Bridges in Mangalore-Udupi-Bhatkal section

N.S. Nampoothiry and S. Balakrishna

There are 29 major bridges and 71 grade separators on the Konican Railway alignment between Bhatkal to Mangalore. While the bridges in the Udupi-Mangalore section are already completed, those in the Bhatkal-Udupi section are in the advance stage of construction. The article highlights the broad construction features of the major bridges in these sections.

In Karnataka, the alignment of the Konkan Railway passes through Dakshinkannada and Uttara Kannada districts. Two sections viz., Mangalore to Udupi (70 km) and Udupi to Bhatkal (72 km) are in the Dakshinakannada district. The section from Mangalore to Udupi was completed in a period of 30 months and opened to traffic in March 1993. Works in Udupi-Bhatkal section are also in an advanced stage of construction. This paper describes the details of the major bridges in the above two sections.

There are 29 major bridges and 71 grade separators in these sections as indicated in Table 1. The total estimated cost of these bridge works is about Rs 56.49 crores.

A majority of these major bridges is having a standardised span arrangement (mainly 22.8-m length). At nine bridge locations pre-tensioned girders have been used, whereas posttensioned girders have been adopted at 10 locations. The girder sections used are standardised by Konkan Railway for similar spans. (For more details, please refer an article "Major bridges on Konkan Railway : Approach to design and standardisation" included elsewhere in this issue.)

Among the bridges the works at Halladi I and II, Sesetha and Madisala are worth mentioning for their special launching scheme. The railway alignment crosses the river Halladi almost parallel to the NH-17 crossing. However, due to the presence of an island, the bridge is split into two as Halladi I (21 spans of 22.8m) and Halladi 11 (10 spans of 22.8 m). Post tensioned girders are used for these two bridges. The girders were cast in a casting yard set up at the Bombay end of Halladi II and at Mangalore end of Halladi I.

Launching at Halladi

In view of the tight time frame for completion of the work, the entire superstructure work was completed in less than a year. The launching arrangement adopted was such that it facilitated speedy erection, safety and also economy in the overall construction.

In both the bridges, advantage of the land span on the shore was taken with very little bunding work. The launching arrangement was independent of the earthwork in approach bank and all the operations were from top, using end-on launching method.

The girders from the stacking bed (at the natural ground level) were moved using rollers, placed on channel guide to the land span portion. The girders are brought into position parallel to land span on the ground. Lifting of all girders are done using the stationary gantry in the land span (first span).

Table 1. Bridges in Mangalore-Bhatkal section

	Mangalore - Udupi section	Udupi-Bhatical section	Total in Mangalore -Bhatkai section (O.K. district)	Total cost Rs crores
Major bridges	6	23	29	32.47
Minor bridges	127	163	290	13.55
Road under bridge	5	16	21	2.50
Road over bridge	22	28	50	7.97
Total	160	230	390	56.49

