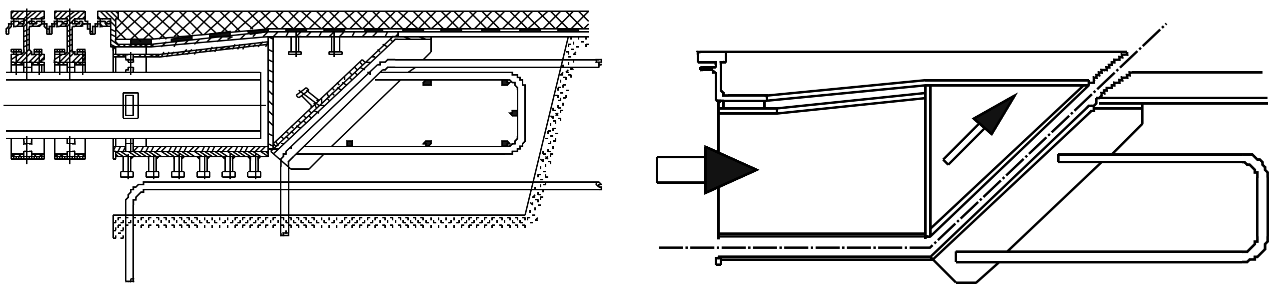

Fig. 6.3 Typical detailing of Seismic Fuse

d) **Noise reduction:** Noise reduction becomes increasingly an issue for densely populated areas. The idea of this newly developed expansion joint combines the advantages of the normal modular expansion joint with the advantage of the finger joint. It is achieved by welding or bolting sinusoidal plates, which are called noise leaves, on the top of the center/lamella beams. The over-rolling tyre cannot bang anymore on a transversal edge. It now rolls along a curved, diagonal line, with the result that the tyre of the passing vehicle cannot develop noise with the same strength as on transversely oriented beams. Test results show that the noise development can be reduced by 80 percent.

e) **Joints with anti-skid surface:** Large modular expansion joints for extremely long span bridge structures require a special safety concept to ensure secure rollover of all kind of traffic, while ensuring safe transmission of braking force but preventing skidding of vehicles on the exposed steel surface of the joints. While smaller expansion joints require only coating for corrosion protection, very large modular expansion joints require special treatment of the exposed joint surface. A friction coefficient of 0.5 between coating and rubber must be ensured for a service life time under all weather conditions and neither pollution nor excessive radiation from sunlight should reduce the long term quality of the special anti skidding coating. For modular strip seal joints with movement capacity larger than 1000 mm the exposed steel surface should be provided with anti skid coatings.

7 SPECIFICATIONS–GENERAL AND MATERIAL REQUIREMENTS

7.1 Buried Joint

7.1.1 *General*

7.1.1.1 This joint shall consist of continuously laid bituminous/asphaltic surfacing over the joint gap bridged by a steel plate resting freely over the top surface of the deck concrete.

7.1.1.2 The width of the joint gap shall be kept as 20 mm.

7.1.1.3 The steel plate shall be 12 mm thick and 200 mm wide. The plate shall be made of minimum number of pieces (not exceeding two pieces per traffic lane width) welded together to form the required length.

7.1.1.4 8 mm dia, 100 mm long nails, spaced at 300 mm centres along the centre line of the plate shall be welded to the bottom surface of the steel plate to protrude vertically into the joint gap in order to prevent dislodging of the plate.

7.1.1.5 The concrete surface shall be free from any loose material and cleared of any grease, oil, paint etc. and the surface shall be sand blasted, clean of all laitance and level true prior to placement of the steel plate.

7.1.1.6 The plate shall be placed symmetrical to the centre line of the joint and it shall be ensured that the plate does not get displaced from its position while laying the wearing course.

7.1.2 *Material*

7.1.2.1 The steel for plate and nails shall be weldable structural steel conforming to IS 2062.

7.1.2.2 The plate and the nails shall be protected against corrosion by galvanising or any other approved anti-corrosive coating with a minimum thickness of 100 micron. These shall be completely free of oil, rust loose paint or other similar material before application of anti-corrosive coating.

7.2 Filler Joint

7.2.1 The components of this type of joint shall be atleast 2 mm thick corrugated copper plate placed slightly below the wearing coat, 20 mm thick compressible fibre board to protect the edges, 20 mm thick pre-moulded joint filler filling the gap upto the top level of the wearing coat, sealed with a joint sealing compound.

7.2.2 The material used for filling expansion joint shall be bitumen impregnated felt, elastomer or any other suitable material, as specified on the drawings. Impregnated felt shall conform to the requirements of IS 1838. The joint filler shall consist of large pieces.

Assembly of small pieces to make up the required size shall be avoided.

7.2.3 Surfaces of the joint grooves shall be thoroughly cleaned with a wire brush to remove all loose materials, dirt and debris, then washed or jetted out.

7.2.4 Pre-moulded expansion joint filler shall not be placed in position until immediately prior to the placing of the abutting material. If the two adjacent surfaces of the joint are to be placed at different times, this type of joint filler shall not be placed until the second face is about to be placed.

7.2.5 Sealants shall be finished approximately 3 mm below the upper surfaces of the joint.

7.3 Asphaltic Plug Joint

This joint shall consist of a polymer modified bitumen binder, carefully selected single size aggregate, closure/bridging metallic plate and heat resistant foam caulking/backer rod.

7.3.1 *General*

7.3.1.1 The joint shall extend to the full depth of the wearing course down to structural concrete. Where needed, a recess may be cut into the deck slab concrete to accommodate the minimum required depth (75 mm) of the joints.

7.3.1.2 The joint shall be provided over the entire width of the structure including kerb and/or footpath. A recess in the kerb and/or footpath shall be made to allow the joint to pass beneath them. The expansion gap in the adjoining kerbs and/or footpaths shall be sealed with a suitable sealant such as polysulphide sealant.

7.3.1.3 Asphaltic Plug Joint may be used to cater for a maximum horizontal movement upto 25 mm and maximum vertical movement of 2 mm. This shall be certified by the manufacturer/supplier of the joint.

7.3.1.4 The minimum width (in traffic direction) of the joint shall be 500 mm and maximum width shall be 750 mm.

7.3.1.5 Minimum depth of joint shall be 75 mm and maximum depth shall not exceed 100 mm.

7.3.1.6 The joint shall be capable of performing satisfactorily, within the temperature (ambient) range of -5 to 50ºC.

7.3.2 *Material*

7.3.2.1 *Binder*

The polymer modified bitumen binder shall have the capacity to fill the gaps and voids between single size aggregate and to impart flexibility to accommodate various design movements. It shall be a patented blend of bitumen, synthetic polymer, fillers and surface active agent and shall be so formulated as to combine necessary fluidity for the installation process, low temperature flexibility and flow resistance at high ambient temperatures: The binder shall satisfy following requirement:

Softening point	:	100ºC minimum
Core penetration at 25ºC, 0.1 mm (BS 2499)	:	100 mm max.
Flow resistance at 70ºC, 5 hours (BS 2499)	:	3 mm max.
Extension Test (blocks prepared to ASTM D 1190 and tested to limits BS 2499)	: :	5 cycle of extension to 50% at a rate of 3.2 mm/hour at 25ºC
Safe heating temperature	:	210ºC

7.3.2.2 Aggregates

The aggregate shall be single size aggregate chosen from basalt granite, grit stone or gabro group. The nominal size of aggregate shall be 12.5 mm for depths of joints upto 75 mm and 20 mm for joints of more depths. The aggregate shall not be flaky and the Flakiness Index shall not be more than 25 percent. The aggregate shall satisfy grading requirements stipulated in **Table 7.3.2.2**.

