First major bridge in Maharashtra on BOT basis

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The article describes the salient construction features of the first major bridge constructed on build-operate-transfer (BOT) scheme in Maharashtra across river Patalganga near Kharpada village on national highway, NH-17, about 16.4 km from Panvel on the Mumbai-Goa road. Work on the bridge began on December 1, 1997 and it was opened to traffic on July 20, 1999 in nineteen months, well ahead of the scheduled completion period of 24 months. This 813.7-m long bridge was constructed at a cost of Rs 431.5 million.

Patalganga bridge project near Kharpada is on NH-17, some 16.4 km from Panvel. The existing bridge, Figure 1, constructed in 1943, has a 5-m wide carriageway having three spans, - with each span having through concrete deck with two bow string concrete girders. Due to substantial increase in the traffic volume and change in pattern of vehicles over the last five decades the bridge had to be used as one way with manual traffic controls at either end, resulting in long line of vehicles at either end of the bridge and severe traffic congestion.

This situation further aggravated as there was a railway level crossing immediately after the existing bridge on the Pen side. Due to commissioning of the Konkan railway, rail traffic has also increased further which was creating traffic jams due to frequent closure of level crossing gate. This led to a decision to have a combined bridge consisting of main bridge across the river, road over bridge (ROB), three viaducts and approaches on either side on a totally new alignment, Figure 2. The government authorities invited tenders on BOT basis with toll rights and the job was awarded to Ideal Road Builders Ltd, a joint venture with Ameya Developers Pvt Ltd on the designs prepared by STUP Consultants Ltd.

Salient features

The proposed bridge is on km 15/400 on Panvel - Mahad - Panaji road NH-17 having a total length of 813.7 m and approaches on either side of 586.3 m. This road starts from the Pune Mumbai road NH-4 the km 16/910, that is, at Palaspe Junction and proceeds to Panaji (Goa) side. Project includes construction of:

1. Toll plaza junction with three toll booths to cater for six lanes of regular vehicle and one additional lane for heavy and odd size vehicles.