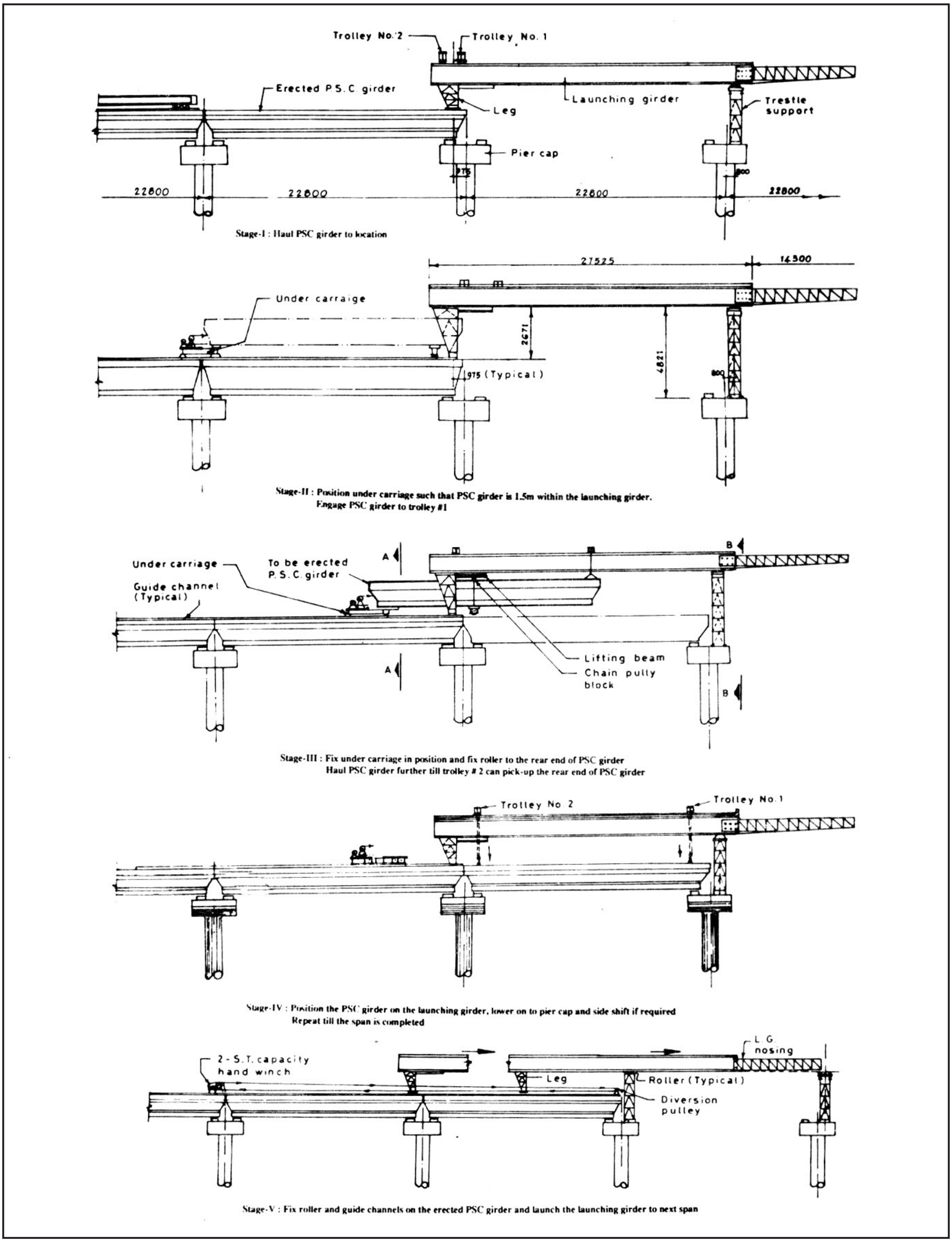

Figure 1. Sequence of launching operations for girders

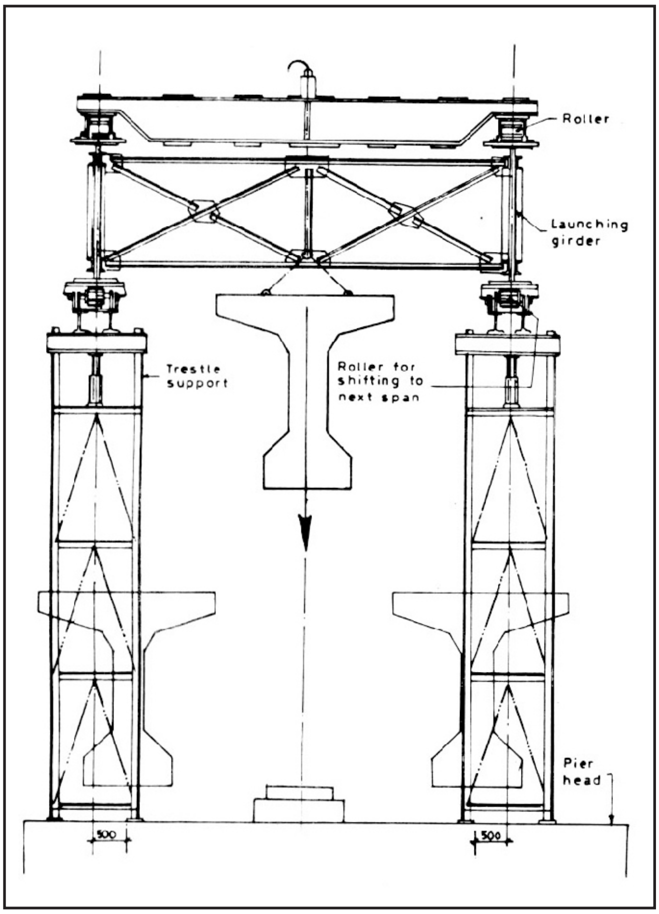

Figure 2. Girder launching arrangement

The stage by stage operations are described below. Figures 1 and 2 show the sequence of launching.

1. *Launching of first span* : Using stationary gantry the PSC girders are lifted one by one and placed in position. The lowering is done in the middle and then PSC girder is side shifted.

2. The launching girder is assembled and erected in the second span (As in Stage-I). The rear end of the launching girder rests on the already launched girders of first span.

3. Second span PSC girder are lifted using stationery gantry and placed over the already-launched first span.

4. The girder is placed over an under carriage moving on a trolly path moved using the winch.

5. The front trolly (Trolly No. 1) of the launching girder grabs the front end of the PSC girders. The front trolley moves over launching girder with PSC girder hooked to the trolley. The rear end of PSC girder will be dragged on the under carriage.

6. *Stage-III :* The rear trolley (Trolley No. 2) picks up the PSC girder and the girder is dragged to position.