Table 7.3.2.2 Grading Requirements of Aggregate

IS Sieve Designation	Nominal size of aggregate	
	20 mm	12.5 mm
	Percentage by weight passing the sieve	
26.5 mm	100	-----
19.9 mm	85 –100	100
13.2 mm	0 – 35	85 – 100
09.5 mm	0 – 7	0 – 35
06.3 mm	-----	0 – 7
02.3 mm	0 – 2	0 – 2
600 micron	-----	-----
75 micron	0 – 1	0 – 1

The aggregates should have good (i) Polished Stone Value (PSV). (ii) Aggregate Abrasion Value (AAV). (iii) Aggregate Impact Value (AIV) and (iv) Aggregate Crush Value (ACV). In addition surface characteristics should promote proper adhesion. The following are the required values:

PSV	>	60
AAV	<	05
AIV	<	18
ACV	=	10-25

7.3.2.3 Closure plate

The closure plate shall be weldable structural steel conforming to IS 2062. The minimum thickness of steel plate shall be 6 mm and the width shall not be less than 200 mm. Closure plate shall be provided with as large length as possible and welded together to form the required length. The number of pieces shall not be more than two per traffic lane width. It shall be provided with equidistant holes at a maximum spacing of 300 mm centres for anchorage to the caulking/backer rod along the longitudinal centre line of the plate. The plate shall be protected against corrosion by galvanising or any other approved anti-corrosive coating paint with a minimum thickness of 100 micron.

7.3.2.4 Foam caulking/backer rod

A closed cell polyolefine or open cell polyurethane foam cylindrical caulking or backer rod having diameter equal to 150 percent of the joint opening shall be provided. It shall be heat resistant and possess good flexibility and recovery characteristics with density of 25 to 30 kg/m^3.

7.4 Compression Seal Joint

Compression seal joint shall consist of steel armoured nosing at two edges of the joint gap suitably anchored to the deck concrete and a preformed chloroprene elastomer or closed cell foam joint sealer compressed and fixed into the joint gap with special adhesive binder.

7.4.1 *General*

7.4.1.1 Steel nosing

The steel nosing shall be of angle section ISA 100 × 100. The thickness of legs shall not be less than 12 mm. The top face of the angle shall be provided with Bleeder holes of 12 mm diameter spaced at maximum 100 mm centres so as to ensure that there are no voids in the concrete beneath the angle.

7.4.1.2 Anchorage

The steel nosing shall be anchored to the deck by headed shear studs or anchor plates cast in concrete or a combination of anchor plates and anchor loops. Anchor bars shall engage the main structural reinforcement of the deck and in case of anchor plates and anchor loops, this shall be achieved by passing transverse bars through the loops or plates. The minimum thickness of anchor plates shall be 12 mm. Total cross sectional area of bars or headed shear studs on each side of the joint shall not be less than 1600 sq.mm per m length of the joint and the centre-to-centre spacing shall not exceed 250 mm for loop anchors and 150 mm for headed shear studs. The ultimate resistance of each anchorage shall not be less than 600 KN/m in any direction. Steel shall conform to Grade B of IS 2062. For sub-zero condition material for steel shall conform to IS 2062 Grade C.

7.4.1.3 *Joint seal*

The sealing element shall be a preformed continuous chloroprene/closed cell foam seal with high tear strength, insensitive to oil, gasoline and ozone. It shall have high resistance to ageing and ensure water tightness. The seal should be continuous for the full length of the joint required for carriageway, kerbs and footpaths, if any. The seal shall cater for a horizontal movement upto 40 mm and vertical movement of 3 mm.

7.4.2 *Material*

7.4.2.1 The material of steel nosing and anchorage conforming to weldable structural steel as per IS 2062 Grade B shall be used.

7.4.2.2 The physical properties of chloroprene/closed cell foam sealing element shall conform to the following:

a) Chloroprene Seal

Shall be preformed extruded multi-web cellular section of chloroprene of such a shape as to promote self removal of foreign material during normal service operations. Chloroprene of joint seal shall satisfy the properties stipulated in **Table 7.4.2.2.1**.

b) Closed cell foam seal

Shall be of preformed non-extruded non-cellular section made from low-density closed cell, cross linked ethylene vinyl acetate, polyethylene copolymer that is physically blown using nitrogen. The material shall possess properties as indicated in the **Table 7.4.2.2.2**.

c) Chemical tests

Chemical tests shall be performed on specimen elastomer and the properties shall conform to the values/standards indicated in **Table 7.4.2.2.3**.

Table 7.4.2.2.1 Properties of Chloroprene Seal

Property	Standard	Specific Value
Hardness	DIN 53505 ASTM D 2240*	63 +5 Shore A 55 + 5 Shore A
Tensile Strength	DIN 53504 ASTM D 412*	Min. 11 MPa Min 13.8 MPa
Elongation at fracture	DIN 53504 ASTM D 412*	Min. 350% Min. 250%
Tear propagation strength Longitudinal Transverse	DIN 53507 ASTM D 264* (Dia C)	 Min. 10 N/mm Min. 10 N/mm
Shock elasticity	DIN 53512	Min. 25%
Abrasion	DIN 53516	Max. 220 mm^3
Residual compression strain (22h/70ºC/30% strain)	DIN 53517 ASTM D 395 (Method B)	Max. 28%
Ageing in hot air (14 days/70ºC) Change in hardness Change in tensile strength Change in elongation at fracture	DIN 53508	 Max. + 7 Shore A Max.-20% Max.-20%
Ageing in ozone (24h/50 pphm/25°C/20% strain)	DIN 53509	No cracks
Swelling behaviour in oil (168h/25°C) ASTM oil No. 1 Volume change Change in hardness ASTM oil No. 3 Volume change Change in hardness	DIN 53521	 Max. + 5% Max.-10 Shore A Max. + 25% Max.-20 Shore A
Cold hardening point	ASTM D 1043	Min. - 35ºC

Note: Only one set of specification viz., ASTM or DIN shall be followed depending on the source of supply.

Table 7.4.2.2.2 Properties of Closed Cell Foam Seal

	Property	Special Value
i)	Density	41.7–51.3 kg/cu.m.
ii)	Compression Set on 25 mm	50 percent compression samples (ASTM D 3575) for 22 hours at 23ºC, 2 hour recovery; 13 percent set.
iii)	Working temperature	-70 to +70ºC
iv)	Water absorption (total immersion for 3 months) (ASTM 3575)	0.09766 kg/Sq.m
v)	Tensile strength	0.8 MPa
vi)	Elongation at break (ASTM D 3575)	195+/- 20 percent

Table 7.4.2.2.3

Adhesion Strength	IS 3400 pt XIV	7 kN/m
Low temperature stiffness	ASTM D-797	Youngs modulus 70 N/mm^2 (Max)
Ash Content	IS 3400 pt XXII	5%
Polymer identification test (Infrared Spectro photometry)	ASTM D 3677	Comparison of Spectra with reference to sample of polychloroprene

7.4.2.3 Lubricant-cum-adhesive

The type and application of material used in bonding the preformed joint seal to the steel nosing and concrete shall be as recommended by the manufacturer/supplier of the seal system.

7.4.2.4 Corrosion protection

All steel section shall be protected against corrosion by hot dip galvanizing or any other approved anti-corrosive coating with a minimum thickness of 150 micron.

7.5 Single Strip/Box Seal Expansion Joints

7.5.1 *General*

7.5.1.1 Edge Beam

This shall be either extruded or hot rolled steel section including continuously shop welded section with suitable profile to mechanically lock the sealing element in place throughout the normal movement cycle. Further, the configuration shall be such that the section has a minimum thickness of 10 mm all along its cross-section (flange & web). Thickness of lips holding the seal shall not be less than 6 mm. The minimum height of the edge beam section shall be 80 mm. The minimum cross-sectional area of the edge beam shall be 1500 mm^2.

