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Unusual Applications of the Incremental Launching Method

Applications atypiques de la méthode de construction par encorbellement

Anwendung des Taktschiebeverfahrens in untypischen Fällen

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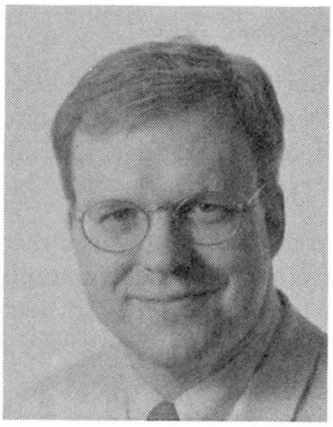

Manfred Curbach, born 1956, studied at the University of Dortmund, was a recipient of a fellowship at the University of Princeton and obtained his Doctor's degree at the University of Karlsruhe. Since 1988 he has worked in Nürnberg at Köhler + Seitz, mainly engaged with the design of bridges.

SUMMARY

The incremental launching method has become one of the most succesful bridge building methods. It has undergone a number of improvements which have led to an increase of flexibility in design and visual appearance. Three examples are used to show how old boundary conditions for the application of the incremental launching method were surmounted.

RESUME

La méthode de construction par encorbellement est devenue un des procédés ayant actuellement le plus de succès pour la construction des ponts. La méthode a été sans cesse améliorée, de sorte que la flexibilité à l'égard de la construction et de la forme s'est agrandie. Trois exemples montrent comment la méthode de construction par encorbellement a pu surmonter d'anciennes conditions aux limites.

ZUSAMMENFASSUNG

Das Taktschiebeverfahren ist eines der erfolgreichsten Verfahren für den Bau von Brücken geworden. In der Zeit seiner Anwendung hat es zahlreiche Verbesserungen erfahren, die zu einer Vergrösserung der Flexibilität hinsichtlich Konstruktion und Form geführt haben. Anhand von drei Beispielen wird gezeigt, wie alte Randbedingungen für die Anwendung des Taktschiebeverfahrens überwunden worden sind.

1. INTRODUCTION

A number of different construction methods has been used in the long history of bridge building. Some of these methods appear to be very successful, leading to greater variability in design as further development occurs. One of these successful methods is the incremental launching method. This paper describes how old boundary conditions used for the application of the incremental launching method were surmounted with the aim of obtaining more flexibility in design and an improved visual appearance.

2. OLD BOUNDARY CONDITIONS

It is not possible to describe in this section all of the boundary conditions which are or have been valid for the application of the incremental launching method. Only some of the main conditions will be mentioned here.

A constant spatial curvature is a basic requirement for the application of the incremental launching method. Proposals have been made to line a noncircular superstructure such as a haunched girder with either wood construction or precast elements in order to obtain the necessary constant curvature. However, this aspect will not be discussed in this paper.

The structural system of the bridge should consist of a continuous girder so that it is possible to launch it through a continuously changing static system. This seems to be no problem since the incremental launching method becomes economic once a specific minimum number of segments are built and, hence, is usually only valid for long systems. That exceptions are possible, and that a series of single span girders is launchable, will be shown later.

The distance between the outside face of the webs is also required to remain constant over the length of the bridge. Differences in the width of the road, as for example, for an additional lane, were realized using different spans for the cantilever of the box girder.

A considerable number of incrementally launched bridges can be identified by a vertical part of the web in the bottom region. This depends on the construction of the lateral guide used during launching. The relevant part of the superstructure has to be vertical because the guide part of the steel launching nose is always vertical and the lateral guides on the columns are mostly not variable for different inclinations.

Many details have been improved in the past in order to surmount these boundary conditions. These improvements will be explained using some examples which have shown the applicability of the details used.

3. SINNTAL BRIDGE SCHAIPPACH

A great number of new bridges were needed for the new high speed railway line of the German Federal Railway. For this project the owner prefered — if possible — single span systems even when normally continuous girders were realizable because of the the following advantages [1,2]:

— no forces due to constraints
— insensitive to settlements
— replacement of individual structural members are possible.

The Sinntal Bridge Schaippach, built between 1980 - 1983, was constructed with single span girders over 10 spans as shown in Fig. 1. All of the single span girders were first stressed together using 24 strands, for details see Fig. 2, in order to be able to launch 9 of the 10 spans with the same height. This produced a continuous girder which was able to be easily launched. After the first segment had reached its planned position, the strands between the first and second segment were released and the remaining superstructure was launched backwards 60 cm using jacks at the former coupling joint to obtain the necessary distance between the single girders. The procedure was repeated between segments 2 and 3 after reaching the final position of segment 2: that is, releasing of the strands and backwards launching of the remaining part. This process was repeated until the last segment was in place.