2. Earthern approach 12 m wide on the Panvel side - 239.5 m

3. Viaduct V1 on the Panvel side having two spans - 54.0 m

4. Main bridge having five spans - 212.5 m

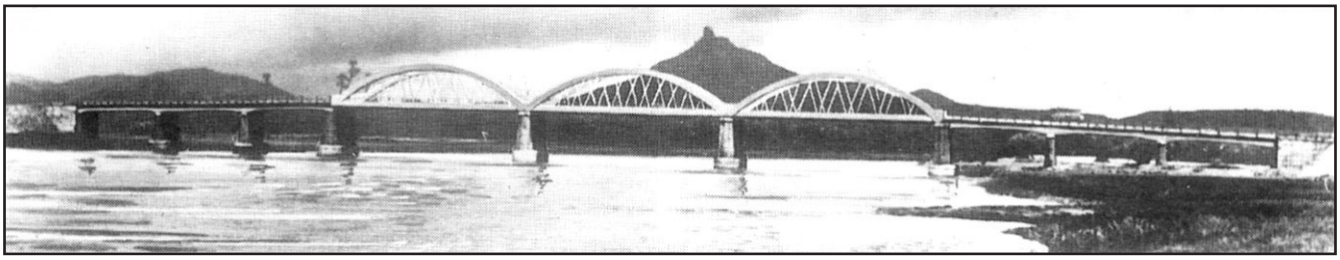

Figure 1. A view of the old bridge constructed in 1943

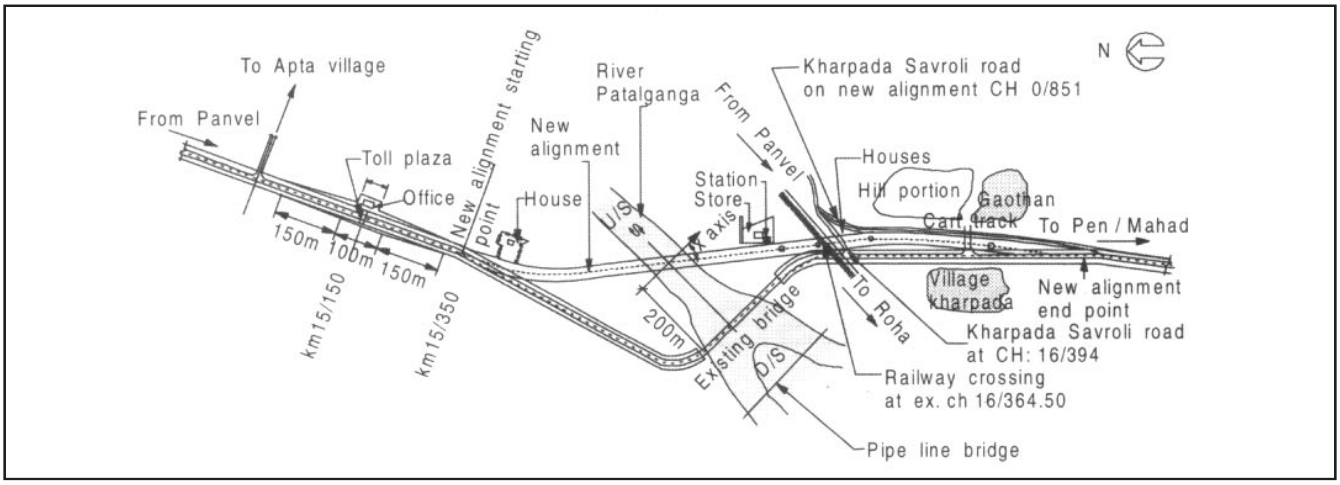

Figure 2. Key plan showing location of the old and new bridges

5. Viaduct V2 on the Pen side having 11 spans - 297.0 m

6. ROB + subway on railway portion having three spans - 83.4 m

7. Viaduct V3 on the Pen side having six spans - 166.8 m

8. Earthen approach 12 m wide on the Pen side - 346.8 m

9. New link road for Kharpada-Savroli road on SH - 84 - 667.0 m

Project cost and time of completion

Total project cost includes cost of construction, commissioning and maintenance of the facility during concession period of 17 years and 9 months including construction period and special project vehicle's (SPV) profit and interest thereon is Rs 1986.1 million. The project construction cost was Rs 431.5 million.

Soil investigations and foundation

Boring was done to investigate the soil by rotary drill using double tube sampler at all foundation locations. Depending on

