



GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS

Guidelines for Planning of Road Over Bridges

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RDSO Guidelines for Planning of Road Over Bridges.

Road Over Bridges are being planned at a large number of places on Indian Railways to eliminate the level crossings. This is an important activity being planned these days and a need has been expressed for guidelines for planning of Road Over Bridges to be issued by Railway Board/ RDSO. On date, there are some 2260 nos Road Over Bridges on Indian Railways and over 1200 ROB's are under different stages of execution. These assets are going to be on the system for a long time and proper planning of these will not only ensure proper facility to the road users but also reduce problems to railway operations/ maintenance in future.

1. **Planning of Layout of piers:** A question that invariably comes up when discussing layout of piers is whether it is mandatory to provide piers at railway boundary. Provision of pier in railway land shall be decided on techno-economic considerations. It may be noted that with small sub structure height, in most cases in ROB's, longer spans will in general be costlier than medium length spans. However, long term interests of Railways must be guarded while planning the piers. The following may be kept in mind in this respect:
 - i. Piers shall not be planned where there is a possibility of current tracks shifting due to realignment, yard remodelling etc or where future tracks might come. Provision for future track(s) shall be considered for most locations outside yards. Since the alignment of the future track(s) is not always known, various possibilities for the same may be examined. If it is feasible, space for minimum one track on either side of existing tracks may be kept. For terminals and major yards, and their approaches, keeping land free from obstructions might be desirable as the entire layout might get changed during remodeling or fresh planning.
 - ii. Piers may be planned in railway land near the edges if it does not affect the number of tracks that can be laid at that location.
 - iii. Piers may be planned along other structures already constructed on railway land like piers of other bridge/ major structures which are not likely to be removed.
 - iv. Piers may be planned if the railway land availability at a location is more than that available at adjoining locations and which, thus, will not affect the planning of the Railways.
2. **Planning span lengths:** Following aspects may be kept in mind while planning of spans:
 - i. Decision on the span lengths shall be taken keeping railway operations in mind and, after that, as per techno-economic considerations.
 - ii. Shorter spans will necessitate more number of piers and will require more land to be permanently occupied. Longer spans become costlier and difficult to launch. Optimization between these two factors shall be done.
 - iii. As a general principle, symmetrical arrangement of spans with respect to existing tracks is desirable.
3. **Planning of foundations:** Deep foundations are, in general, costlier as compared to the open foundations. The ROB's don't have water flowing around them, so scour is not a concern and the depth of foundation can be kept smaller also. If the soil conditions dictate or there is some other

advantage like ease of construction, reduction in duration of caution order, we must go in for deep foundations like piles. If such constraints are not there open foundations shall be adopted, if feasible from bearing capacity considerations.

4. **Planning of sub structure:** Normal construction methodology followed in majority of ROBs involves providing RCC sub structure in the ROBs. At locations where space available is less, lots of extra care is required at site during concrete casting to ensure safety of train operations. This problem can be tackled by imposing suitable speed restrictions and/or working in blocks. At such locations, it would, therefore, be worth considering the option of providing precast concrete or steel sub structure. Steel sub structure can be clad in precast concrete to give it a better look.
5. **Planning of girders:** As far as possible, girders as per RDSO design shall be adopted for spans above railway tracks. **In case the site conditions warrant use of girders other than RDSO's standard drawings, reasons for doing the same shall be recorded and approval of Chief Bridge Engineer shall be obtained for the same.**
6. **Skew arrangement:** Lots of demands for design of skew girder Road Over Bridges are faced by the railways, especially for national highways where owing to higher speeds, road authorities are reluctant to introduce any curves in the road alignment. Sometimes skew arrangement is required at congested sites where change of alignment is not possible. Demands for skew angles as high as 70° have been noticed. It must be noticed that skew girders have the supports quite away from the natural line of transfer of loads and as a result the girders are subjected to high torsional loads as well as extra bending moments on the obtuse corner. The acute corners are subjected to uplift as a result of the asymmetry of the load due to the skew girders.