7.5.1.2 Anchorage

The edge beams of single strip/box seal joints shall be anchored in the concrete with rigid loop anchorage or headed shear stud anchors. In case of headed shear stud anchors it is to be ensured that the studs are anchored in concrete adequately reinforced around the studs and are not in plane concrete shoulders. The anchorage system shall satisfy the requirement of Clause **8.2.1**. The anchor loops shall be connected to the edge beam by means of anchor plates welded to the edge beam. Total cross-sectional area of anchor loop or headed shear studs on each side of the joint shall not be less than 1600 mm^2 per meter length of the joint and the centre-to-centre spacing shall not exceed 250 mm for loop anchors and

150 mm for headed shear studs. The thickness of anchor plate shall not be less than 0.7 times the diameter of anchor loop or 12 mm whichever is higher. The anchor at the edge profiles should be at a right angle to the joint. Planned deviations of this direction are allowable only for the range of 90º +/- 20º. (The anchoring reinforcement of the construction must lie parallel to the anchor loops).

7.5.1.3 *Sealing element*

This shall be a preformed/extruded single strip of such a shape as to promote self-removal of foreign material during normal joint operation. The seal shall possess high tear strength and be insensitive to oil, gasoline and ozone. It shall have high resistance to ageing. The specially designed proprietary type of locking system of seal in the housing of edge beam shall be such to ensure 100 percent water tightness as well as ease of installation and replacement. Mechanical fastening of sealing element with edge beam shall not be permitted. Sealing element shall be continuous over the entire joint.

7.5.2 *Material*

7.5.2.1 The steel for edge beams shall conform to any of the steel grade equivalent to RST 37-2 or 37-3 (DIN), S235JRG2 or S355K2G3 of EN10025 (DIN 17100), ASTM A 36 or A 588, CAN/CSA Standard G40.21 Grade 300 W or Grade B of IS 2062. For subzero condition, material for steel shall conform to IS 2062 Grade C.

7.5.2.2 The sealing element shall be made of chloroprene rubber (CR). The properties of the material shall be as specified in **Table 7.4.2.2.1** for CR.

7.5.2.3 All steel sections shall be protected against corrosion by one of the following two methods – (i) Hot dip galvanising with a minimum thickness of 150 micron (ii) Epoxy coating- All surfaces of the steel inserts and anchorage including the surfaces to be in contact with or embedded in concrete shall be sand/shot blasted to SA 2½ and provided with a coat of epoxy primer enriched with metallic zinc. Surfaces not to be in contact with or embedded in concrete shall be provided with an additional coat of epoxy primer enriched with metallic zinc, one intermediate coat of high build epoxy paint reinforced with MIO (Micaceous Iron Oxide) and one coat of high performance epoxy finish paint as per paint manufacturer’s specification with a minimum total dry film thickness of 150 micron.

7.5.2.4 Anchorage steel shall conform to Grade B of IS 2062 or equivalent standard.

7.5.2.5 Joints for which the gap width does not close fully, the movement capacity shall be (80 - minimum opening) i.e. the capacity of the joint having a minimum opening gap width of 20 mm will be 60 mm. Only for joints that close fully, the movement capacity of joint shall be 80 mm.

7.5.2.6 Minimum gap for inserting the chloroprene seals in the expansion joint shall be 25 mm.

7.6 Reinforced Elastomeric/Coupled Elastomeric Joint

7.6.1 *General*

7.6.1.1 Steel Inserts

The elastomeric slab units shall always be fixed to the steel inserts properly anchored in the deck concrete. Fixing of elastomeric slab units with anchoring bolts directly embedded in deck concrete shall not be permitted. Steel inserts along with anchorage shall be fabricated at manufacturers workshop and not at site.

7.6.1.2 Anchorage

The anchorage shall either be loop anchors connected to the inserts by anchor plate or sinusoidal anchor bars welded with the horizontal leg of the steel inserts. For loop anchors with anchor plate the thickness of the anchor plate shall not be less than 12 mm. Diameter of anchor loops shall not be less than 16mm and the spacing of anchors shall not be more than 250 mm in any case. For sinusoidal anchors, diameter of bar shall not be less than 12 mm.

7.6.1.3 Elastomeric slab units

Elastomeric slab units shall be fully moulded to the required size in one single vulcanizing operation including the reinforcing plates and encasing layers as integral and homogenous part. Edges of reinforcing steel sections shall be rounded. The elastomeric slab units shall be manufactured generally as per the stipulations laid down in Clause 917 of IRC:83 (Part II). Adjoining portions of elastomeric slab units shall be provided with suitable male-female groove to ensure water tightness.

7.6.1.4 Fixing bolts

Fixing bolts and nuts shall be made of stainless steel. Tightened nuts shall be locked by using lock washers.

7.6.1.5 Elastomeric plugs

The plug holes provided in elastomeric slab units to house fixing bolts shall be plugged with elastomeric plugs pressed in position after applying adhesive on the appropriate surface.

7.6.1.6 Adhesives and sealants

Special sealant to be poured into the plug holes before plugging and special adhesive to be used for installation shall be as per the recommendation of manufacturer.

7.6.1.7 Necessary spacer bars to ensure proper positioning of bolts and leveling and aligning steel inserts during fixing with deck as well as special jigs to be used to preset the elastomeric slab units shall be provided by the manufacturer.

7.6.2 *Material*

7.6.2.1 Mild steel to be used for manufacture of steel reinforcing plates, inserts and anchorage shall generally comply with Grade B of IS 2062.

7.6.2.2 Cast steel to be used for manufacture of steel reinforcing plates shall generally comply with IS 1030.

7.6.2.3 The elastomer to be used for manufacture of Elastomeric Slab Units shall generally comply with Clause 915.1 of IRC:83 (Part II), compounded to give hardness IRHD 60 ± 5.

7.6.2.4 All surfaces of the steel inserts and anchorage including the surfaces to be in contact with or embedded in concrete shall be sand/shot blasted to SA 2½ and provided with a coat of epoxy primer enriched with metallic zinc. Surfaces not to be in contact with or embedded in concrete shall be provided with an additional coat of epoxy primer enriched with metallic zinc, one intermediate coat of high build epoxy paint reinforced with MIO (Micaceous Iron Oxide) and one coat of high performance epoxy finish paint as per paint manufacturer's specification with a minimum total dry film thickness of 150 micron.

7.7 Modular Strip/Box Seal Expansion Joints

7.7.1 *General*

7.7.1.1 A modular expansion joint consists of two or more modules/cells of individual capacity 80 mm to cater to a horizontal movement in excess of 80 mm. It shall allow movements in all three directions and rotation about all three axes as per the design requirements. The structural system consisting of two edge beams, one or more central/separation beams or lamellas and cross support bars supporting individuals or multiple central beams to transfer the loads to the bridge deck through the anchorage system.

7.7.1.2 *Edge beams and central beams/lamella*

Clause **7.5.1.1** shall be applicable for edge beams. Centre beams/lamellas shall be either extruded or hot rolled/cold rolled steel section including continuously shop welded section with suitable profile to mechanically lock the sealing element in place throughout the normal movement cycle. Further, the configuration shall be such that the section has a minimum thickness of 10 mm all along its cross-section (flange and web). Thickness of lips holding the seal shall not be less than 6 mm. The minimum height of edge beam and central beam sections shall be 80 mm. Minimum cross-sectional area of each edge beam shall be 1500 mm sq.

7.7.1.3 *Anchorage*

Clause **7.5.1.2** shall be applicable for anchorage of edge beam. Studs and/or loop anchors with anchor plate may be used as anchorage of other components like joist box, covers of controlling system etc.

7.7.1.4 *Sealing element*

Clause **7.5.1.3** shall be applicable.

