"Elevated Road-cum-Rail Crossings" (Precast Tunnel type RC box)

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Synopsis

Application of Carbon Fiber Reinforced Polymer, CFRP, system in the rehabilitation of bridge structures are gaining importance in the recent decades owing to the advantages it possesses in comparison with other traditional methods of repair and strengthening. This paper deals with the strengthening done for the damaged PSC girders of Railway Bridge, having numerous vertical flexural cracks originating from bottom of girders, with CFRP composite system. Prestressed CFRP laminates along with U CFRP sheet wrapping were used to enhance the flexural stiffness of damaged PSC girders. ACI 440-2R-2008 was used for designing the strengthening scheme. Structural response of girders was measured pre and post strengthening to assess the effectiveness of repair. Test results showed that with proper detailing, CFRP system can be designed to enhance the flexural capacity of damaged/cracked prestressed girders.

Prelude :

The High Level Safety Review Committee Report – February 2012, has recommended total elimination of all the level crossings (manned and unmanned) within 5 years at an estimated cost of Rs.

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50,000 crores which will get recovered over 7-8 years due to saving in operation and maintenance costs and improved train operation.

Various alternate means to eliminate LC have been suggested in the past such as Manning, LUS, Diverting the road leading to UMLC through adjacent manned LC/LUS & Direct Closure of UMLC, if road traffic is less. However each one of the above methods have some drawback as detailed below:

1. Manning:

Manning itself is not a proper solution which does not eliminate accidents all together; it further requires gate-keepers inter-locking, co-operation with other departments & periodical maintenance. More manned LCs make train operations complex & restrict line capacity as explained below:

a) It involves huge recurring expenditure in maintenance.
b) Train LP has to face more number of Gate signals which affects his concentration on train running.
c) Punctuality loss of train shall increase in case of Gate failure.

1. LUS (Subways) :

(i) Limited height sub-way is a good concept but could not be implemented mainly because of refusal by the state administrations in giving consent because of reduction in the available facility to the road users, drainage problems etc. as detailed under:

a) Obtaining District Collector's approval for closure of unmanned LCs is an ardous/task, since State Govt. gives least care for the same. As the name indicates Limited Use Subway, local public as well as revenue officials have an impression that only limited height/small size vehicle can pass through District Administration does not give his consent.

b) Drainage has been found one of the major problems. Even if collection well is provided pumping out the water from collection well is becoming an issue as local panchayat are not coming forward for pumping out the water and Railway does

not have any organisation to pump out water from mid section subways. Also keeping the pump unguarded is prone to theft in remote areas.

(ii) Number of unmanned LC located at ground level (or) at cuttings could not be converted into subways due to the following :

a) Due to likely water stagnation (particularly if ground water table is at a higher level).

b) Due to tall retaining wall required at both approaches.

c) District Administration not granting approval (or) seeking tall/deep subways of upto 6.5 m height to pass the over dimensional harvesting machine for agriculture.

d) Public having reservations on use due to likely darkness in side.

Solution:

- Precast tunnel type RC barrel for track is more suitable for eliminating both the manned LC having less TVU & unmanned level crossings located at shallow/deep cuttings since the necessity for a longer approach road can be avoided.

(iii) Construction of ROB will not be economical, especially where TVU is low and LC is situated across Village/Other District Road (ODR) as it costs more than Rs.15 crores depending upon the alignment etc. In addition, execution of ROB takes not less than 3-5 years in general which increases further where land acquisition is involved. Considering the above aspects, ROB is not appropriate solution for eliminating all the LCs.

3. Diverting the road through adjacent manned LC/Subway:

a) Though some of the UMLCs are very near (about 500m or so) to manned LCs/LUS but District Collector is not in a position to give his consent due to public protest as they do not want to loose existing facility of crossing the track through shortest distance & do not want to travel additional distance through diverted route.

b) Sometimes no railway land is available to lay the road parallel to track.

4. Direct Closure of unmanned LC (due to less traffic):

a) In some of the cases, it is observed that though TVU at the UMLCs is very less and very less road vehicles cross these UMLCs, these road vehicles are State Government Buses meant for transporting local public to remote village on other side of track as no other means of transportation is available. Hence District Collector express helplessness in giving direct closure, even though TVU of the LC is very less.

b) Some of the UMLCs having very less TVU have fertile land on one/both sides but those LCs are used by Bullock carts for transporting paddy from one side to their houses duly crossing the track. Due to advanced technique, machines has been developed for harvesting the paddy which is having a height of 5.0m & is being used by all the farmers and hence public are not accepting even Less TVUs at such LCs.

- Due to the reasons elaborated above, elimination of UMLCs by the above methods have not been encouraging.

Objective :

In this paper, an effort has been made to wipe out most of the drawbacks in the above methods of elimination of LC and one low cost solution which may be termed as "Elevated Rail-Road Crossing" is conceived in this paper so as to achieve the goal and thus giving respect for human lives.