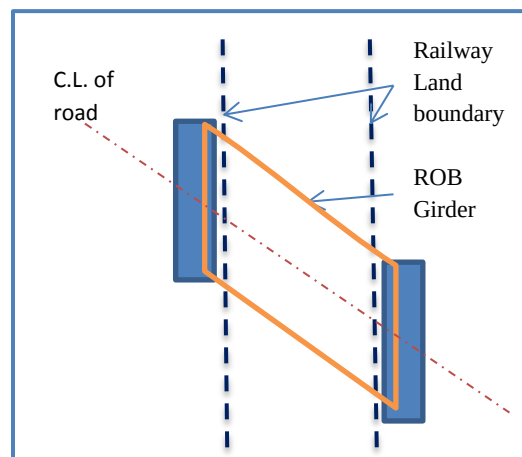


Figure 1 Normal method of providing skew spans

Larger skew angles are not desirable as capturing the proper behaviour of girder at larger skew angles is not easy. Providing sufficient torsional restraint is also difficult. Therefore, efforts shall be made to get to square alignment, if possible, or to reduce skew angles to within limits.

Advantages of reducing skew angles:

- It is easier to provide the square alignment girders and chances of mistakes in fabrication as well as assembly are less.
- Behaviour of skew girders under seismic loads is inferior to the square arrangement. The skew arrangements are under “not desirable” arrangement from bridges in the various codes.
- The behavior of square spans and skew girders with less than 20° skew angle is more logical and easily understood. Errors of design are likely to be lesser.
- Square girders can be adopted for lower skew angles upto 20° and the fabrication is easier in such cases.

7. Methods for reducing skew angles (Providing square girders, if feasible) in Road Over Bridges:

Various strategies can be tried individually or in combinations to reduce the skew angle as much as possible. Choice of strategy/ combination thereof will depend on site conditions. The strategies and constraints in adopting the same are discussed below:

a) **Providing longer spans:** If space constraint is not there, providing longer span can help in reducing or eliminating skew angle. In such a case, the sub structure is skew to railway alignment but the ROB girders are square or at lesser skew angle.

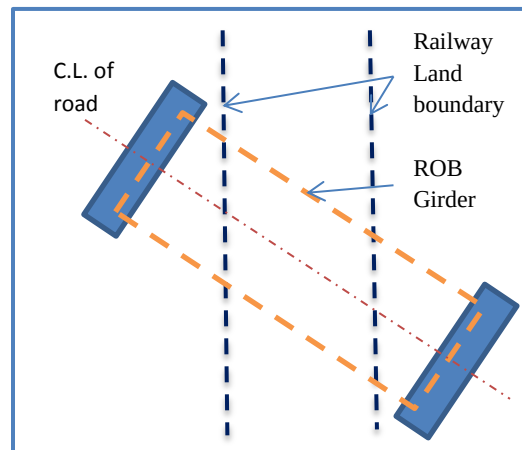


Figure 2 Skew alignment made square by providing longer span.

Constraints:

- The span is longer, so the depth of girder might go up theoretically. (Does not happen practically as some margin is kept to take care of the extra bending moments and torsion due to skew).
- The piers are not parallel to railway land boundary. So if the piers are being built in railway land, the width of land rendered unusable for future is increased.
- Standard design of longer span required shall be available. If it is not available, the design will have to be done afresh.

b) **Constructing sub structure in skew to railway land boundary:** It is not mandatory that the sub structure shall be parallel to railway land boundary even though it is desirable to reduce the railway land permanently rendered unusable. If the space constraint is not there, the sub structure can be

constructed in skew to the railway land boundary, thus reducing the skew angle of the girders to within 20 degrees.

