Comparative Study of Bonded & Unbonded Post-Tensioning T-Beams In Building

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Abstract- *The report examines in detail the application of segmental precast T-Beam construction in achieving long spans in bridge structures. Numerous examples from throughout the world indicate that such construction can provide an effective means of achieving long span in the range of to . Used segmental pre-cast bridge structure member is manufactured in a number of short units which during erection are joined together, end to end, and post-tensioned to form the completed superstructure. Cantilever concrete T-Beam girder bridges composed of precast reinforced and pre-stressed concrete beams with a T- cross section and a cast-inplace top slab are frequently used for medium spans due to their competitiveness. The service of such bridges is very much influenced by their segmental construction, due to time-dependent materials behavior that makes it difficult to accurately predict the stresses, strains, and deflections. A 1:2 scale model of a two span cantilever bridge was tested in order to study its behavior during the construction process and under permanent loads. The analysis results were compared with analytical predictions obtained by means of a prototype model developed for the nonlinear and time-dependent analysis of segment ally erected, reinforced and prestressed concrete structures. Generally good agreement was obtained, showing the adequacy of the model to reproduce the structural design of the different elements in the post-tensioned pre-stressed bridge structure.*

I. INTRODUCTION

Post-tensioning is a technique of pre-loading the concrete in a manner which eliminate tees, or reduces, the tensile stresses that are included by the dead and live loads. Post tensioning is a method of strengthening concrete or other materials with high-strength steel strands, wires or bars. High strength steel ropes, called strands, are arranged to pass through the concrete. When the concrete has hardened, each set of strands is gripped in the jaws of a hydraulic jack and stretched to a pre-determined force. Then the strand is locked in a purpose-made device, called an anchorage, which has been cast in the concrete. The strand is thereafter held permanently by the anchorage.

The non-jacking end of the strand may be bonded in concrete, or it may be fitted with a pre- locked anchorage which has also been cast in the concrete.

The anchorage at the jacking end is called a live anchorage whereas the one at the non-jacking end is termed a dead anchorage. To allow the strand to stretch in the hardened concrete under the load applied by the jack, bond between the strand and concrete is prevented by a tube through which the strand passes. The tube, termed a duct or sheathing, may be metal or plastic pipe, or it may consist of a plastic extrusion molded directly on the rope. If extruded, the strand is injected with rust-inhibiting grease. After stressing, the sheathing, if not of the extruded kind, is grouted with cement mortar using a mechanical pump. The terms tendon and cable, are the general names for the high strength steel lengths used in post-tensioning – equivalent to reinforcement in reinforced concrete.

Post-tensioning application includes office and apartment buildings, parking structures, slabs- on-ground, bridges, sports stadiums, rock and soil anchors, and water-tanks. In many cases, post-tensioning allows construction that would otherwise be impossible due to either site constraints or architectural requirements. There are post-tensioning applications in almost all sectors of construction. In building construction, post-tensioning allows longer clear spans, thinner slabs, fewer beams and more slender elements. Thinner slabs mean less concrete is required. On the other hand it means a lower overall building height for the same floor-to-floor height. Post-tensioning can thus allow a significant reduction in building weight versus a conventional concrete building with the same number of floors.

Stronger concrete is usually required for pre-stressed than for reinforced work. Present practice in this country calls for 28 day cylinder strength of 28 to 55 Mpa of pre-stress concrete. While corresponding value for reinforced concrete is around 24 Mpa. Higher strength is necessary in pre-stressed concrete for several reasons. First in order to minimize their cost, commercial anchorage for pre-stressing steel are always designed on the basis of high-stre ngt h concrete. Experience has shown that 28 to 34 Mpa strength will generally work out to be the most economical mix for pre-stressed concrete. To attain strength in excess of 34 Mpa, it is necessary to use a water-cement ratio of not much more then 0.45 by weight.

II. MODELING AND ANALYSIS

Analys is of T-Be am:

The modeling of the long span beam in the structural analysis tool ADAPT-PT BUILDER. Analysis give the complete post-tensioned result bonded and unbonded system.