7.7.1.5 Joints for which the gap width of modules do not close fully the movement capacity shall be (80 - minimum opening) × number of modules, i.e. the capacity of a 5 module joint having a minimum opening gap width of 20 mm will be 60 × 5 i.e. 300 mm. Only for joints that close fully, the movement capacity of each module shall be 80 mm.

7.7.1.6 *Support and control system*

The control system should allow closing and opening of the joint and also ensure that all modules open and close equally during all movement cycles of the joint. The overall support and control system shall be either single/multiple support bar control system or swivel joist system comprising of resilient/shock absorption components and elastic/sliding control system in form of sliding bearings and sliding springs conforming to the specifications recommended by the manufacturer. The control system shall be such that the gap width is independently flexible i.e. to allow full 80 mm gap width in one gap when all the other gaps are fully closed. The centre-to-centre spacing of transverse support bar shall not exceed 1.75 m.

7.7.1.7 Minimum gap for inserting the neoprene seals in the expansion joint shall be 25 mm.

7.7.2 *Material*

7.7.2.1 The steel for edge beams, centre beam/lamella, transverse support bar and other steel components shall conform to any of the steel grade corresponding to RST 37-2 or 37-3 or 52-3 (DIN), S235JRG2 or S355K2G3 of EN10025 (DIN 17100), ASTM A36 or A588, CAN/CSA standard G40.21 Grade 300 W.

7.7.2.2 The material for sealing element shall conform to **Table 7.4.2.2.1** for Chloroprene Rubber (CR).

7.7.2.3 The specification for all other materials shall be as per original manufacturer's recommendation.

7.7.2.4 All steel sections shall be suitably protected against corrosion by one of the following two methods – (i) Hot dip galvanising with a minimum thickness of 150 micron (ii) Epoxy coating- All surfaces of the steel inserts and anchorage including the surfaces to be in contact with or embedded in concrete shall be sand/shot blasted to SA 2½. Surfaces not to be in contact with or embedded in concrete shall be provided with zinc metal spray galvanising or a coat of epoxy primer enriched with metallic zinc, one intermediate coat of high build epoxy paint reinforced with MIO (Micaceous Iron Oxide) and one coat of high performance epoxy/polyurethane finish paint as per paint manufacturer's specification with a minimum total dry film thickness of 150 micron.

7.8 Finger Joints

7.8.1 *General*

7.8.1.1 *Steel fingers*

This shall be either forged steel section or machined from single pieces of steel plates. Projection of Fingers made of welded section shall not be used. Finger type joints shall be made watertight as shown in **Fig. 5.3.2.1 and 5.3.2.2**.

7.8.1.2 The finger joints shall be anchored in the concrete with rigid loop anchorage or headed shear stud anchors. In case of headed shear stud anchors it is to be ensured that the studs are anchored in concrete adequately reinforced around the studs and not in plane concrete shoulders. The anchorage system shall satisfy the requirement of Clause **8.2.1**. The anchor loops shall be connected to the edge beam by means of anchor plates welded to the edge beam. Total cross-sectional area of anchor loop or headed shear studs on each side of the joint shall not be less than 1600 mm^2 per meter length of the joint and the centre-to-centre spacing shall not exceed 250 mm for loop anchors and 150 mm for headed shear studs. The thickness of anchor plate shall not be less than 0.7 times the diameter of anchor loop or 12 mm whichever is higher. The anchor at the edge profiles should be at a right angle to the joint. Planned deviations of this direction are allowable only for the range of 90º +/- 20º. (The anchoring reinforcement of the construction must lie parallel to the anchor loops).

7.8.2 *Material*

7.8.2.1 The steel for edge beams shall conform to any of the steel grade corresponding to RST 37-2 OR 37-3 (DIN), S235JRG2 or S355K2G3 of EN10025 (DIN 17100), ASTM A 36 or A 588, CAN/CSA Standard G40.21 Grade 300 W or equivalent to Grade B of IS 2062. For subzero condition, material for steel shall conform to IS 2062 Grade C.

7.8.2.2 All steel sections shall be protected against corrosion by one of the following two methods – (i) Hot dip galvanising with a minimum thickness of 150 micron (ii) Epoxy coating- All surfaces of the steel inserts and anchorage including the surfaces to be in contact with or embedded in concrete shall be sand/shot blasted to SA 2½ and provided with a coat of epoxy primer enriched with metallic zinc. Surfaces not to be in contact with or embedded in concrete shall be provided with an additional coat of epoxy primer enriched with metallic zinc, one intermediate coat of high build epoxy paint reinforced with MIO (Micaceous Iron Oxide) and one coat of high performance epoxy finish paint as per paint manufacturer’s specification with a minimum total dry film thickness of 150 micron.

7.8.2.3 Anchorage steel shall conform to Grade B of IS 2062 or equivalent standard.

8 TESTING AND ACCEPTANCE STANDARDS

8.1 This section of the guideline is aimed to lay-down the pre-installation criteria of acceptance based on predetermined methods of evaluation including testing of materials.

8.2 Before installing joints in a bridge, sufficient evidence of the reliability of the proprietary products must be furnished. A copy of the following fatigue and wear test reports, as applicable depending upon the type of joint, carried out by a recognized laboratory/ university/institute on the joint components as a part of product development test shall be furnished once for the entire lot of supply. The tests covered in Clause **8.2.1 to 8.2.5** need not be carried out on the materials of the joints of supply lot but should be carried out from time to time by the original manufacturer as per their product development and quality plan for the same type of joints to ensure the performance requirement of the particular joint component against fatigue and/or wear.

8.2.1 For single strip seal, modular strip seal and finger joints the manufacturer shall produce complete report of the test of anchorage system in a recognised laboratory to determine optimum configuration of anchorage assembly under dynamic loading in support of the efficacy of the anchorage system adopted for the joints of entire lot of supply.

8.2.2 For modular strip seal joints the manufacturer shall produce a test report from a recognised laboratory that the sliding bearings have been fatigue tested for 6×10^6 (6 million) load cycles with a frequency of 5 Hz. The durability test should be carried out for 3 loads levels viz., 80 kN, 120 kN and 160 kN.

8.2.3 For modular strip seal joints the manufacturer shall produce a test report from a recognised laboratory that the wearing of sliding interface of bearings of modular joints has been tested for a total sliding distance of 5000 m at a load of 48 kN.

8.2.4 For modular strip seal joints the manufacturer shall produce a test report from a recognised laboratory that the sliding material of sliding springs of expansion joints has been tested for a total sliding distance of 20’000 m with a load equivalent to a stress of 30 MPa.

8.2.5 For modular strip seal joints the manufacturer shall produce a test report from a recognised laboratory that the butt-welded splicing of centre beams has been tested with 2×10^6 (2 million) load cycles with a frequency of 5.55 Hz and a load equivalent to a stress of 165 MPa.

8.2.6 In cae of Reinforced Elastomeric Joints/Reinforced Coupled Elastomeric Joints, abrasion resistance test shall be carried out in accordance with IS:3400 (Pt 3) or DIN 53516.

8.2.7 An expansion joint assembly in a bridge deck shall have minimum number of joints, subject to the manufacturer’s specification for the proprietary products.

8.3 Pre-installation Criteria - The pre-installation criteria should include the following off-site tests.

8.3.1 Routine tests

Routine tests including tests for materials conforming to specifications shall be carried out by the original manufacturer i.e., in case of imported joints by the foreign manufacturer as part of their quality control procedure for all joints to be supplied by them. Detailed documentation of all the tests and inspection data as per complete quality control procedure shall be supplied by the original manufacturer in the form of Quality Control Report. Routine tests shall primarily include:

- Raw materials inspection.
- Process inspection.
- Complete dimensional check as per approved drawings.