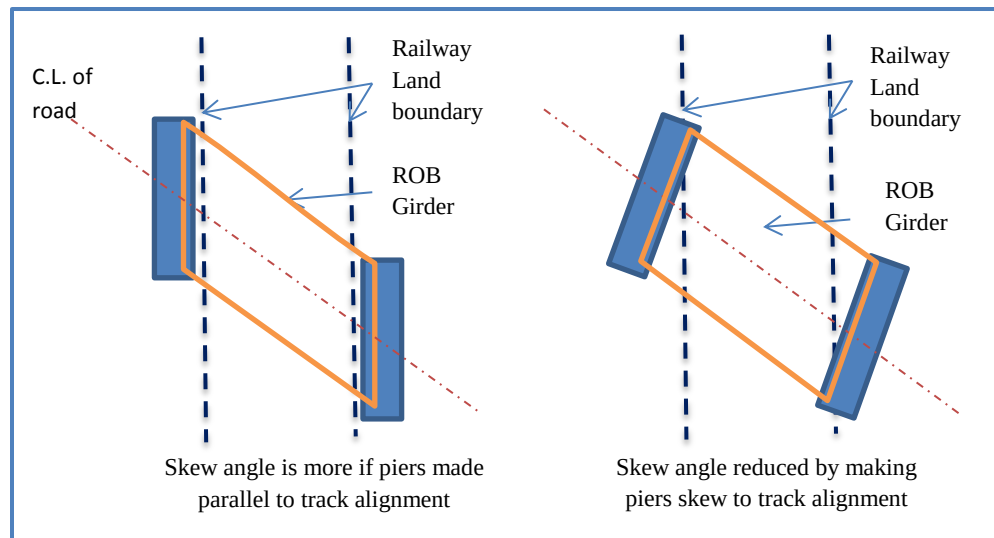


Figure 3 On left: Normally provided skew girder; On right: Skew sub structure constructed to reduce skew angle (without change in span)

Constraints:

- The piers are not parallel to railway land boundary. So if the piers are being built in railway land, the width of land rendered unusable for future is increased.
- The skew piers can violate the Schedule of Dimensions of existing or future tracks. This needs to be checked.

c) **Constructing Skew bed block:** Land is a precious resource and at lots of locations, railways might require the entire railway land boundary for its current and future operations and the land on approaches might also not be available. In this situation, both the options a) and b) discussed above will not be feasible. Option b) might not be desirable if the standard girder design is not available for the longer length contemplated. In such situations, an option can be to construct the foundation and the sub structure parallel to railway land boundary occupying minimum width, but to reduce the skew angle of the girder, the bed block can be made in skew. In this approach, the land is not wasted and the extra width in bed block is provided above the Schedule of Dimensions so that maximum space is useable, without affecting the train operations.

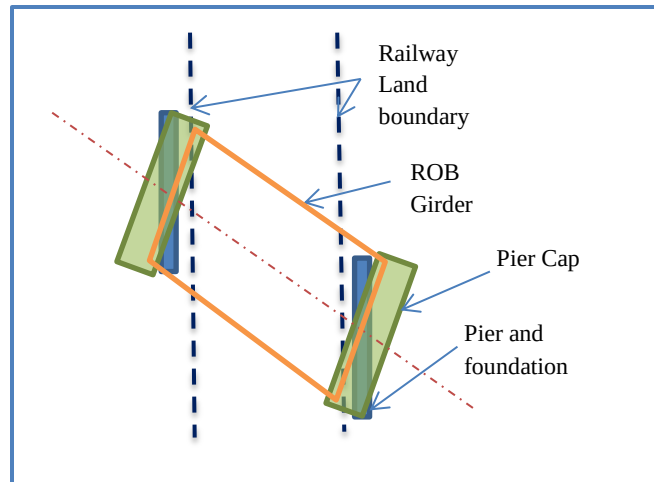


Figure 4 Arrangement with pier cap in skew

Constraints:

- The cantilever length of pier cap is increased. The depth of pier cap can increase.
- The skew piers can violate the Schedule of Dimensions of existing or future tracks. This needs to be checked.

d) **Altering shape of Pier Cap:** The lateral clearance requirement as per Schedule Of Dimensions (SOD) is lesser at more height above the rail level compared to lesser heights. Therefore, the pier wall/columns can be built at lesser distance from center line of track as compared to the bed block. In order to reduce this lateral distance, few steps can be taken.