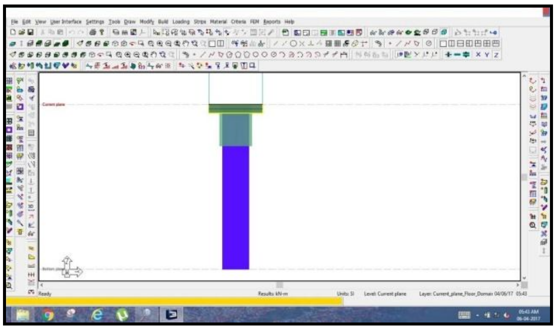

Figure: 1 Model view of long span T-beam in ADAPT-PT BUILDER

Following table shows the deflection in load span beam for different span length due to different conditions.

Table .1 Deflections in long span T-beam for Different Span Length

	Deflection (mm)			
Span(m)	Sustained load		Service load	
	Bonded	Unbonded	Bonded	Unbonded
10	0.27	0.5	0.1	0.08
12	0.91	0.66	1.68	1.43
14	3.5	3	4.71	4.22
16	7.71	7.2	9.97	8.9
18	13.4	12.87	17.1	16.3
20	22.1	20.43	27.5	26.35

Table shows deflection of the beam with different span for sustained load and service load. due to combination different value were obtained after analysis. Also deflection in bonded and unbonded beam deflection variation very nearer up to ratio 1-3%.

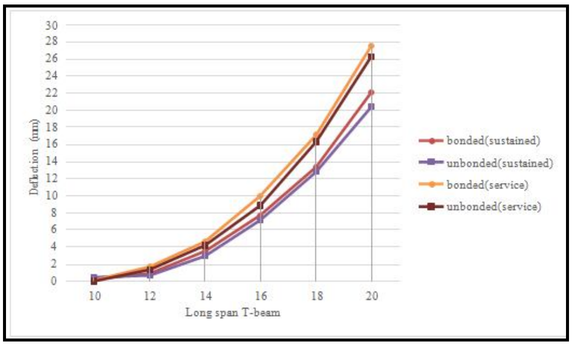

Figure: 2 long Span T-beam v/s Deflection

Table 2 Bending moment in long span T-beam for Different Span Length

	Bending Moment(KN.m)			
Span(m)	Sustained load		Service load	
	Bonded	Unbonded	Bonded	Unbonded
10	19.47	16.25	39.76	29.34
12	89.53	74.09	109.65	10709
14	195.67	178.97	261.24	295.14
16	335.3	318.68	423.49	407.39
18	452.58	434.74	563.22	545.39
20	567.44	551.42	693.79	677.74

Bending moment is change with span and also change its cable profile. Both system different in bending moment ratio 3-15%

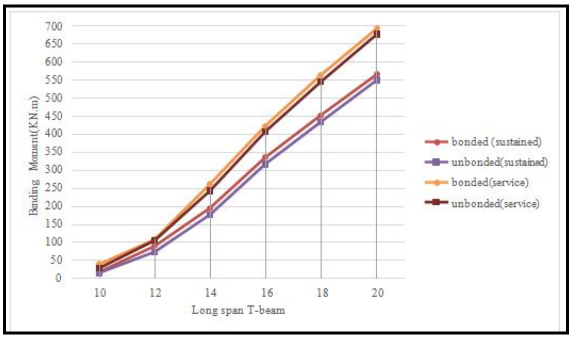

Figure: 3 long Span T-beam v/s Bending moment

Bending moment show in figure the value bonded and unbonded increase with span and also nearer value. The long span beam applying load is same but bending moment is variance due to span different

Table 3 Shear force in long span T-beam for Different Span Length

	Shear Force (KN)			
Span(m)	Sustained load		Service load	
	Bonded	Unbonded	Bonded	Unbonded
10	60.1	54.98	75	71.17
12	94.9	87.53	113	107.69
14	125.2	117.77	146	140.96
16	150	143.68	175	170.36
18	171	165.89	200	170.36
20	194	186	215	221.13

Table shows Sheer force of the beam with different span of sustained load and service load. due to combination different value were obtained after analysis.