Table 2. Pretensioning details

Type of girder	I	II	III
No. of strands	50	62	62
Length of strand	21.4 m	21.4 m	21.4 m
Pre-tensioning force	673.4 t	820 t	820t
Elongation (maximum)	14.7 cm + 5 percent	14.7cm + 5 percent	14.7 cm + 5 percent
Debonding length	4 cables-4.15 m 8 cables-1.15 m	4 cables-7.15 m 12 cables-1.115 m	4 cables-7.15 m 12 cables-2.15 m
Upward deflection (maximum) of girder after transferring the load to the girder	10 mm	20 mm	20 mm

7. The girders are launched in the middle and then side shifted.

8. *Moving the launching girder to next span :* Trestle support is placed on the next pier. Rollers are placed on the trestle supports. Rear leg which is temporarily fixed on the launched span is released. The launching girder is moved forward using winch.

9. Further span-by-span operations are continued as mentioned above. On an average each span (three girders) was taking one week for launching and a monthly progress of four spans was achieved.

Advanced technologies have been adopted and a number of innovations are made for the quick and speedy execution as well as to ensure safety and durability of these bridges which are close to the sea coast.

Pre-tensioned girders

Pretensioning technique was adopted by the contractor for prestressing the precast girders which were steam-cured to speed up the construction. The 3-girder system is connected by end diaphragms and the cast-in-situ portion of slab between flanges of adjacent girders.

High tensile steel (H.T.S.) strands are used for prestressing. These are stressed against the end bearing structure in the trough unit. Stressing is done with single strand stressing system - Tensacci, Italy. Breaking load of each strand is 18.738 tonnes. These are stressed to 13.2 tonnes.

The superstructure consists of three 'T' girders connected together by in-situ diaphragms, and wearing coat. H.T.S. strands consisting of 12.5 mm strands were cut to required length, washed with soap water to remove oil and were epoxy painted over the debonding length before introducing in the cage.

The mixing of concrete is done in an ELBA batching plant and concrete is pumped into the mould. Concreting of one girder takes about three hours. 18 numbers of plate vibrators are fixed to the steel shuttering and two needle vibrators of 60mm diameter are also used for proper compaction of the concrete. The quantity of concrete required for one girder is 27 m^3.

Out of 60 test cubes taken, 30 cubes are cured in normal water curing and 30 cubes are cured by steam curing. When the concrete attained a minimum strength of 400 kg/cm^2 (after about 30 hours with steam curing) the force was passed on to the girder by releasing the end jacks.

Steam curing

Atmospheric steam curing was adopted to accelerate the gain of strength of concrete products. After concreting the beam, it was covered with multiple layers of wet gunny bags in order to prevent the evaporation of bleeding water from the surface of the concrete. After initial set of about five to six hours, depending upon the atmospheric temperature, curing was done by covering the top of concrete with hessian cloth and spraying water to keep the concrete temperature around 30°C. This prestreaming curing was continued for four hours. The trough was then closed with steel covers and steam was allowed to pass slowly. The temperature on the 12 thermometers fitted on either side of trough and on the top were noted. The rise of the temperature inside the trough was controlled at 10 to 12°C per hour. The steam curing temperature inside the trough was maintained 60°C to 65°C for nine hours. After the completion of steam curing the temperature inside the trough was brought down to normal at a rate of 10°C/hour (equal to outside temperature).

Permeability test

Permeability tests are carried out on standard test cylinders as per German specification DIN: 1048. Cylindrical spedmens, 200 mm diameter and 120-mm high are prepared and after normal curing for 28 days, these cylinders are subjected to permeability test in special testing machines. Cylinders are fixed in the machine and water under pressure is applied from bottom as given below :

1 kg/cm^2 for 48 hours

3 kg/cm^2 for 24 hours

7 kg/cm^2 for 24 hours

Specimen is broken and water penetration depth is measured. As per DIN specifications, the depth of penetration of water should not exceed 25 mm for PSC works.

In addition to the various tests done for the materials used for concreting, such as sand, metal, water, cement, etc. total chloride and sulphate contents are also tested. As per IS: 1343, the permissible limit of total chloride content is 0.06 percent. In some of the tests conducted, the chloride content was as low as 0.00009 percent. This was due to exceptionally good care taken for materials including water at the time of concreting.

Special care was taken to ensure sufficient cover for all the concrete. The minimum cover of 50 mm was provided. Galvanised binding wires were used for binding reinforcement steel.

Conclusion

1. With the proper selection and testing of various materials and close supervision at site, very high quality of concrete of the required strength and durability is achieved.

2. With the adoption of steam curing for prestressed concrete girders the construction activities were speeded up.

3. By adopting special process of treatment for the reinforcement rods, the durability of the structure is ensured as the structures are located very close to the sea with highly corrosive atmosphere.

4. By careful planning, optimal design, cost effective construction methods and speedy execution, maximum economy is achieved.

N.S. Nampoothiry, Chief Engineer, Konkan Railway Corporation Ltd., Udupi.

S. Balakrishna, Dy. Chief Engineer, Konkan Railway Corporation Ltd., Kundapura

(Source: ICJ December 1993, Vol. 67, No. 12, pp. 645-648)