

## 6.0 CHAPTER 6 - DECK JOINTS

### 6.1 PURPOSE OF DECK JOINTS

Deck joints are provided on bridge structures to span the openings between the ends of the bridge deck and the abutment backwalls and the openings between the deck at the piers of simple span structures. The joints are required to accommodate any movements at these openings caused by thermal movement or live load deflections of the superstructure and to provide a relatively smooth riding surface across the opening. Also most deck joints are required to prevent the water from the deck getting onto the ends of the girders and the substructure. This can be done by either providing a waterproof seal in the joint or a drainage system underneath the joint to collect and direct the water away from the bridge elements.

### 6.2 HISTORY/BACKGROUND

Early deck joints were generally some type of steel sliding plate where a steel plate attached to one side of the joint slid on a steel plate attached to the deck surface on the other side of the joint. De-icing salts were not widely used on roadways and there was little attempt to prevent water from getting through the joints. In some cases, where there were only small openings, no joints were provided. In these cases steel angles were sometimes provided to protect the edge of the concrete deck. For joints that had large thermal movements which required thick plates to span the openings, the plates were cut in a finger pattern to provide a smooth riding surface across the joint.

With the increased use of de-icing salts and a better understanding of the problems caused by chloride contaminated water, more attention was directed at handling water at deck joints. For large finger plate joints, which had space underneath, drainage systems were designed to collect water running through the joints and to direct it away from the structure. These systems worked relatively well. However, they often became blocked with debris and had to be cleared out regularly to be effective. Also, they were normally made of steel which corroded over time. For small openings which could not accommodate a drainage system, attempts were made to prevent water from going through the joints. A number of different types of seals and caulking were tried. At joints that had little or no movement, waterstops made of flexible waterproof materials were cast into blockouts at the ends of the girders. For joints with small movements compression seals were sometimes used. These compression seals were made of a rubber type material which could be compressed and placed into the joint between the concrete surfaces. The expansion forces in the seal before it was installed were then supposed to hold the seal in place. In practice none of these early waterproof type joints worked very well.

In the early to mid 1970's a number of companies started to develop a gland type joint which consisted of steel extruded shapes, which were cast into the concrete on each side of the joint, into which a waterproof seal was inserted. The Department started using these types of joints in the mid 1970's. These joints worked relatively well if they could be kept free of debris. However, with rocks and other debris getting into the joint and traffic running over it, the seals would often get damaged or torn. This led to the development of a gland type joint with a coverplate which prevented debris from getting into the joint. The coverplates were removable to allow the seals to be inspected and replaced when necessary. This type of joint worked well to protect the seal but

over time the coverplates became loose resulting in a maintenance problem and a potential traffic hazard. The gland joint manufacturers started to develop better materials for the seals which were more resistant to damage. In the mid to late 1980's, the Department started using gland type joints with the new seal materials without coverplates and found that they worked fairly well on paved roadways. The Department now only uses coverplates on gland type joints on gravel roadways.

The gland type joints can only accommodate moderate amounts of movement. The largest gland joints can in theory accommodate total a maximum of 100mm of movement. However, in practice the Department generally restricts its use to movements of less than 100 mm. There are modular gland type joints manufactured that can accommodate larger movements but they have generally not performed well and have had maintenance problems. For large deck joint movements the Department uses steel finger plate joints with drainage systems for the water coming through the joint. These systems have been improved with the use of more corrosion resistant materials and details which make them easier to clean out.

All types of deck joints require some type of maintenance and in recent years there has been a movement among bridge designers to design the shorter bridges without deck joints. The girders and deck are made continuous over the piers and the ends of the deck at the abutments are made integral with the abutment backwalls. Any thermal movements are accommodated by flexing of the abutments and stresses in the superstructure. The Department now uses integral abutment design for all concrete girder bridges of total length of less than 50m and steel girder bridges of total length less than 40m and may in some cases use integral abutment design for longer structures. Sketches of an integral abutment can be seen in Figures 6.1 & 6.2.