8.3.1.1 Raw material inspection

Test on all raw materials used for the manufacturing of joints as per relevant material standards based on this specification shall be carried out by the manufacturer.

8.3.1.1.1 Confirmation of the grade of steel

Grade of the steel for the edge beam should be confirmed by conducting tests for yield stress, tensile strength, elongation etc. corresponding to RST 37-2 or 37-3 or 52-3 (DIN), S235 JRG2 or S355K2G3 of EN10025 (DIN 17100), ASTM A36 or A588, CAN/CSA standard G 40.21 grade 300W or equivalent to Grade B of IS 2062. The manufactures/suppliers shall have in-house testing facilities for conducting these tests.

8.3.1.1.2 Steel for the anchorage should conform to IS 2062 for Single gap Strip Seal Joints.

8.3.1.1.3 The following tests as indicated in **Table 7.4.2.2** should be made for checking the properties of the chloroprene seal: (a) Hardness (b) Tensile strength (c) Elongation at fracture (d) Tear propagation strength (e) Residual compressive strain (f) Change in hardness (g) Change in tensile strength (h) change in elongation at fracture (i) Ageing in ozone and (j) Swelling behaviour in oil. The manufactures/suppliers shall have in-house testing facilities for conducting these tests.

8.3.1.2 Process inspection

Process inspection generally including inspection of all manufacturing processes adopted to manufacture the joints e.g., welding, corrosion protection, clamping, presetting, greasing, bonding by adhesives, riveting etc., as appropriate, shall be carried out by the manufacturer.

8.3.1.3 Complete dimensional check

Complete dimensional check of all components of joint as well as the assembled joint with respect to the approved drawings and tolerances as per this specification, shall be carried out by the manufacturer.

8.3.2 Acceptance tests

In addition to the tests specified under Clause **8.3.1.1**, the manufacturer as well as the local supplier in case of imported joints should have complete in-house testing facilities for the following tests mentioned under Clause **8.3.2.1 to 8.3.2.4**. These tests, as applicable **(Table 8.3.3)**, shall be carried out by the manufacturer once in every six months and records shall be maintained. Test specified in Clause **8.3.2.5** should however be carried out on Modular Strip/Box Seal Joint at least once which shall be certified by an external institute/niversity of international repute. The client should insist upon these records before acceptance of the joint.

8.3.2.1 Cyclic motion

Cyclic motion test may be carried out once on one meter sample piece selected at random from the entire lot of supply for each type of joint irrespective of movement capacity. The test sample shall be fixed to the test frame using fastening bolts and subjected to 5000 expansion and contraction cycles @ minimum 30 cycles per hour. The test movement shall be 10 percent more than the design/contraction movement. Any sign of distress or permanent set of any component or the assembly due to fatigue will cause rejection of entire lot of supply.

8.3.2.2 Ponding

Water shall be continuously ponded along one meter length of joint for a minimum period of 4 hours for a depth of 25 mm above the highest point of joint top. The width of ponding shall be at least 50 mm beyond the anchorage block of the joint on either side. The depth of water shall not fall below 25 mm anytime during the test. A close inspection of the underside of the joint shall not reveal any leakage.

8.3.2.3 Debris expelling test

Debris expelling test shall be carried out on one meter sample piece selected at random from the entire lot of supply. The fully open gap shall be filled with granular debris flush with joint top and cycled 25 times for full opening and closing. The mass of debris repelled after 25 cycles shall be expressed as the percentage of initial mass. The percentage expelled shall not be less than 75 percent.

8.3.2.4 Pull-out test

Pull-out test shall be carried out on one meter sample piece selected at random from the entire lot of supply. The Joint shall then be stretched until the sealing element slips off from its housing. The minimum stretching of the joint before slip-off shall be at least 150 percent of the rated movement capacity of the seal.

8.3.2.5 Opening Movement Vibration (OMV) test

The Opening Movement Vibration (OMV) test is designed to test the ability of the Modular Expansion Joint to withstand the repeated movement demands of the bridge superstructure while being subjected to a simulated traffic load. The OMV test simulates the most common movement of the joint, the movement due to the daily thermal expansion and contraction of the superstructure by opening and closing the expansion joint with an actuator. Traffic loads are simulated by attaching a powerful pneumatic vibrator to one of the lamella/centre beams. This test shall be carried out in accordance with NCHRP Report 467. The joint should be tested for the equivalent of 75 years of 365 daily thermal cycles.

8.3.2.6 Arrangement for protection of steel sections against corrosion should be checked.

8.3.3 *Applicability of acceptance tests on different types of joints*

The acceptance tests described in Clause **8.3.2** shall be applicable as per **Table 8.3.3** for different types of joints:

Table 8.3.3 Applicability of Acceptance Tests on Different Types of Joints

Performance evaluation tests	Buried Joint/ Filler Joint/ Asphaltic Plug Joint/	Finger Joint	Compression Seal Joint	Reinforced Elastomeric/ Coupled Elastomeric Joint	Single Gap Strip/Box Seal Joint	Modular Strip/Box Seal Joint
Cyclic motion	Not applicable	Not Applicable	Applicable	Applicable	Applicable	Applicable
Ponding	Not applicable	Not Applicable	Applicable	Applicable	Applicable	Applicable*
Debris expelling test	Not applicable	Not applicable	Applicable	Applicable	Applicable	Applicable*
Pull-out test	Not Applicable	Not applicable	Not applicable	Not applicable	Applicable	Applicable*

* For modular strip seal expansion joint ponding test, debris expelling test and pull-out test shall be carried out on one meter edge beam samples only, complete with sealing element and anchorage.

Note : Since the above mentioned joints are proprietary products, clients may like to ensure a suitable specified minimum guarantee period for joints considering overall service life of structure.

9 INSTALLATION

9.1 This section serves as a general guideline for installation of Expansion Joints. Expansion Joints should always be installed under thorough supervision of the manufacturer's/ supplier's engineer in order to ensure the quality of installation so that expansion joints function as intended during their entire life span. Detailed Installation Manual should be supplied by the joint manufacture.

9.2 The design of an expansion joint is performed by determination of the extreme values of the expected movements and the position of installation. The installation data depends on the planned construction sequence.

9.3 Taking the width of gap for movement of the joint into account, the dimensions of the recess in the decking shall be established in accordance with the drawings or design data of the manufacturer.

9.4 Detailing of structure should be done with due consideration of the type of joints, movement capacity, presetting detail, recess dimension required for installation, requirement of reinforcements and its detailing to avoid removing or cutting off interfering reinforcing bars during installation.

9.5 The presetting of expansion joint may be done by means of an auxiliary construction.

9.6 It is recommended to lay the road surfacing/wearing coat before commencing installation of joint. Before laying wearing coat the recess portion shall be filled with sand and wearing coat shall be laid in a continuous manner over the deck slabs and recess portion. Prior to the installation of the joints, portion of wearing coat over the recess shall be removed by a suitable method e.g. saw cutting and the infill sand shall be removed subsequently.

9.7 Preparation of the Recess

The recess must suit in size and form to the geometry of the expansion joint. However, the width shall not be less than the specified value for a particular type of joint. In order to avoid difficulties during installation, the following points must be checked and considered:

- Dimension check of recess
- Check of the levels
- Check of the skew and slope
- Check of the designed gap between bridge deck and abutment and/or between adjoining decks.
- Checking of the existing structural reinforcement according to the drawings.

Missing rebars must be replaced by inserting bars penetrating sufficiently deep into the concrete. Rebars that would obstruct the installation of the expansion joint should be bent to accommodate the expansion joint anchorages. Removing or cutting off interfering reinforcing bars shall only be done after consultation with the engineer in charge.

