Installation of Elastomeric Bearings in Gradient (Sloped) Type Bridge Constructions

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ABSTRACT

Bearings are provided in the bridge construction to transfer the load safely from superstructures to substructures. Different type of bearings is being used in different scenario. For economical consideration, Elastomeric Type Bearings are commonly used in bridge constructions. Elastomeric Bearings are to be placed in true horizontal plane below the super structures. Formation of true horizontal plane below the structures is not difficult in case of bridges constructed at "0" gradient, whereas special care has to be taken to create horizontal plane in case of bridges constructed in gradient.

In most of the cases, bridges constructed across the sea, creak, river, road/railway crossings are with "0" gradient i.e., in level condition (true horizontal plane), but in case of flyovers and metro viaducts, it is required to keep bridge structure in gradient, depends upon on topography and existing structures in the city area.

In order to create true horizontal plane at the bearing location, a separate structure called down stand/ up stand is to be formed in the girder itself.

Keywords: Elastomeric Bearing, Down Stand/Up Stand, Segmental Construction, Micro Concrete

I. INTRODUCTION

Metro Rail network in India is rapidly expanding in major Indian cities having population more than 30 lakhs. Around 15 cities have already been covered in metro network. Metro rail system is the only mode for mass rapid public transport in big and medium cities and lead to making growing cities more liveable and sustainable.

Metro alignments generally run through one end of the city to other end and along the outer/peripheral ring roads. Majority of the metro alignment will be elevated structure (Viaduct) and only in central business, area will be underground Tunnel.

Elevated structure (Viaduct) constructed with segmental type of pre cast, post stressed box girder and most of places bearing used in viaduct are Elastomeric Bearings, only in sharper curves and span more than 31 m, a pot PTFE type bearing are used. Elastomeric bearings are to be placed in true horizontal plane to avoid tangential forces. The horizontal plane at bearing location can be formed by constructing the down stand/ up stand with pre-designed gradient in the girder itself.
Horizontal plane created in the pre cast pier segment changes due to various reasons, viz 1) gradient of down stand and alignment are not matching, 2) twist (small magnitude) in the segments will happen during stressing. Therefore, the plan of the soffit of the precast down stand will not be in true horizontal plane and unequal distribution of loads over the elastomeric bearing.

In order to avoid this practical difficulty, in staid off pre cast down stand, a cast in situ down stand can be formed by this innovative method.

### II. EXISTING METHODS AND FLAWS

Different metro organizations have adopted different construction methodologies for installation of elastomeric bearings for pre cast post tension segmental box girder construction. However, method of forming the down stand is same in all metro constructions, but filling the gap so formed is different.

**A. Placing the grout below the bearing (Fig.1)**

1. Top level of bearing pedestals over pier cap/Portal Beam were casting by keeping 25 to 30 mm lower than the required level to make the room for filling the cementitious grout.

2. After matching all segments in the span and stressing operations were completed. Stressed girder placed on temporary bearing and continuing the same procedure for next span.

3. At the time of aligning and placing the girder in the final location, girder moved with the help of jacks to bring final line and level (at this operation, it will difficult to bring the pre cast down stand/up stand to exact true horizontal plane).

4. Elastomeric bearing pads were placed attaching to the down stand/up stand provided at the soffit of the pier segment, irrespective of its plane (horizontal or inclined) resulting variable gap between elastomeric bearing and top of bearing pedestal constructed on top of pier cap.

5. In order to rest the elastomeric bearing, sim plates were placed in the gap formed between elastomeric bearing pad and concrete pedestal.

6. The gap between elastomeric bearing pad and pier pedestal grout is filled with free flow from top of viaduct.

7. Proper shattering arrangement was made to hold the grout by steel angles.

8. Finally, thickness of grout varied from 25 to 110mm in depth and grout stick to the elastomeric bearing pad.

**Fig. 1 – Placing the grout above the bearing (Fig.2)**

1. Pedestals are casting to the required line and level and placing the elastomeric bearing pad on the top of pedestals

A grout is filled through pipe (vertical duct) provided in the pre cast pier segment directly over the bearing with suitable shuttering arrangements.