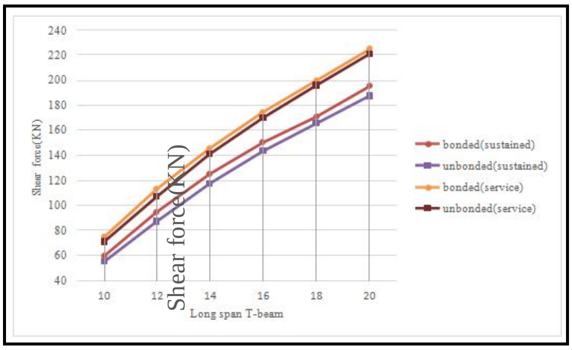

Figure: 4 long Span T-beam v/s Shear Force

For Sheer force graph bonded and unbonded post-tensioning is increase due to span and both system difference ratio due to 1-6%.

Table 4 Top stress in long span T-beam for Different Span Length

	Top stress(N/mm2)			
Span(m)	Sustained load		Service load	
	Bonded	Unbonded	Bonded	Unbonded
10	1.92	1.47	2.19	2.04
12	3.27	3.03	3.99	3.75
14	4.26	4.05	5.13	4.91
16	6	5.76	7.17	6.95
18	7.67	7.43	9.12	8.88
20	9.16	8.95	10.88	10.6

There is variation up to 1 to 5%. Top stress is effect on compression member beam. That effect creates crack in beam. But not higher than the 15(N/mm2) as per code.

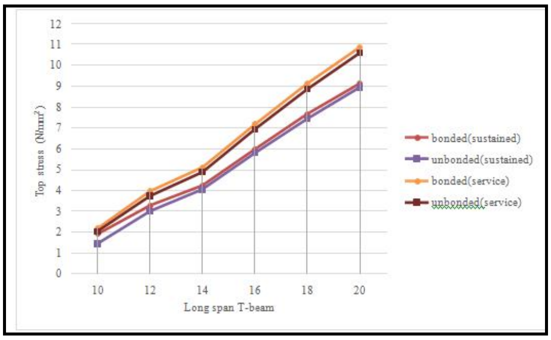

Figure: 5 long Span T-beam v/s Top stress

Top stress in bonded and unbonded long span beam value suitable base on code. Suitable value is lower that kind of minimum value is consider

Table 5 Bottom stress in long span T-beam for Different Span Length

	Bottom stress(N/mm2)			
Span(m)	Sustained load		Service load	
	Bonded	Unbonded	Bonded	Unbonded
10	-1.7	-1.96	-1.04	-1.14
12	0.09	-0.37	0.72	0.45
14	1.37	1.12	2.41	2.17
16	3.68	3.42	5.08	4.82
18	5.4	5.12	7.15	6.87
20	7.22	6.97	9.22	8.97

There is variation up to 1 to 4%. Bottom stress value consider base on (IS: 1343-1980,22.7,22.8) serviceability crate area is given. That Type-1,2,3 design create area for unfrocking section

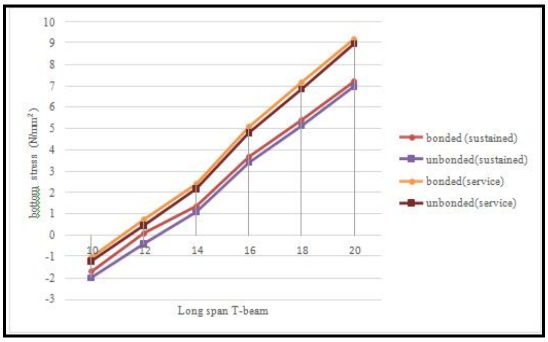

Figure: 6 long Span T-beam v/s Bottom stress

III. CONCLUSIONS

1. For 5 to 20m span unbonded beam is better and for over 20m span bonded beam shows good results.

2. From the table it is observed that there is 5 to 25 % reduction in depth of unbonded beam in comparison with bonded beam.
3. There is 2 to 5 % reduction in bottom stresses of unbonded beam in comparison with bonded beam.
4. Also the long term stress generated is more in case of bonded beam and base on case study bonded anchoring is complicated compare to unbonded system.

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