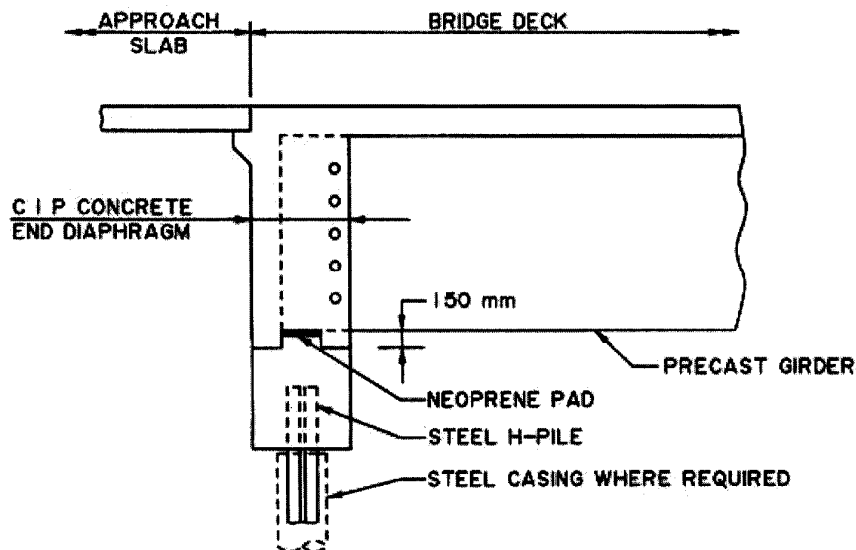


Figure 6-1 Full Integral Abutment

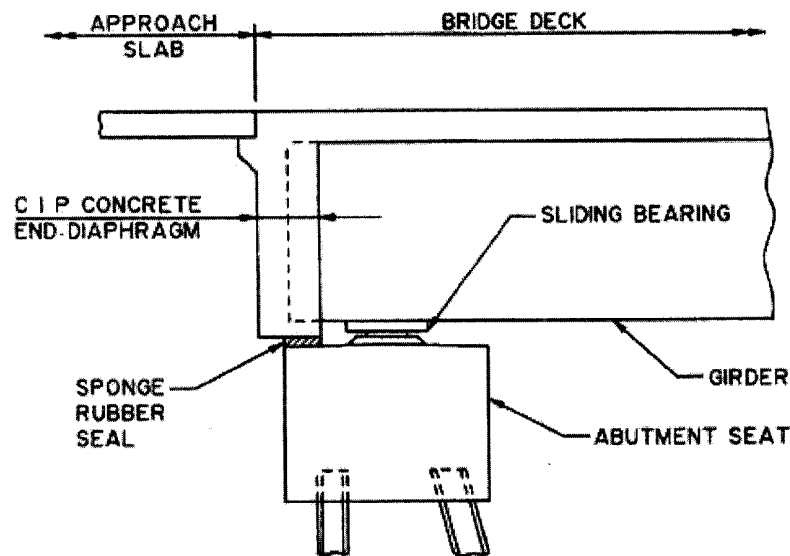


Figure 6-2 Semi-integral Abutment

### 6.3 DECK JOINT TYPES AND PROBLEMS

#### 6.3.1 FINGER PLATE JOINTS

Finger plate joints are still the most common type of joint used on long continuous girder bridges. A large steel plate is cut in a finger pattern. One side of the plate is attached to the girder side of the abutment joint and spans the gap between the end of the girders and the abutment backwall. This plate slides on a steel plate which is attached to the abutment and has the other half of the cut finger plate attached to it to mesh with the sliding finger plate. A picture of a finger plate joint can be seen in Figure 7.3 of the Level 1 BIM Manual.

#### Defects/Problems

- A common defect with this type of joint is gaps between the finger plate and the plate it is sliding on (see picture Figure 6.3). This defect has a number of different causes. Deflection of the girders from the dead weight of the deck can cause the one side of the joint to rotate. To prevent this, these joints are generally now placed after the concrete deck has been cast and this rotation has taken place. Another cause of this gap can be settlement or rotation of the abutment. Distortion of the plates due to welding during the manufacture or improper installation can also cause this problem. If not fixed, stresses in the finger plate due to heavy truck traffic can cause cracking of the welds and the plates. Also, the ends of a sticking up finger can be caught by snow plows which can cause damage to the joint and plow and create a potential hazard. This defect can be difficult to solve. Heating and bending of the fingers is sometimes used. Shims are sometimes placed under the finger plate. In some cases the joint must be removed and reset.

- Voids under the steel plates due to improper placement of concrete during installation is another common defect. The voids can allow water through the joint which bypasses the drainage system and the lack of support for the plates can cause breakage of the joint anchors. This defect can generally be corrected by drilling holes in the steel plate and pressure grouting the voids.
- Deterioration of the concrete paving lips at the finger joint is another common defect (see picture Figure 6.4). The concrete around these joints often does not get properly compacted and the joint generally creates somewhat of a bump where there is a pounding of this concrete by heavy traffic.
- The steel fingers are sometimes not aligned properly so that the finger surface on one side will close before the other (see picture Figure 6.5). This can be an indication of some transverse movement of the bridge or abutment. However, it can also be caused by improper manufacture or installation of the joint.
- Problems with the drainage system are common for these joints (see picture Figure 6.6). Sand and debris often fill the trough drains blocking the flow of any water. Also in some cases there is leakage between the trough drains and the backwall to which it is attached. On older structures the trough drains may be heavily corroded with numerous perforations.



**Figure 6-3 Vertical misalignment of finger joint**



**Figure 6-4 Deterioration of concrete paving lip**



**Figure 6-5 Fingers not properly aligned and broken finger**



**Figure 6-6 Drain filled with sand and starting to corrode**

### 6.3.2 GLAND JOINTS

Gland joints consist of metal extrusions, which are anchored into concrete on each side of the joint, into which a flexible waterproof seal is placed. A picture of a gland type joint can be seen in Figure 7.5 of the Level 1 BIM Manual. Gland type joints are used on bridges that have small to moderate thermal movements.