The Structure of ERR :

Elevated Rail-Road crossing consists of RCC BOX (for running the train through it) having road approaches on either side for about 275m and made up of earth filling, soling, WBM, BT & Reinforced Earth Retaining Structures. Salient features of tunnel box proposed are as under:

- Span of RCC Box: 5.44m for single line.
- Barrel length: 6.0m (app.)
- Height of RCC Box: 7.0m (top of bottom slab to bottom of top slab).
- Thickness of bottom slab: 600mm.
- Thickness of RCC Box wall & top slab: 500mm (Tapering vertical walls are possible)
- Levelling coarse & sand filling thickness below base slab: 200mm.
- Road work at approaches: Gravel filling, soling-200mm, sub-base course-150mm, base course-100mm, bituminous top-50 mm.
- Galvanised 'W' Beam Crash Barrier at the approach roads to act as parapet wall.

  Reinforced Earth Retaining Structures for approach road as per clause 701.2.6 of MORT&H consisting of RCC panel, filter media & earth reinforcing material (i.e. Geogrid/GI steel strip etc. as per specification).

- The work includes detailed design (to be supplied by the contractor) for the entire reinforced earth structure for different sectional heights, supply assembly and erection of soil reinforcing elements, supply & placement of facia panels, construction of earthwork in layers and all associated components as per the requirement and approved design including supervision of all works including earthwork and pavement works for effectiveness of RES.
- The reinforced earth structure shall be designed to cater for all the design loads including earth pressure, surcharge and live loads as per National Highway traffic and other design criteria specified in IRC codes. The design of reinforced earth structure shall be based on the actual site conditions and shall match with the approved construction drawings of elevated crossings
- Specification & quality assurance of the materials used for Reinforced Earth Retaining Structures are detailed below:

Design Loads :

- IRC loads on top of RC box
- Lateral Earthpressure, porepressure etc (Triangular)
- 25+ axle load from track over bottom slab of RC box.
- Earthquake loads
- Foundation soil pressure

A. Material Specification (Clause 3102/MORT&H):

a) Backfill Requirement:

Backfill materials used in the Reinforced Earth wall shall be reasonably free from organic or otherwise deleterious materials and shall conform to the following mechanical requirements.

(i) **Mechanical Requirements**

Sieve size	Percent passing
100mm	100%
75 micron	less than 15%
Coefficient of uniformity Cu = (D60/D10) ≥ 2	

- Materials with more than 15% passing 75 micron sieve and more then 20% of particles smaller than 15 microns are inadequate and shall not be used.
- Materials with more than 15% passing 75 micron sieve and 10 to 20 % of particles smaller than 15 microns are acceptable provided that the internal friction angle is not smaller than 30°.

(ii) Compaction

Compaction of backfill material shall be 100% Proctor Density (P.O.) for 1 metre depth below road crust and 95% of P.O. for remaining portion of fill materials.

b) Facia Material

· The facing shall be of precast reinforced concrete panels M-35 grade with a minimum thickness of 180mm with aesthetic finish as per approved drawing. The panels shall be machine finished. The

facing should be designed to cater to maximum transversal, vertical and longitudinal flexibility to cater to seismic and ground movements.

- Connection between the facia and the reinforcing element shall be using polyethylene trips /rods, fibre glass/ galvanised steel dowels or any other material shown in the drawing. The connection strength shall be approximately used for design and analysis.
- Overlapping in principal reinforcement or in the joint shall ensure load transfer through joints, perpendicular to the direction of laying in case of geosynthetic reinforcement.

Modus Operandi / Execution Method :

(1) RCC Tunnel Box proper:

Prior to line block

- Pre Casting of bottom slab of RCC box in segments of the width 1.50m duly leaving reinforcement for the walls and allow the curing period
- Pre casting of box segments 1.5 m/2m in length and as per the size/cross section.

During line block

- Dismantling of the track to the required length (say 7-13 m)
- Earth work excavation to the depth of 1.0m
- Providing base course with sand filling for a depth of 200mm
- Erection of precast RCC box bottom slabs in segments
- Erection of precast box segments by heavy duty cranes.

Thus without any disruption to the traffic and with few blocks of short duration, the entire work can be completed

(2) Approach Road & Reinforced Earth Retaining Structures:

Since approach road has to be used by road vehicles, execution has been proposed as per the specification of MORT&H. Following steps has to be adopted for executing the work as outlined therein :

(i) Excavation (Sub-clause3103.1/MORT&H):

Excavation shall be in accordance with the requirements of General and Special Specification and in close conformity to the limits and construction stages shown in the drawings. The plan area of the reinforced earth structure shall be excavated to provide a nominally level base which may be stepped at the back as required, to receive the horizontal reinforcing element.