- i. The most obvious step is to construct a tapered pier cap, to suit the requirement of the section modulus as per shape of bending moment diagram. Due to the tapered shape, pier cap can be constructed closer to the running line than a rectangular one.
- ii. **One innovation suggested by Northern Railway construction organization is to construct the pier cap at a level higher than the conventional height without changing the road level.** For this, the girders shall be provided in pockets made in the pier cap rather than at the top of the pier on a pedestal. The bearings can be provided in this pocket and thus the height from rail level to the bottom of the pier cap can be more than that in conventional pier caps without affecting the clearance below the girders or the road level. The height of the end diaphragms shall be reduced so that jacking can be done from outside the pockets. The schematic arrangement is shown below:

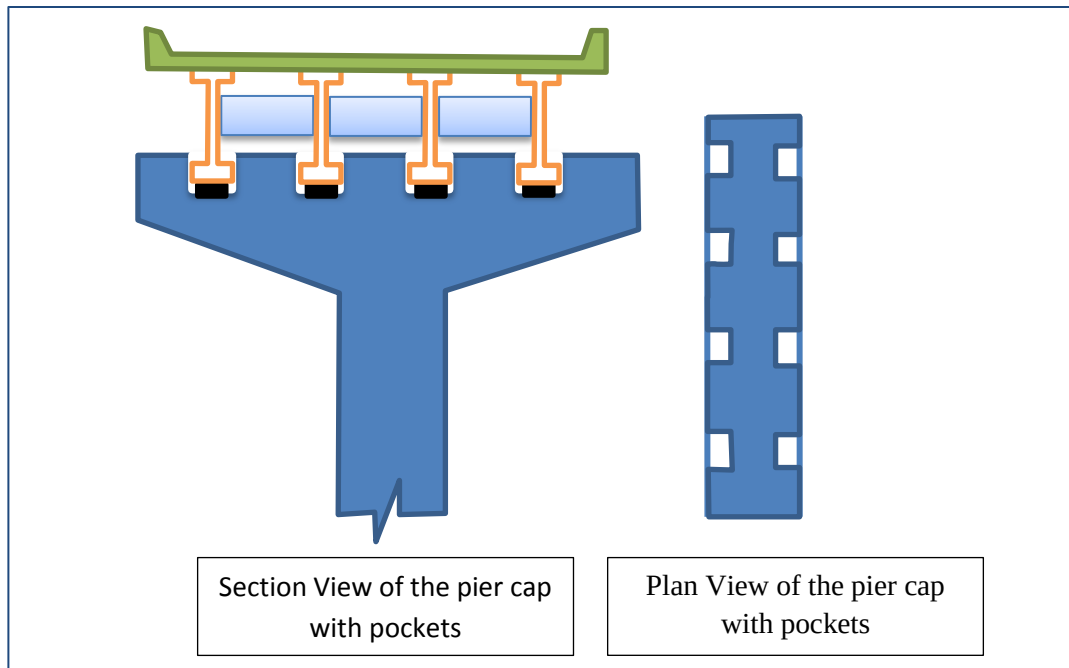


Figure 5 Arrangement with pockets to accommodate girders

- iii. **Providing fish bellied girders:** Another method for increasing the height of pier cap from ground is to construct fish bellied girders as shown below.

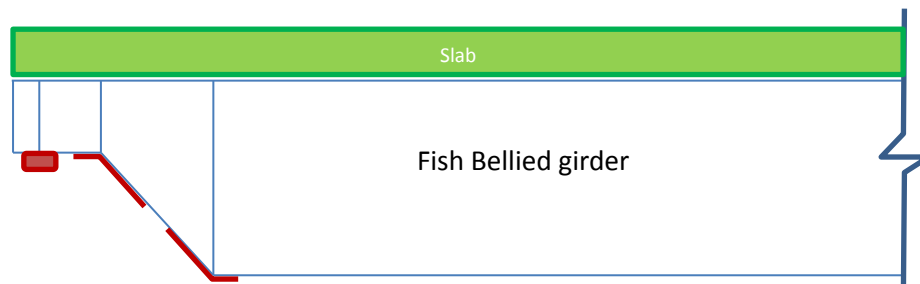


Figure 6: Cross sectional view of a fish bellied girder

Disadvantage: Fish bellied girders are slightly difficult to fabricate and require splice in bottom flange as well as web.