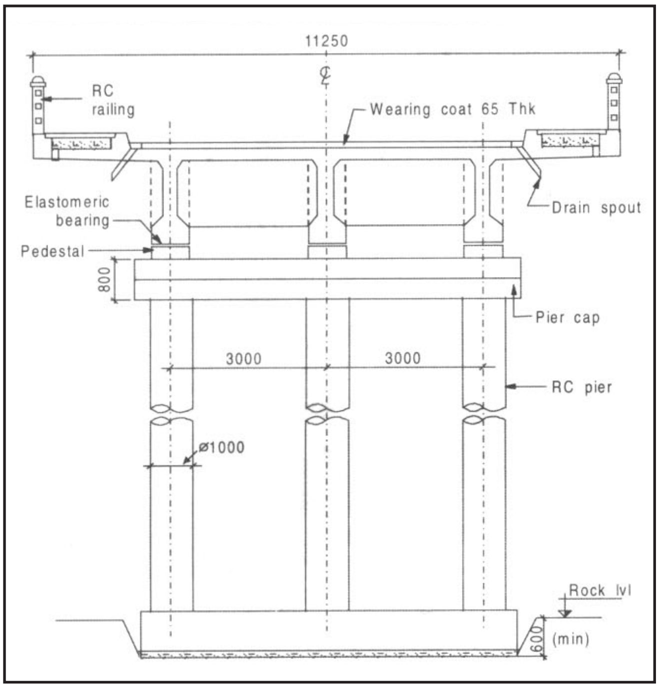

Figure 3. A typical cross section with open foundation

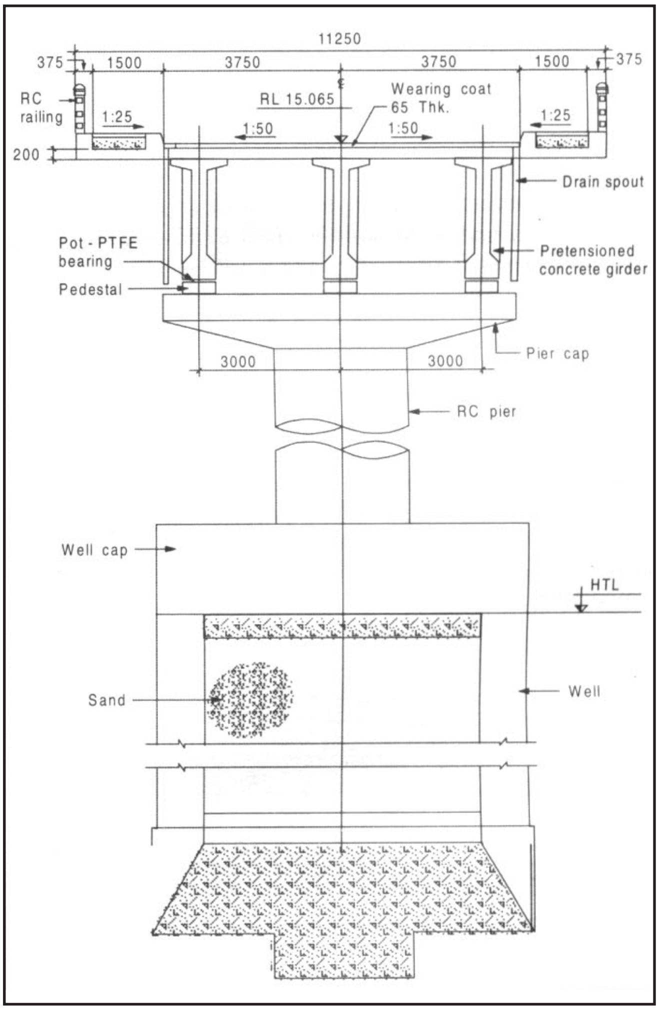

Figure 4. A typical cross section with well foundation

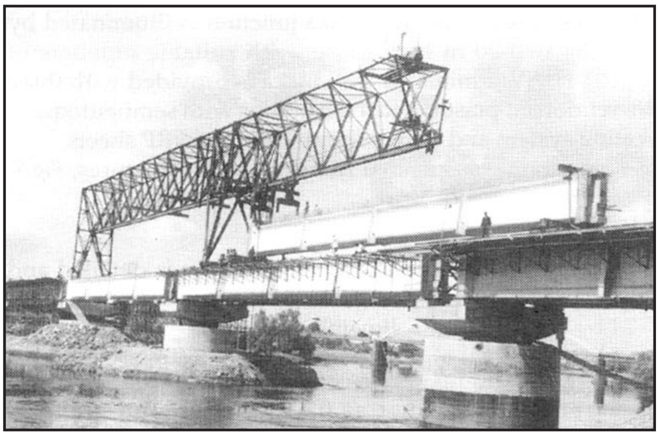

Figure 5. Launching of precast girders

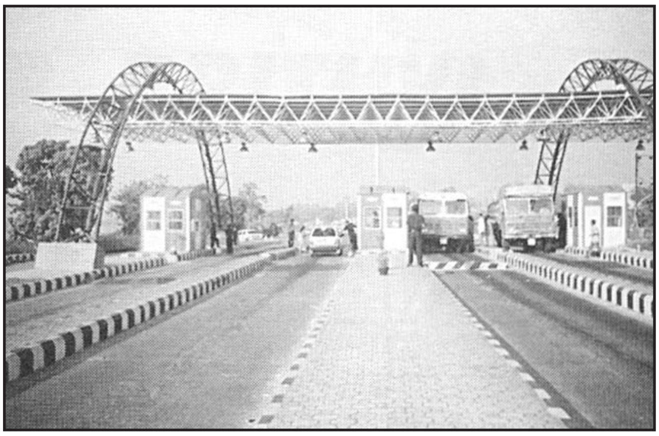

Figure 7. Toll plaza

the depth of the rock and nature of the strata different type of foundations such as 17 open foundations, 3 well foundations and 8 pile foundations are provided, Figures 3 and 4. All the foundations were taken upto soft rock and hard rock having bearing capacity of 100 t/m^2 and 200 t/m^2 respectively except for one foundation. At this location no rock was available even at a depth of 31 m and as per geologist's opinion there was a valley few hundred years back which was filled up. In view of this the foundation was designed to rest on a strata having bearing capacity of 25 t/m^2. All other open foundations were laid to have minimum anchorage of 600 mm in hard rock and 1500 mm in soft rock.

For well foundations sand islands were constructed to lay the cutting edge. For evenly seating the well on rock, divers were deployed to excavate rock wherever dewatering was not possible. Concreting of bottom plug was carried out using tremie.

For pile foundations 1200 mm diameter bored cast in-situ piles were provided at nine different locations and piling was carried using rotary hydraulic drilling equipment. 6 mm thick mild steel liner was provided to the pile from cutoff level upto top of soft rock.

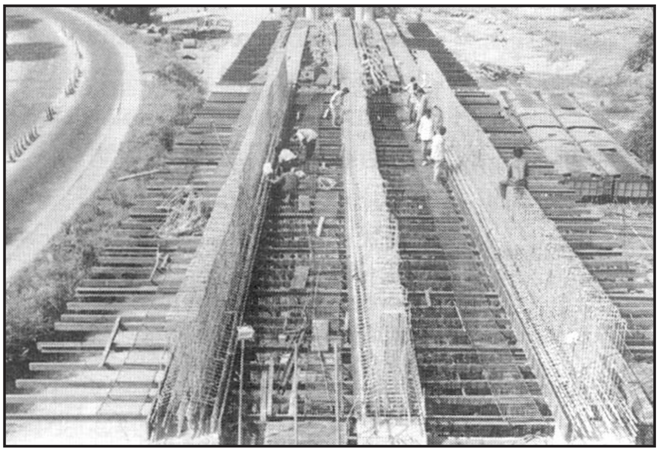

Figure 6. Concreting of viaduct span on staging

Substructure