The recess shall be cleaned thoroughly. If necessary, the surface should be roughened. All loose dirt and debris shall be removed by wire brushing, air blowing and dried with hot compressed air.

9.8 Shuttering

Shuttering must be used to seal the space between the underside of the joint and the vertical face of the recess. The shuttering must be fitted in such a way that it forms an appropriate seal against the edge of the recess. The recess shall be shuttered in such a way that dimensions in the drawing are maintained. The formwork shall be rigid and firm.

9.9 Placing in the Recess

Level marks must be set next to the recess by the installation engineer. This enables a controlled levelling of the expansion joint. Lowering the expansion joint/joint construction/insert etc. into the recess should be done in such a way that the entire length of the joint is evenly lowered into the recess. Thereafter, the joint/joint construction/insert is precisely levelled and adjusted in the longitudinal, transverse and vertical planes. If required, the joint/joint construction/insert must also be adjusted to the gradient of the final surface level. As soon as the joint/joint construction/insert is accurately placed, the engineer in charge shall provide a written confirmation of the correct placement of the same.

9.10 Connecting

9.10.1 It is recommended to install the expansion joint/joint construction/insert in the early morning when the temperature is distributed almost uniformly over the whole bridge. Immediately before the installation, the actual temperature of the bridge should be measured. If it is not within the considered tolerance, the present adjustment must be corrected. The joint/joint construction/insert shall be lowered in a predetermined position. Following placement of the joint/joint construction/insert in the prepared recess, the joint/joint construction/insert shall be levelled and finally aligned and the anchorage steel on one side of the joint welded to the exposed reinforcement bars of the structure. Upon completion, the same procedure shall be followed for the other side. With the expansion joint/joint construction/insert finally held at both sides, the auxiliary brackets shall be released, allowing it to take up the movement of the structure. After carrying out the final fixing, the protection against corrosion is completed.

9.10.2 For fully assembled joints with one end fixed and other end movable e.g. modular strip/box seal joint, connection is detailed below:

9.10.2.1 The 1st Side

The fixed side of the assembled joint (either the abutment or the bridge deck side) is designated the 1st side for connecting the joint. The preliminary fixing is made by evenly placing then welding of rebars over the entire length between the anchor loops and the deck reinforcement. To facilitate concreting, it is recommended that the gap between recess and shuttering is sealed by a grout seam. The seam must be left to dry prior to final concreting. After this, additional rebars are welded until all anchor loops are firmly connected to the deck reinforcement. The expansion joint is sufficiently fixed when no vibrations are noted when lightly bouncing on the joint.

The extent of the fixing of the expansion joint described above is not designed to accept dynamic load from traffic. It serves only to firmly pin the expansion joint in the recess until the concrete has been poured and sufficiently cured. It is, therefore, vital that the expansion joint is not subjected to any loads that could in any way displace the precise location of this fixing.

9.10.2.2 The 2nd Side

Depending on the size of the expansion joint and the expected movement during the installation, the most suitable time must be determined for the fixing of the 2nd (moveable) side. Usually this is the early morning hours with the smallest temperature deviations. The procedure is identical to that at the 1st side. As fast as possible, preferably with several fitters at the same time, the joint is provisionally fixed to the reinforcement.

Immediately afterwards, the fixation brackets must be removed. The expansion joint can now follow the longitudinal movement of the bridge.

Thereafter, the gap between recess and shuttering should be sealed with grout seam and the remaining rebars should be welded as described previously.

9.11 Concreting

9.11.1 Prior to final concreting, the position of the joint/joint construction/insert must be recorded. The Engineer-in-charge must give written confirmation of the correct position of the joint and the recess concreting. The recess must be thoroughly watered. This prevents too much water draining from the fresh concrete. Before pouring the concrete the joint construction should be protected by a cover. Controlled concrete having strength not less than that in superstructure subject to the minimum of M 35 shall be filled into the recess. The water cement ratio shall not be more than 0.4, if necessary admixtures may be used to improve workability. The filling concrete must feature low shrinkage. Good compaction and careful curing of concrete is particularly important. The freshly placed concrete is to be properly vibrated. Damage to the shuttering must be avoided during vibration. The filling concrete must be finished flush with the carriageway surfacing. It is recommended that the concrete is kept damp until it has cured in order to avoid fissures caused by drying too fast. After the concrete has cured, the movable installation brackets and shuttering still in place shall be removed.

9.11.2 For Modular strip seal joint the space beneath the joist boxes must be completely filled with concrete. This ensures that traffic loads are safely transmitted into the structure. Incorrectly placed concrete and/or cavities beneath the joist boxes will lead to damage of the joint.

9.12 As soon as the concrete in the recess has become initially set, a sturdy ramp shall be placed over the joint to protect it from site traffic. Expansion joint shall not be exposed to traffic loading before completion of carriageway surfacing in any case.

9.13 The elastomeric sealing element may be field installed. For strip seal and modular strip seal joints the sealing element should be in continuous lengths spanning the entire roadway width. Proper fit of the seal of the sealing element must be ensured. The seal shall be installed without damage to the seal by suitable hand method or machine tools.

9.14 Specific Procedure for Asphaltic Plug Joint

9.14.1 The recess in the deck slab, if required, shall be repaired with epoxy mortar and cleaned and dried again.

9.14.2 The foam caulking/backing rod shall be placed about 25 mm down into the joint opening.

9.14.3 The aggregate shall be washed, cleaned and heated to a temperature between 120 – 180ºC prior to placement.

9.14.4 The binder shall be preheated to temperature of 170-190ºC before application.

9.14.5 While sealing the joint opening with preheated binder, care shall be taken that the binder does not spill on to the joint surface of the deck.

9.14.6 The joint shall not be installed when the ambient temperature goes below +5ºC or above +35ºC or while it is raining/snowing (Planning for installation must take into account the weather condition).

9.14.7 When element weather resumes, the joint installation may be continued after the upper layer and/or exposed surface of the partially completed joint has been prepared by heating and/or coating with binder as necessary.

9.15 Specific Procedure for Compression Seal Joint

9.15.1 The dimension of the joint recess and the width of the gap shall conform to the approved drawing.

9.15.2 Anchoring steel shall be welded to the main reinforcement in the deck maintaining the level and alignment of the joint.

9.15.3 The width of pocket shall not be less than 300 mm on either side of the joint. Care shall also be taken to ensure efficient bonding between already cast/existing deck concrete and the concrete in the joint recess.

9.15.4 At the time of installation, joint shall be clean and dry and free from spalls and irregularities, which might impair a proper joint seal.

9.15.5 The lubricant-cum-adhesive shall be applied to both faces of the joint and joint seal prior to installation in accordance with the manufacturer's instructions.

9.15.6 The joint seal shall be compressed to the specified thickness for the rated joint opening and ambient temperature at the time of installation which shall be between +5 to + 35ºC.

9.15.7 The joint seal shall be installed without damage to the seal. Loose fitting or open joints shall not be permitted.

9.16 Specific Procedure for Single Strip/Box Seal Joint

9.16.1 Taking the width of gap for movement of the joint into account, the dimensions of the recess in the decking shall be established in accordance with the drawings or design data of the manufacturer.

9.16.2 The recess shall be shuttered in such a way that dimensions in the joint drawing are maintained. The formwork shall be rigid and firm.

9.16.3 Immediately prior to placing the joint, the presetting shall be inspected. Should the actual temperature of the structure be different from the temperature provided for presetting, correction of the presetting shall be done. After adjustment, the brackets shall be tightened again.

9.16.4 To ensure proper fit of the seal and enhance the ease of installation, dirt, spatter or stranding water shall be removed from the steel cavity using a brush, scrapper or compressed air.