- e) **Providing portal across the track:** A very good method to reduce the skew angle is to rest the girders on portal provided across the track rather than on the piers directly. This method is used by Metros to cross the roads and other obstructions. Casting the beam of the portal over running track is very difficult and shall be avoided. To solve this issue and also to ensure that the road level is not increased unnecessarily, beam of the portal can be a steel beam and the girders of the road over bridge shall be connected to the web of this beam. This arrangement can utilize the standard RDSO girders by eliminating the bearing stiffener and the bearings under the girders. The bearings in this case shall be

provided under the cross girder of the portal. The arrangement of the piers for the portal shall be as shown in figure 7 below:

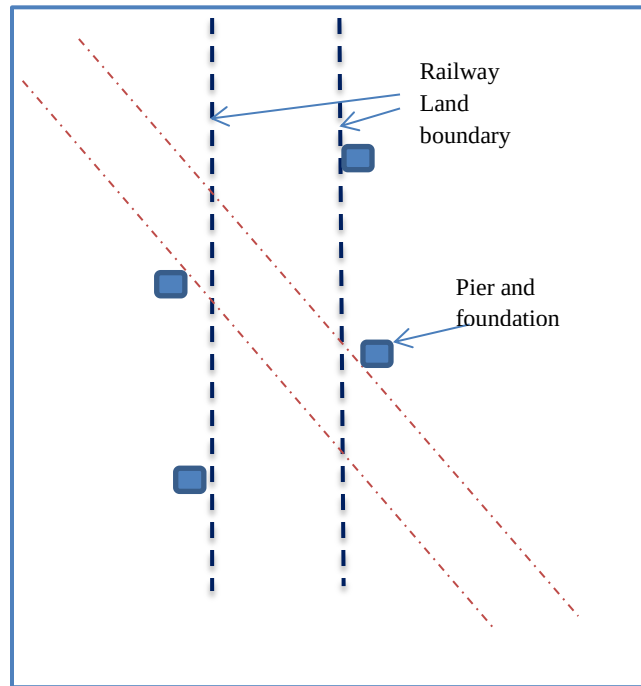


Figure 7 Layout of piers for the portal construction

The portal beam shall be provided over the piers such that the beam is normal to the road alignment. Bearings (POT-PTFE) shall be provided under the portal beam as shown in figure 8 below.

