Rehabilitation and testing of a road bridge

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The paper describes rehabilitation of a highway bridge replacing the collapsed steel truss superstructure by a T-beam and slab over the existing piers and abutments. A load test is conducted to check the strength of old substructure as the increase in the load is about 56 percent on each pier due to increased carriageway width. This rehabilitation saved cone siderable time and cost. A brief review of the rehabilitation and testing works is presented.

A road bridge with a clear carriageway of 5.5m was constructed a few decades ago at Veeraghattam in Srikakulam district of Andhra Pradesh. It had 6 spans of approximately 20m each, making a total length of 120m. Each span was separately simply supported using steel trussesand reinforced concrete (RC) deck slab. The substructure consisted of stone masonry piers over well foundations.

Recently, due to ravages of nature and weathering, the superstructure collapsed leaving the piers and abutments in sound condition. After a preliminary investigation, it was decided to make use of the piers and abutments for supporting the new superstructure in view of economy and reduced time of construction, the latter being more important. A simple rehabilitation scheme having the same carriageway width and trussed superstructure over old piers was found insufficient to the needs of increased traffic density. As such, it was thought fit to construct a T-beam and slab superstructure with an increased carriageway width of 7.5m over the existing piers. The rehabilitation and renovation of the bridge has all the advantages of reduced cost, reduction in construction time and catering to the present-day higher traffic densities. But, as the dead weight of the superstructure has increased substantially and as the foundation data are not available, it is thought appropriate to load test one span and limit the maximum weight of vehicle that can be allowed on the bridge. Accordingly, the very first span (where there was no water) was load tested and found to be safe for 70R tracked vehicle loading.

Renovation and testing of the bridge

The bridge at Veeraghattam has been renovated by constructing a deck slab over three T-beams interconnected by three diaphragms. The weight of trusses per span of old bridge and 25-cm thick RC deck slab with a 70R live road is estimated to be about 205t so that each pier gets a load of 205t. The new superstructure has consumed a total concrete of 100m 3 weighing 250t and the total load per pier with 70R load works out to be 320t. Hence, after renovation, the piers have to carry 56 percent extra load.

Hence, it was proposed to conduct a load test on one span next to the abutment. Stresses in pier and bearing pressures have been calculated and found to be as follows :

Dimension of pier	=	1.8 x 8 m
Area	=	$14.4\ m^2$
Load	=	320 t

Bearing stress on masonry = $\frac{320}{144}$ = $22.2 t/m^2$ and is less than the permissible value of 25 t/m^2 for coursed rubble masonry. Hence, the masonry is safe. The total bearing pressure at foundation is calculated to be 13.9 t/m^2 which is less than the safe bearing pressure of 15 t/m^2 of the soil.

Experimental verification for deflections

Six points were chosen for measurement of deflection. Two points 1A and 1B were chosen on the pier top, below the extreme girders and were intended to measure horizontal displacement in the column due to the eccentricity of the load

Table 1. Deflections and settlement

Tztne of observation	Dial gauge readings in mm						Level reading	Load (tonnes)
	For horizontal deflections of pier		For verticle deflection under load		For maximum deflection at mid span			
	1A	1B	2A	2B	3A	3B		
12.30 PM	6.08	2.98	20.91	3.90	3.00	1.00	1.410	0
1.45 PM	6.30	3.05	20.88	3.76	2.75	0.73	1.410	4.825
310 PM	6.81	3.30	stuck and did not work	3.80	2.64	0.62	1.415	18.90
5.00 PM	7.07	3.57	2.00	3.87	2.72	0.82	1.415	27.87
6.00 PM	7.12	3.80	2.23	4.17	3.50	1.43	1.410	39.07
7.00 PM	7.14	3.93	2.28	4.19	3.52	1.48	1.410	63.00
8.00 PM	7.18	4.04	2.30	4.22	3.57	1.58	1.410	84.00

applied in one span near the pier. Two more points 2A and 2B were chosen exactly under the middle point of load application under the extreme girders. Last two points, 3A and 3B were chosen at mid span points of the extreme girders.

At all the above points, glass plates were fixed with araldite and Baty dial gauges with magnetic base were fixed to measure horizontal deflections at 1A, 1B and vertical deflections at 2A, 2B, 3A and 3B. The least count of the dial gauges was 0.01 min. All these dial gauges were supported on timber posts with struts on all the sides. Over the top of timber posts, M.S. plates were fixed and the dial gauges were fixed magnetically to the plates and tips were touching the glass plates with some initial reading. To measure the vertical settlement of the pier, a levelling staff was fixed at bottom of pier and level readings were taken using Dumpy level arranged 30m away in a shade. Dial gauge was not used because the nearby soil may also sink and the relative settlement read by dial gauge may be zero, eventhough the pier settles actually. The dial gauge readings and level readings are tabulated in Table 1.

For loading purposes, two tracks were made with wood (840 mm x 4570 mm) with a gap in between such that the total width is 2900mm. A wooden platform was arranged with overhangs such that the total load on the platform is transmitted through the two tracks to the deck slab. Moist sand bags were arranged on the outersides and sand was poured inside. On an average, each bag weighed 51 kg and the density of moist sand was 1.9 kg/m^3. The density of wood was calculated to be 0.9 kg/m^3. The track load is arranged near the pier.

From the readings of the dial gauges shown in Table 1, the following maximum deflections and settlements have been computed :

Maximum horizontal deflection of the tip of pier from 1 A

$$\text{And } 1B = \frac{1.10 + 1.06}{2} = 1.08 \text{ mm}$$

Deflection at mid span is obtained from dial gauges 3A and 3B.

3A = 2.64 - 3.57 = 0.93 mm

3B = 0.62 - 1.58 = 0.86 min

Average maximum deflection is 0.895 mm.

Deflection under load is 0.46 mm (4.22 - 3.76), obtained from one dial gauge 2B.

Maximum settlement of pier = 1.415 - 1.41 = 0.005 mm

Maximum load placed on the bridge span = 84.0 t.

The deflections were initially negative because of differential temperatureand hence the total deflectionsareconsidered.

All the deflections are within the permissible values and there is no settlement of pier. Each span can be safely loaded to a maximum of 84t. The bridge is now open for traffic, allowing heavy vehicles. The main advantage of this renovation technique is considerable reduction of construction time which saved inconvenience to traffic both in respect of fuel and time of travel.

Conclusion

1. Renovation and rehabilitation work depends upon each situation and one has to assess the strength of the parts that can be used fruitfully for reducing the cost and economising time.

2. Simple restoration of a structure collapsed as a result of natural disaster is not ideal. With prior planningand taking into consideration thefuture needs it is possible to increase the carriageway width which is more useful in the long range.

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