9.16.5 The actual junction of the surfacing/wearing coat with the block out concrete/ steel edge section shall be formed by a wedge shaped joint with the sealing compound. The horizontal leg of the edge beam shall be cleaned beforehand. It is particularly important to ensure thorough and careful compaction of the surfacing in order to prevent any premature depression forming in it.

9.17 Specific Procedure for Modular Strip/Box Seal Joint

9.17.1 Taking the width of gap for movement of the joint into account, the dimensions of the recess in the decking shall be established in accordance with the drawings or design data of the manufacturer.

9.17.2 To ensure proper fit of the seal and increase the ease of installation, dirt, spatter or stranding water shall be removed from the steel cavity using a brush, scrapper or compressed air.

9.17.3 The actual junction of the surfacing/wearing coat with the block out concrete/ steel edge section shall be cleaned beforehand. It is particularly important to ensure thorough and careful compaction of the surfacing in order to prevent any premature depression forming in it.

9.17.4 Since procedure for installation of various joints, mentioned above, are indicative and the suppliers may have their own specific procedures for installation of each type of joint, they will be responsible for performance of the joints for the period of guarantee.

9.18 Specific Procedure for Reinforced Elastomeric and Coupled Elastomeric Joint

9.18.1 Deck casting to be done leaving pockets/recess and width of gap for movement of the joint in accordance with the drawings or data of the manufacturer.

9.18.2 The steel inserts lowered inside the pocket/recess shall flush with the finished level of the wearing coat maintaining the profile/camber.

9.18.3 Spacer bars appropriate to the correct installation width and also presetting, if required depending upon the time of installation, to be fitted under proper supervision to ensure proper positioning of bolts and levelling of steel inserts and maintaining the same during connection of inserts to deck reinforcement and concreting of pocket.

9.18.4 Concreting of pocket to be done with proper care using proper mix conforming to the manufacturer’s specification besides ensuring efficient bond between old and new concrete. The concreting in pocket shall be flush with top level of steel insert and wearing course.

9.18.5 Spacer bar to be removed at an appropriate time before fixing of elastomeric slab units.

9.18.6 For presetting of elastomeric slab units, special jigs should be used, if required. Elastomeric slab units shall be fixed by tightening the bolts with lock washers in position. Before putting the plugs in position, special sealant to be poured inside the plug holes and gaps to make the joint watertight.

9.19 Specific Procedure for Finger Joint

9.19.1 Taking the width of gap for movement of the joint into account, the dimensions of the recess in the decking shall be established in accordance with the drawings or design data of the manufacturer.

9.19.2 The recess shall be shuttered in such a way that dimensions in the joint drawing are maintained. The formwork shall be rigid and firm.

9.19.3 Care should be taken to ensure the alignment along the joint and also the level of fingers at both sides of the joint.

9.19.4 The fixing bolts of steel fingers shall be tightened properly. Each individual units of the steel fingers should be properly matched with the adjacent units.

10 INSPECTION AND MAINTENANCE

10.1 This section serves as a general guideline for inspection and maintenance of Expansion Joints during service period. Expansion Joints should be designed and manufactured to make it maintenance free to the extent possible. Detailed inspection & maintenance manual should be supplied by the joint manufacture in order to ensure that the expansion joints function as intended during their entire life span. Starting with the day of installation, the Expansion Joint components are continually exposed to natural elements, e.g. temperature changes, rain, snow, moisture, ozone, carbon dioxide and ultraviolet rays and elements that are introduced by humans, e.g. traffic impact, chemical influences, industrial pollutants and the like. The combined effect of these elements on the joint components is a steady and unavoidable deterioration process. Regular inspection and maintenance are vital measures for durability of the expansion joint.

10.2 Suitable easy access to the underside of the joint shall be provided for inspection and maintenance.

10.3 Inspection of Expansion Joints at site is required from time to time to ascertain the performance of the Joints. Periodic nominal maintenance of joints shall be carried out in order to ensure better performance and longer life of the joints. The Joints are required to be inspected at an interval of one year for the first five years and at an interval of two years thereafter. However the Joints shall also be examined carefully after unusual occurrences like heavy traffic, earthquakes, cyclones and battering from debris in high floods.

10.4 The inspection shall be preceded by careful cleaning of the joints as well as its surrounding space, depending on the actual conditions of the joints e.g. deposit of salt, debris, dust or other foreign material.

10.5 Elements of Inspection

It is necessary that gaps are maintained properly and surface treatment given on adjacent areas should exclude laying of wearing coat, i.e. covering of gap should be prevented. The following are recommended inspection elements and actions which are considered necessary to monitor and upkeep the Joints.

10.5.1 *Debris accumulation in the joint gaps, if any*

The inspection shall be preceded by careful cleaning of the expansion joints to permit free movement. Remove incompressible clogging of the joint due to debris accumulation. All inaccessible accumulated foreign objects shall be cleaned either by pressurized air or by water Jet. It is to be noted that high water pressure (above 100 bar) or heated water (above 25ºC) are to be avoided.

10.5.2 *Riding comfort over the joints*

The alignment of the Joint is a helpful indicator of the general behavior of the superstructure and substructure concerning movements as tilting, rotation etc. In general the deviation of the alignment can cause a reduction of the driving comfort for vehicle crossing or can have a negative influence on the Joint system as a whole.

The points required to be inspected with care are:

- The alignment in transverse direction (referring the joint)
- The vertical alignment measured along longitudinal direction with respect to the level of adjacent road surface

The alignment in transverse direction shall be measured with a 4 m straight edge. The deviation between the joint and straight edge should not be more than 5 mm. The vertical alignment measured along longitudinal direction with respect to the level of adjacent road surface should not be more than 3 percent.

10.5.3 *Measurement of movement*

During inspection at site, measurements are required to be taken and documented to compute its movement and rotation values in relation to their design values to ascertain whether the performance of the joints is satisfactory. To ascertain maximum movement, measurement should be taken once during peak winter (early morning) and once during peak summer (afternoon) and corresponding atmospheric temperature should be recorded. The recorded value of movement shall be compared with the design values.

10.5.4 *Measurement of dimensions*

The dimensions of the joints are required to be measured and compared with the original dimensions to ascertain any excessive stress or strain on the joints.

10.5.5 *Evidence of locked in condition*

If any movable or rotating part of a joint is found to be in locked-in/jammed condition, necessary rectification measures shall be taken immediately. Distribution of width of surface gaps (if any) provided to accommodate movement should be checked over the length of the joint. Any abnormal variation of surface gap width over the length of the joint and/or the distribution of gap width beyond the design limits, if detected, the joints should be thoroughly checked for the locked in condition in order to detect mechanical obstruction and possible remedial measures should be taken immediately.

10.5.6 *Evidence of corrosion*

The condition of the corrosion protection shall be checked carefully. Damages detected and repaired early will certainly avoid expensive repairs at a later date. If corrosion of any part of exterior exposed steel surface of the joints is detected, the following measures may be taken.

- Detect affected part
- Wire brush the affected portion to clean of it’s rust.
- Apply protective coating as per manufacturer’s specifications.

In addition, the root cause of the defect should be analysed and proper action be taken to avoid recurrence of the problem.

10.5.7 *Condition of the adjacent bridge structure*

The bridge structure adjacent to the Joint shall be examined for the following common defects, which may lead to further damage of the joint. If damages are detected they must be repaired as soon as possible to avoid further extension of the damage.

- Spalled concrete
- Broken off edges
- Cracks or fissures in the structure
- Rust spots on the concrete surface
- Exposed reinforcement

The concrete/asphalt nosing adjacent to expansion joint must be free of damages in order to ensure a smooth passage of the traffic without heavy shocks. This increases the lifespan of the expansion joint considerably.