**Fig. 2 – Space created to pour the micro concrete**

**Fig. 3 – Grout placed above the bearing**
B. By Fixing steel plate 16 to 25mm thick over 3 to 10 mm thick epoxy grout (Fig-3).

C. Grinding the surface of the concrete at top and bottom of elastomeric bearing and filling grout if required

The above construction methods are not in accordance with the standard code of practice. The installation procedure explained in the IRICEN Publication book at para 9.3, bearings must be placed between true horizontal surfaces (Maximum tolerance 0.2 per cent perpendicular to load) and at true plan position of their control lines marked on receiving surfaces (Maximum tolerance +/- 3mm). Concrete surface shall be free from local irregularities (Maximum tolerance +/- 1mm in depth). As par 9.7 of IRICEN publication book (Ref-2), for precast concrete or steel super structure elements, fixing of bearing to them may be done by application of epoxy resin adhesive to interface, after specified surface preparation. Elastomeric bearings are supposed to be kept in true horizontal plane on bearing pedestal, without any foreign material. As such methodology adopted in construction of pre cast post tensioned segmental box girder is not in accordance with the procedure explained in IS code /IRICEN publications.

Some Photographs showing the failures (Fig.6 to 8)

III. MODIFIED APPROACH

In view of the above deficiency in construction, it is proposed to construct the cast in-situ down stand in staid off pre cast down stand in the pier segment itself, so that Elastomeric bearing can be placed in true horizontal plane. This cast in-situ high strength cementitious grout (Micro concrete) shall be placed
in the recess provided in the precast segment along with shear reinforcements.

The following methodology explains the procedure of construction of cast in-situ down stand.

1. A recess shall be formed at the location of bearing in the pier segment.
2. While casting of pier segment, dowels are to be kept in order to take care of shear force, if any & hold steel mesh.
3. A duct is to be created by placing the PVC pipe in pier segment itself. This will facilitate for pouring of non-shrink concrete from top exactly over top of bearing.
4. After placing and stressing the segments and aligning the stressed segments (girder) brought to the required line and level.
5. After checking line, level and plane of bearing, a non-shrink grout is to be poured from top of the viaduct over the bearing.
6. Shuttering arrangements are to be removed after attaining the required grout strength.

With this methodology both (Top & Bottom) surface of the bearing will be in true horizontal plane and rest of the procedure will be as per IS code/ IRCEEN Publication book.

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Pre-Cast Down Stand</th>
<th>Cast in situ down stand</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete used to form down stand</td>
<td>M-50 grade</td>
<td>M-60 grade and above</td>
<td>Minimum strength of concrete is M-60 in case of cast in situ.</td>
</tr>
<tr>
<td>Plane of down</td>
<td>Not in perfect horizontal plane</td>
<td>Perfect horizontal plane formed</td>
<td>Due to pre-determine d plane in</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Load distribution</th>
<th>Not uniform due inclined plane</th>
<th>Uniform due true horizontal plane</th>
<th>Bearing failures are noticed in pre cast</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of construction</td>
<td>Less</td>
<td>Little More</td>
<td></td>
</tr>
<tr>
<td>Life of Bearing</td>
<td>Failed before the manufactured warranty</td>
<td>Will be as per manufacturer warranty</td>
<td></td>
</tr>
<tr>
<td>Maintenance</td>
<td>Regular maintenance required during service life</td>
<td>No maintenance required during service life</td>
<td></td>
</tr>
</tbody>
</table>

TABLE I
Comparison of existing and proposed system

IV. CONCLUSION

Additional component (down stand/ up stand) provided in the pier segment to form true horizontal plane for segmental type super structures (girders) construction shall be done with cast in-situ concrete instead of pre cast down stand/ up stand to form true horizontal plane and proper seating on bearing, so as to avoid un equal load distribution and failures in elastomeric bearings.
V. REFERENCES

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