(ii) Foundation Preparation (Sub-clause3103.2/MORT&H):

The foundation for Reinforced Earth Structures (RES) shall be graded level for a width equal to or exceeding the length of reinforcing strips or as shown in the drawings. Prior to wall construction, the foundation shall be compacted with a smooth wheel vibratory roller. Any foundation soil found to the unsuitable shall be removed and replaced. Ground improvement/strengthening measures, as necessary, for the design and execution of RES shall be carried out.

(iii) Erection (Sub-clause3103.3/MORT&H):

Precast concrete panels shall be placed vertically with the aid of a light crane. For erection, panels are handled by means of lifting devices set into the upper edge of the panels. Panels shall be placed in successive horizontal lifts in the sequence shown on the drawings as backfill placement proceeds. As fill material is placed behind a panel, the panels shall be maintained in vertical position by means of temporary wooden wedges placed in the joint at the junction of the two adjacent top rows of panels during construction. As construction proceeds and a fourth row is erected, the lowest row of wedges can be removed and so on.

External bracing may also be needed for the initial lift. However, bracings shall be placed in an area not more than 1.5 meter wide beyond the outer face of panels.

Vertical tolerances (plumpness) and horizontal alignment tolerance shall not exceed 10mm when measured along a 3 meters straight edge. The maximum allowable offset in any panel joint shall be 10mm.

(iv) Facia Batter (Sub-clause3103.4/MORT&H):

It may be necessary to set facing unit at an additional batter than as provided in the drawing as there is a tendency for initially positioned units of facia to lean outwards as the fill material is placed and compacted. Care and caution shall be taken to counter this phenomenon.

(v) Orientation of Soil Reinforcing Element (Sub-clause 3103.5/MORT&H):

The soil reinforcing element shall be placed (free from all kinks, damage and displacement during deposition, spreading, levelling and compaction of the fill) at right angles to the face of the wall, with greater cross sectional dimension in the horizontal plane. The placement of the elements including their vertical! horizontal spacing and length shall be as in the drawing.

(vi) Backfill Placement (Sub-clause3103.6/MORT&H):

Backfill placement shall follow closely the erection of each lift of panels. At each reinforcing strip level, back fill should be roughly levelled before placing and connecting! bolting the soil reinforcing element. Soil reinforcing element shall be placed normal to the face of the wall or as shown on the drawings. The maximum layer thickness shall not exceed those specified in the approved design and method statement.

At the end of each day's operation, the Contractor shall shape the last level of backfill as to permit runoff of rainwater away from the wall face. Backfill shall be compacted in accordance to the project specifications for embankment except that the minimum required compaction shall be 100% to 95% of maximum density as specified and shall be determined by the standard tests and that the moisture content shall be plus or minus 2% of the Optimum Moisture Content as determined. Backfill compaction shall be accomplished without disturbance or distortion of soil reinforcing elements and panels. Compaction in a strip of 1.0 meter wide

adjacent to the backside of the wall facing shall be achieved by the use of a manually operated vibrating compactor, such that adverse edge stresses are not transferred to the facing panels during construction.

During construction of reinforced fill the retained material at the rear of the structure shall be maintained at the same level as the reinforced fill.

(vii) Drainage (Sub-clause3103.7/MORT&H):

Drainage shall be provided as per detail given in drawing. The retained fill shall have a suitably designed drainage bay and associated drainage system to allow for free draining of the reinforced fill. The minimum drainage gallery width shall be 600mm.

Abstract Estimate :

1.	Excavation, track dismantling etc.	-	₹ 0.1 Cr.
2.	RCC tunnel box	-	₹ 0.7 Cr.
3.	a) Panel/reinforced retaining wall b) Earth fill c) W'beam crash barrier	-	₹1.1 Cr.
4.	Launching by crane, joining etc.	-	₹ 0.3 Cr.
5.	Miscellaneous & unforeseen items	-	₹ 0.1 Cr.
			₹ 2.3 Cr.

The work can be carried out with the Railways powers of sanction in Plan Head-30.

Advantages of ERR (Tunnel box type) :

1. No land acquisition is involved since the ramped approach road is planned for construction at the same alignment of existing road.
2. Wherever the embankment height is less, provision of limited use subway is having major problems for draining out the stagnated water and at such locations this elevated crossings (ERR) are very much suitable.

3. Obtaining permission from local authorities has become very difficult due to various reasons explained in previous paras. In case of ERR local authority may give consent readily as most of the problems encountered in case of LUS, diversion, direct closure are eliminated in elevated crossing.

4. RUB restricts future development (restricted Ht, width and moving dimensions) but ERR does not have restriction in respect of height, width of moving vehicles etc.

5. Speedy construction.

6. No any drainage problems.

7. No major equipments like higher capacity crane required.

8. Duration of line block required may be less.

Dis-advantages/Constraints

1. Construction of approaches beyond Railway boundary may also required to be carried out by Railway & Further maintenance of approaches beyond Railway limit is to be done by state Government.

2. Out of the total cost of about ` 2.30 crores, major works involved in the construction are panel retaining wall & galvanised 'W' beam crash barrier.