10.5.8 *Condition of the elastomeric units/sealing component*

The condition of the elastomeric units/seals shall be carefully inspected to uncover possible defects as under:-

- Loose
- Torn

- Split
- Cracked
- Damaged
- Cut

If any one of the above defects appears, remedial actions should be taken, the degree of which depends on the prevailing defects. In general following remedial actions are possible:

- Cleaning
- Servicing
- Replacing the damaged part

10.5.9 *Water tightness-evidence of leakage*

Leakage of water together with temperature and chemical reaction might be a reason for following damages beside an unpleasant appearance:

- Destruction of the bridge structure, broken concrete
- Corroded steel parts, e.g. reinforcement, drainage pipe.
- Rust staining, dirt staining.

If evidence of leakage is detected remedial actions must be taken by replacing the sealing element or applying sealing element as per the instruction of the joint manufacturer or tightening the loose components depending upon the cause of the leakage.

10.5.10 *Evidence of noise*

Abnormal rollover noises generated by the joint under traffic load can be regarded as the indicator for the condition of the joint and also for the adjacent bridge structure. Abnormal noise may be caused by loosened and/or damaged joint components, loosened bolts, metal to metal contact due to damage of joint components. If such an abnormal noise is noticed, the origin of the noise should be probed first and depending upon that, remedial works shall be taken up by tightening the loose fastenings and/ or replacing the damaged components.

10.5.11 *Visible damage of the joint components*

Any visible damage of joint component, welded and bolted connections as well as connection of joint with bridge structure if detected during inspection, proper remedial measures should be taken immediately in consultation with joint supplier.

Results and actions: The results of every inspection have to be recorded in the inspection report and shall be classified in each case into the following types of action:

i) No action.

ii) Further measurements/long-term monitoring or design analysis needed (e.g. considering extreme temperatures/exposures, variation of loads etc.). Actions to be outlined in a report.

iii) Minor repair works e.g. cleaning, repainting etc.

iv) Repair or replacement of entire joint or components of the joints. Actions to be outlined in a report. In case of defects where the cause of necessary actions cannot be determined by the inspecting person or the responsible bridge engineer, the Expansion Joint manufacturer should be consulted.

11 HANDLING AND STORAGE

11.1 All the aggregates and binder for the Asphaltic Plug Joints shall be pre-bagged and clearly marked. All the material shall be stored on concrete platform at 150 mm above the ground in covered enclosures to avoid contamination.

11.2 The expansion joint materials shall be handled with care and stored under cover on suitable lumber padding.

11.3 All joint material and assemblies shall be protected from damage and assemblies shall be supported to maintain true shape and alignment during transportation and storage.

11.4 For transportation and storage, auxiliary brackets shall be provided to hold the joint assembly together, especially for single strip/modular strip/box seal joints.

11.5 The manufacturer/supplier shall supply either directly to the Engineer or to the Bridge Contractor complete joint with all the materials and accessories including sealants and all other accessories for the effective installation of the joints.

12 REPLACEMENT OF THE EXPANSION JOINTS

12.1 Replacement of expansion joints is difficult once they are laid. Therefore, it is desirable that the joints should perform satisfactorily during the entire service life. So it is advisable that the client may ensure guarantee or proprietary indemnity bonds or financial guarantee from the manufacturers/suppliers of expansion joints for a reasonable period, for satisfactory in-service performance. This period may be about ten years.

12.2 A complete replacement is necessary if the steel parts of the joint exhibit advanced fatigue damage. However, replacement of joint on concrete bridge deck is extremely difficult and expensive.

12.3 More frequent is the replacement of single member, especially elastomeric components. Seals should be easily replaceable. The modular strip/box seal joints should be detailed to make all components are replaceable from top of carriageway.

12.4 For replacing the components of single/modular strip/box seal expansion joints, the gap width must be opened to at least 25 mm. In the case of an elastic linkage, smaller widths are possible because the rails can be displaced. On the other hand the seals must not be stretched fully. Expansion joints for large movements should be accessible from the underside to change members of the linkage like elastomeric elements.

12.5 Though the seals may be repaired by vulcanization on site it should be avoided and total replacement of the seal should be opted. If a replacement of the rails becomes necessary they can also be joined on site. However, the joints should be situated in zones with minimal stress range and must be welded very carefully because of the high fatigue loads.

12.6 It is recommended that irrespective of the validity or expiry of the performance guarantee period for the joints, the original manufacturer/supplier should also be consulted/ involved in the process of replacement of the joints.

12.7 While replacing an expansion joint, the requirement of any other suitable type of joint (other than one proposed to be replaced) may be examined keeping in view the expected movements.

13 REFERENCES

13.1 In preparation of this publication, the following Indian and International Standards and References were considered. At the time of publication the editions indicated were valid. All standards are subject to revision and the parties to agreements based on these guidelines are encouraged to investigate the possibility of applying the most recent editions of Standards.

S. No.	Document Number	Title of the Document Number
1)	IRC:83 (Pt 3)	Standard Specification and Code of Practice for Road Bridges, Section IX-Bearings, Part II: Elastomeric Bearings
2)	IS 1838	Specification for preformed fillers for expansion joint in pavements and structures (Non extruding and resilient type)

3)	IS 2062	Steel for general structural purposes-specification (fifth revision) superseeding IS 226
4)	IS 3400 (Pt III)	Method of test for vulcanised rubbers: Abrasion resistance using a rotating cylindrical drum device (first revision)
5)	IS 3400 (Pt XIV)	Method of test for vulcanised rubbers - adhesion of rubber to metal
6)	IS 3400 (Pt XXII)	Method of test for vulcanised rubber - Chemical analysis
7)	BS 2499	Specification for hot applied joint sealants for concrete pavements
8)	EN 10025	Produits lamines a chaud en aciers de construction non allies-conditions techniques de livraison
9)	DIN 17100	Steels for general structural purposes; Quality standard
10)	DIN 53505	Shore A and shore B Hardness: Testing of rubber Testing rubber and elastomers:
11)	DIN 53507	Determination of the tear strength of elastomers; Trouser test piece
12)	DIN 53508	Accelerated ageing of rubber
13)	DIN 53509	Determination of resistance of rubber to ozone cracking under static strain
14)	Din 53516	Determining the rebound resilience of rubber using the Schob pendulum
15)	DIN 53517	Testing of rubber, elastomers: Determination of Abrasion resistance
16)	DIN 53521	Determination of the behaviour of rubber and elastomers when exposed to fluids and vapours
17)	ASTM A 36	Standard specification for Carbon Structural steel
18)	ASTM D 395	Standard test methods for rubber property-Compression set
19)	ASTM D 412	Standard test methods for vulcanised rubber and thermoplastic elastomers Tension

20)	ASTM A 588	High strength low alloy Structural Steel with 50
21)	ASTM D 624	Standard test method for Tear Strength of conventional vulcanised rubber and thermoplastic elastomers
22)	ASTM D 797	Rubber property-Young's modulus at Normal and Subnormal temperatures
23)	ASTM D 1043	Standard test method for stiffness properties of plastics as a function of temperature by means of a Torsion test
24)	ASTM D 1190	Standard specification for concrete joint sealer, Hot-applied elastic type (same as ansia 37.136)
25)	ASTM D 2240	Standard test method for rubber property-Durometer Hardness
26)	ASTM D 3575	Standard test methods for flexible cellular materials made form olefin polymers
27)	ASTM D 3677	Standard Test Methods for Rubber Identification by Infrared Spectrophotometry.

13.2 Publications

1) Manufacturer's literature

2) MORT&H Specifications for Road and Bridge Works 2001 (4th Edition)

3) IABSE (Zurich) 'Structural Bearings and Expansion Joints for Bridges' by Gunter Ramberger 2002.

4) NCHRP Report 467, :Performance Testing for Madular Bridge Systems, TRB, NRC, USA.