For main bridge and ROB, reinforced concrete (RC) solid single circular piers were provided and for all other locations, that is, for viaduct spans piers consisted of three solid circular RC shafts which were cast in-situ using conventional jump form shuttering. These piers were capped by providing solid rectangular/trapezoidal pier caps. On the Pen side spill through type abutments, and on the Panvel side non-spill through type abutments were provided.

Superstructure

Superstructure consists of three prestressed concrete (PSC) I girders with deck slab. PSC girders were cast in the precasting yard located on the approach, shifted to stacking bed for curing and then transported to the location and launched in position using the launching truss, Figure 5.

For casting PSC girders, two casting beds and eight stacking beds were provided. Transporting the girders from casting bed to stacking bed and stacking bed to launching truss location was carried out by using trolleys and electric winches.

A suitably designed launching truss of 82 m length was fabricated with rear and front legs. Rear leg was resting on a trolley. Launching truss was provided with two sets of crab wheel arrangement for longitudinal movement of PSC girder and MS flat suspenders and hydraulic jacks for lifting/lowering arrangement. PSC girders were launched and lowered along the centre line of bridge and then side shifted to the required location using suitably designed side shifting arrangement provided on the pier cap.

Electrically operated winch was used for auto-launching of launching truss and for longitudinal movement of PSC girder over the launching truss. After placing of all PSC girders in position suitable transverse bracings of structural steel between the girders was provided. After launching of all spans, the RC deck slab was cast in-situ. Overhang portion of the deck slab was supported over brackets fixed to exterior faces of outer PSC girders and portion spanning across PSC girders was supported by providing sacrificial RC precast slab