#### Defects/Problems

- A common defect with this type of joint is torn or dislodged seals (see pictures Figure 6.7 & 6.8). Minor tears in a seal can sometimes be repaired but replacement of the seal is normally required for this defect. If the seal has been dislodged out of the extrusion it can sometimes be placed back in the extrusion if there is no other damage to the seal.
- Damage to the metal extrusions from snow plows is another problem with this type of joint (see picture Figure 6.9). Repair of this problem involves removal and replacement of the damaged section of the extrusion. It will also normally require the replacement of the seal. The present practice for these joints is to recess the joint extrusion slightly below the deck surface to help prevent this problem.
- Deterioration of the concrete in the blockouts or paving lips is also a problem at this type of joint for the same reasons as at the finger plate joints. In these cases the deteriorated concrete is removed and re-cast.
- Sometimes the skew angle on a joint can closely match the skew angle on a snow plow blade and the plow blade can fall into the opening of the gland type



joint causing damage to the joint and plow. Generally, this is only a concern on bridges having a skew of 20 to 45 degrees. To prevent this problem metal straps, called snow plow guards, are welded to one side of the extrusion extending across the joint opening (see picture Figure 6.10). However, due to heavy truck traffic, these straps can be a maintenance problem with the welds anchoring the straps or the straps themselves breaking and requiring replacement.



**Figure 6-7 Torn seal**



**Figure 6-8 Dislodged seal**



**Figure 6.9** Damage to metal extrusion



**Figure 6.10** Damaged snow plow guard

### 6.3.3 ARMOURED GLAND JOINT

This type of joint is a gland joint with a bolted cover plate which protects the gland seal from damage. A picture of an armoured gland joint can be seen in Figure 7.6 of the Level 1 BIM Manual. This type of joint is normally used for gland joints on gravel roads.



### **Defects/Problems**

- A common problem with this type of joint is gaps between the bolted coverplate on the non-bolted side of the plate similar to problems that occur with finger plate joints. Traffic crossing the joint will cause the coverplate to flex and the bolts to break or to become loose. Shimming of the cover plate will help this problem but it is often a continuous maintenance problem.
- Missing, broken and loose bolts are very common problems with this type of joint. These defects are often related to the previous problem of improper bearing of the coverplates and may also be caused by improper tightening of the bolt or the type of bolt used. If there are problems with too many of the bolts, the cover plate can come completely out of the joint causing a traffic hazard.
- Because the armoured gland joint requires a wider plate welded to the extrusion to accommodate the coverplate and coverplate bolts, there are sometimes problems placing concrete under the joint plates. This can result in voids under the joint similar to the problems with finger plate joints. If these voids are detected, they can be pressure grouted.

### **6.3.4 ASPHALT PLUG JOINT**

This type of joint consists of a segment of flexible asphaltic material that spans the gap between the ends of girder spans or between the end of a span and the backwall. A picture of this type of joint can be seen in Figure 7.7 of the Level 1 BIM Manual. This type of joint is sometimes referred to as a thermoplastic joint. These joints would be used for fixed joints or joints with very little thermal movement.

### **Defects/Problems**

- The material can become very flexible in warm temperatures and on joints on steep grades, the material can tend to move down the grade. Also, the braking forces of traffic can cause the material to move.
- In lower temperatures the material becomes harder and cracking of the material can occur.
- At the curb this material is placed up the curb face. However, if not held in place by a metal plate, it will tend to flow down the curb face.
- This type of joint can be simple to install but it requires a sound well cured concrete surface to support the flexible asphaltic material.

### 6.3.5 SLIDING PLATE JOINT

This joint consists of two steel plates which overlap one on top of the other and slide back and forth. A picture of a sliding plate joint can be seen in Figure 7.4 of the Level 1 BIM Manual. It is a type of joint that is not presently used for bridge structures in Alberta but it was commonly used in the past for joints with moderate thermal movements. It is not waterproof and generally does not have any type of drainage system.

#### Defects/Problems

- Like many of the joints, it can have deteriorated concrete at the blockouts/paving lips along the joints.
- Since they are not waterproof, the main problems with these type of joints is the damage being caused by the water leaking through the joints.
- These joints also can have gaps between the plates which slap in traffic eventually failing the joint anchor welds.

### 6.3.6 BUFFER ANGLE JOINT

This joint consists of metal angles cast into concrete on either side of the gap. A picture of a buffer angle joint can be seen in Figure 7.8 of the Level 1 BIM Manual. It is only used on small span bridges with very little thermal movement on local roads. The gap between the angles may sometimes be filled with some type of sealant. However, in many cases the gap is just left open. The main purpose of the buffer angles is to protect the ends of the girders or bridge deck.

#### Defects/Problems

- The buffer angles can sometimes be damaged by snow plows especially if they protrude above the deck surface.
- The blockout concrete at the buffer angles can be deteriorated (see picture Figure 6.11).
- There can be vertical misalignment between the angles in different spans. This can be a sign of failure of a bearing or timber cap, but can also be caused by improper placement of the girders.



**Figure 6.11 Deterioration of concrete at buffer angles**

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