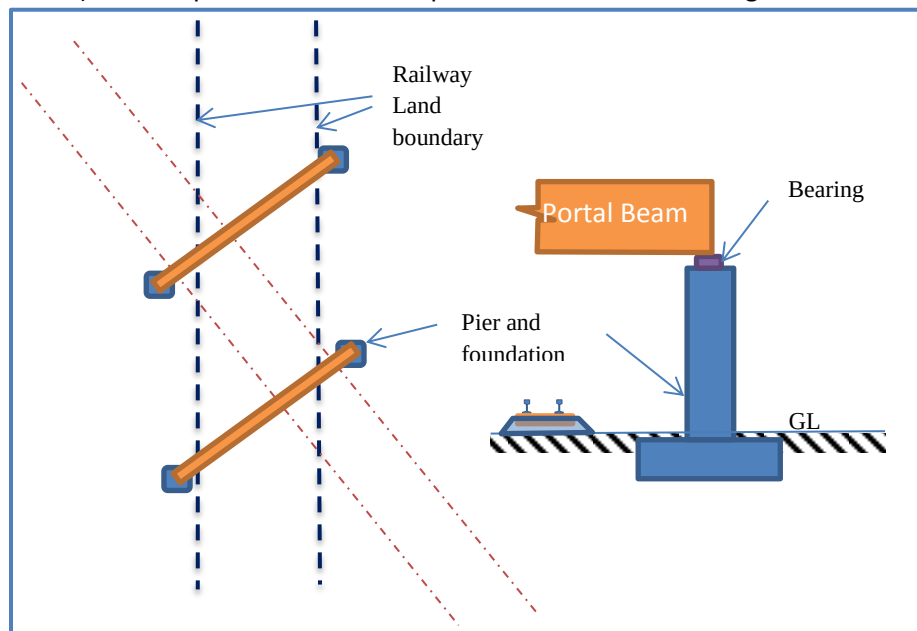


Figure 8 Beams for portal

The beams for the ROB shall be supported on bearing stiffener in the web of the portal beam. The layout is as shown in figure 9 below:

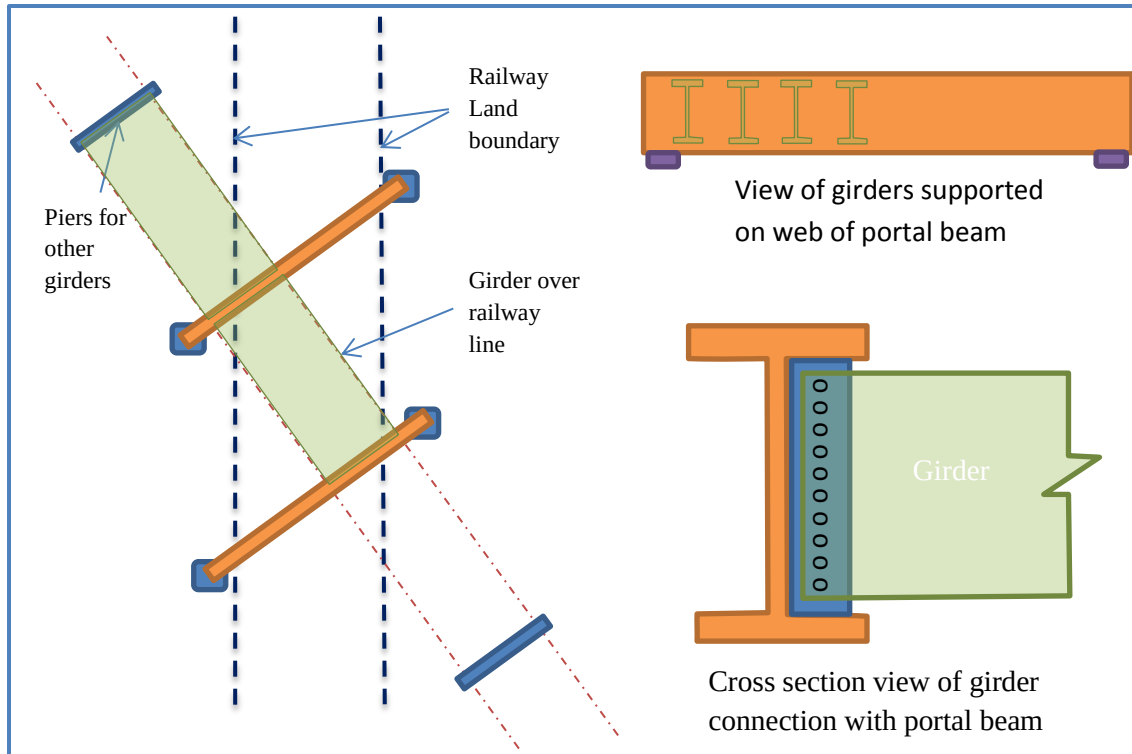


Figure 9 Provision of girders on the portal

This arrangement can be used as per site conditions and if the skew angle is too much, then multiple spans can be provided over the railway track, with suitably designed portal beams/ piers.

8. **Conclusion:** The Road Over bridge construction is an important activity and all efforts shall be made for speedy execution of works. It is hoped that these guidelines for standardization of structural planning of ROB's will help decision making in this respect.

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