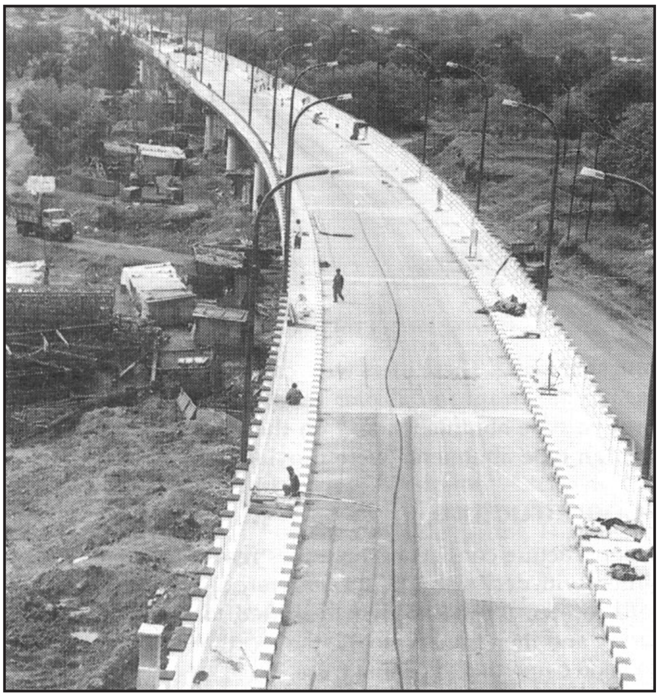

Figure 8. A view of completed bridge

panels supported over girders. This facilitated in saving of construction time.

Initially, it was planned to launch all five spans by using launching truss. However, as the work progressed to save time of construction two spans of major bridge portion were cast on staging, Figure 6. This facilitated early completion by five months though it involved additional investment in staging arrangement.

The viaduct spans were cast by providing conventional centering using truss, trestles, etc, and the RC girders and deck slab were in-situ. For the span over the railway track, centering was provided using a combination of trestles, trusses and H-frames in such a manner that railway traffic was not disturbed during concreting. Erection and dismantling of centering over the existing rail track was carried out after taking 'traffic block' from railways for a short period. Ready-mixed concrete was transported by transit mixers from a distance of 25 km from the 'patching plant and was pumped in position.

POT-PTFE bearing for main bridge (five spans) and neoprene bearings for viaduct and ROB (22 spans) were provided . Strip seal type expansion joints were provided with 40-mm thick asphaltic concrete with 25-mm mastic asphalt wearing coat over the deck.

Lighting arrangement

Deck slab is illuminated by providing 9 m high electric poles on both sides of the deck. A total of 60 poles are provided over the entire length of the bridge (813.7 m). Approaches are illuminated by providing 11.2 m high electric poles on both sides of the road. Toll plaza junction is illuminated by providing two 30 m high masts with suitable numbers of SNT 001 HPSV luminaires. Toll plaza is provided with three fibre reinforced plastic (FRP) toll booths with semi-automatic ticketing system and covered with coloured FRP sheets fixed to a space frame suspended from two arch structures, Figure 7.

Durability

From durability consideration, the structure is detailed and constructed as per the provisions of IRC special publication SP-33 by adopting the following measures:

1. the maximum water-cement ratio for all structural concrete was kept as 0.4 and minimum grade of structural concrete was M 40.
2. fusion bonded epoxy coated reinforcement steel was used in entire construction
3. adequate drainage is provided for deck slab and footpaths
4. epoxy paint was applied to the substructure and superstructure.

The following materials were used:

1. cement : 5,200 MT
2. low relaxation prestressing strands : 67 MT
3. high yield strength deformed bars : 1,310 MT
4. concrete : 11,600 m^3.
5. earth work : 70,000 m^3.
6. asphalting : 20,000 m^2.

Completed view of the bridge is shown in Fig 8.

Credits

Clients	:	Government of India, ministry of surface transport Government of Maharashtra, Public Works Department Central Railway - chief engineer (construction)
Enterprenear	:	IRB Infrastructure Limited
Contractors	:	Ideal Road Builders Limited, joint venture with Ameya Developers Pvt Ltd
Design consultant	:	STUP Consultants Limited
Project management consultant	:	STUP Consultants Limited
Expert geologist	:	Dr S.R. Kulkarni
Project financiers	:	Industrial Credit and Investment Corporation of India Ltd and The United Western Bank Ltd.

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