Enz-viaduct: a 1044 m long prestressed concrete box girder bridge

Enz-Viaduct: a 1044 m Long Prestressed Concrete Box Girder Bridge

Viaduc de l'Enz: un pont en poutre-caisson en béton précontraint

Enztalbrücke: eine 1044 m lange Spannbeton-Hohlkastenbrücke

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DESIGN

The New Railroad Line from Mannheim to Stuttgart crosses the valley of the river Enz about 25 km before Stuttgart. This is the longest viaduct on this new line. It consists of 18 spans of 58 m each, that means a bridge length of 1044 m. The maximum height of the rails above the valley is 47 m.
The bridge is straight on its total length in plan view. The gradient has a change of longitudinal inclination from -0.15 % to +1.2434 %. The radius of the sag-curvature is 60,000 m. This curvature comprises half of the bridge length and is so flat that it can hardly be recognized in the elevation view.
The "General Design" for viaducts of the New Railroad Lines provides for simple supported box girders with a distance of the piers of 44 m. In order not to impair the free view through the scenic valley, the distance between piers has been chosen with 58 m. Additional aesthetical advantages are obtained from the choice of a continuous girder. With a depth of 4.75 m only (compared to 5.3o m required for a simple supported girder) the structure can be designed more slender (piers 3.o m wide instead of 3.5 m).

The total length of the box girder of 1044 m is devided into three equal parts of 348 m each (6 spans of 58 m). Should it ever be necessary, the bridge can be replaced in parts of 348 m in length. A new 348 m long bridge would be built on auxiliary piers aside of the old bridge. By lateral shifting, the old bridge could be replaced by the new one within a few days. The three parts are connected by longitudinal couplers at the piers No.6 and 12 (see poster).
The horizontal forces from braking and accelerating of the trains are transmitted to the abutments (axis 0 and 18). There, the forces are carried onto the ground via hydraulic dampers. The dampers follow slow changes in the width of the rail expansion joints from temperature changes. The dampers react as stiff members in case of the occurance of sudden forces. The bridge is fixed to the piers Nos.7 through 11. This group of five piers holds the bridge in position even if braking should occur many times to the same direction. The group of fixed piers is also able to take the whole braking force, should the hydraulic dampers ever fail.

CONSTRUCTION

The bridge has been built by the incremental launching method on its total length of 1044 m, straight, also in elevation view. Half of its length has been bent into the radius of 60,000 m during launching. Additional prestressing has been provided for these additional moments of constraint.
During launching the three continuous girders have been fixed together to one continuous box girder. After launching the bending stiffness has been released above piers Nos.6 and 12.

The envelopes of the bending moments show maximum moments near the front end of the girder during launching (see poster). The auxiliary steel launching nose has been 36 m long. The length of a casting element was 29 m, that means half a span length. The trough has been cast on Wednesday, the deck slab on Friday, prestressing and launching has been done on Monday, for a mid span element. The pier elements required two weeks of construction time.
The fabrication plant behind the abutment consisted of three parts of 29 m length each:
a) preassembly of reinforcement and tendons,
b) casting chamber with movable roof and
c) curing chamber with heating in winter.
The concrete cover has been measured by magnetic devices (Proceq Profometer) immediately after removal of formwork. About 40,000 measurements have been made. Also cracks in the concrete have been carefully searched. Improvements in the reinforcement (and in its fixing in the formwork) have been made as a result of the careful inspection during construction works.

ACKNOWLEDGEMENT

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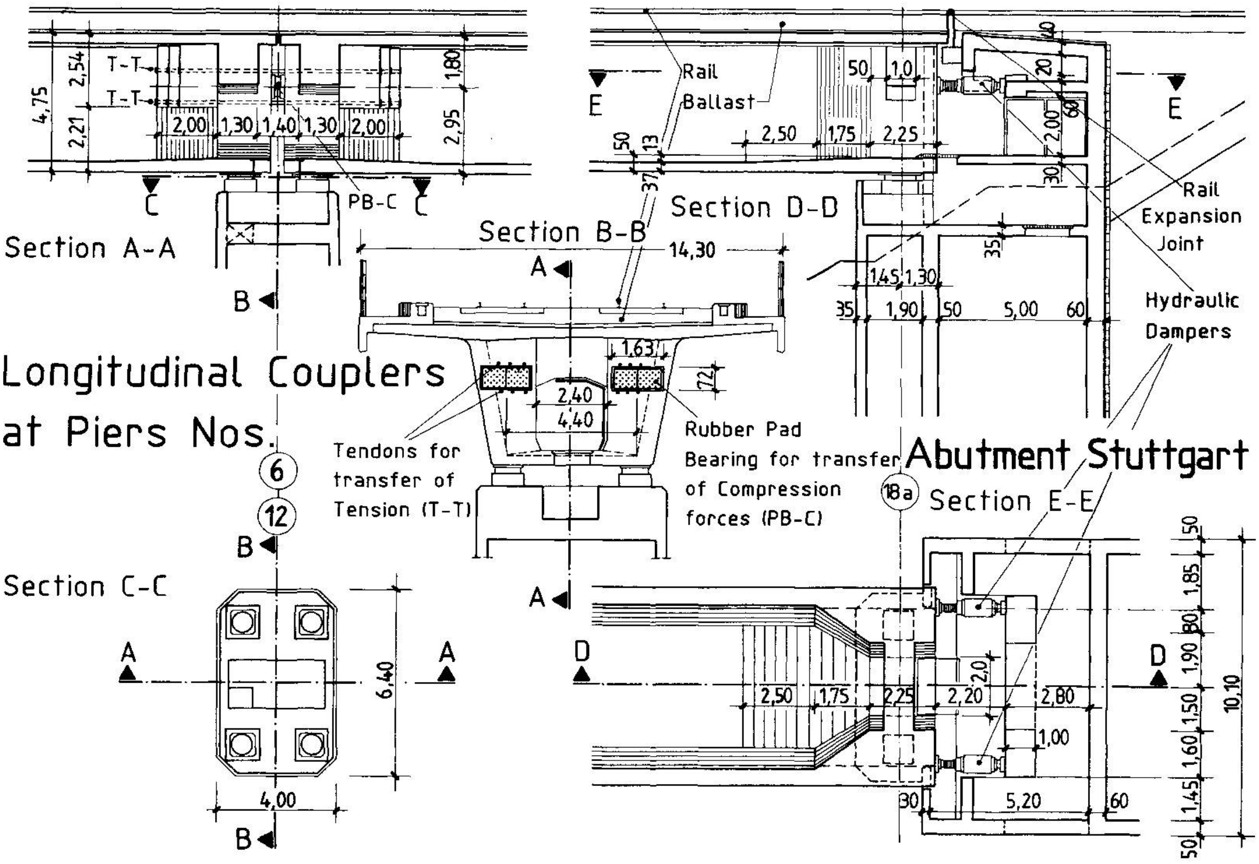

Enz-Viaduct: Coupling devices, hydraulic dampers and rail expansion joint