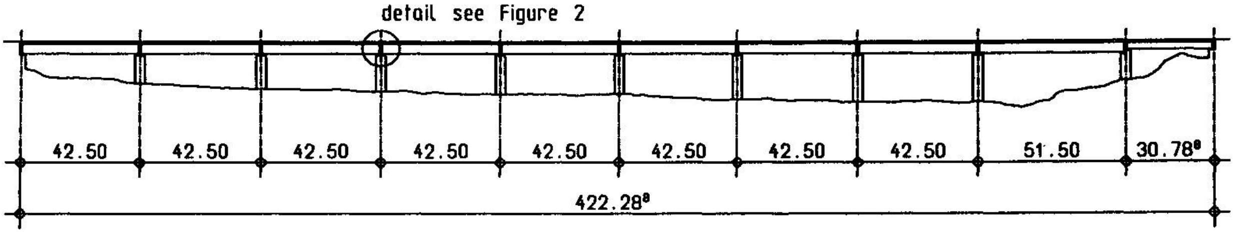

Figure 1. Elevation of structure of Sinntal Bridge Schaippach

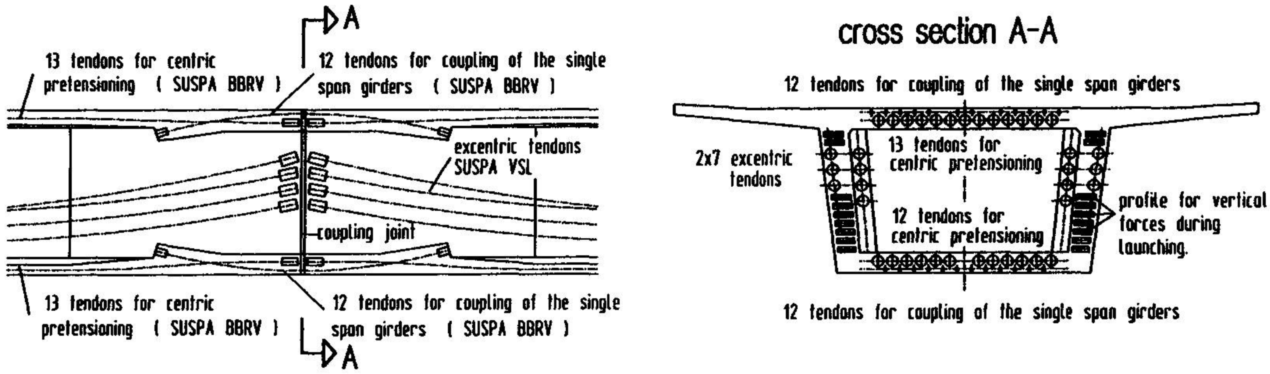

Figure 2. Coupling joint of the single span girders, longitudinal section and cross section

Owner:	German Federal Railway DB
Consultant, Alternative design:	Köhler + Seitz, Nürnberg
Building Contractor:	Adam Hörnig GmbH & Co , Aschaffenburg
Check Engineer:	Prof. Dr.-Ing. Herbert Kupfer, München

4. DANUBE BRIDGE FISCHERDORF

A bridge having a length of about 660 m was built over the river Danube to connect the Federal Highway between München and Deggendorf. As can be seen from Fig. 3 the bridge consists of two x two approach bridges, each with 5 spans of 55.5 m, and a composite arch bridge in the middle part.

The four approach bridges were built using the incremental launching method. Temporary piers were necessary because the height of the box girder which was only 2.36 m. In order to reduce building costs, temporary piers were built only in one longitudinal axis, so that

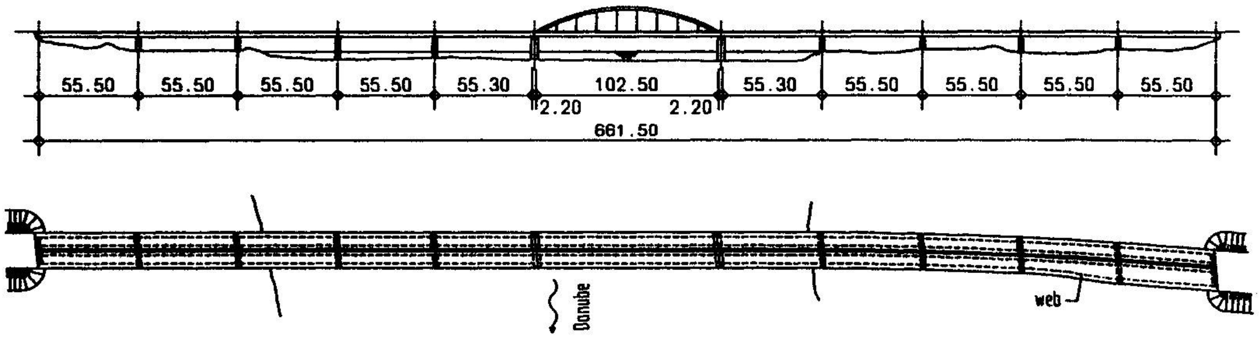

Figure 3. Elevation and plan view of structure of Danube Bridge Fischerdorf

the first of the adjacent superstructures was launched in the longitudinal axis of the second one, and then launched in the lateral direction to its final position. This method has been applied successful at the bridge over the river Danube near Wörth [3]. The second approach bridge was then launched in its own axis.

It was necessary to widen the road by about 3.75 m for one of the four superstructures. This distance was to large to achieve by varying the width of the cantilever, and the box girder itself had to be changed. The box girder was widened within two segments from a width of 5.0 m to 8.2 m using two parabolas. This resulted not only in a change to the formwork in the casting yard, but also to all of the launching blocks which had to be wide enough to accomodate this range of widening. During launching in the longitudinal direction one has to remember that sliding also occurs in the lateral direction.

The only requirement for the launching blocks which were placed on permanent columns having only sliding plates was that the sliding plates had to be placed under the web with a distance of about 10 cm from the outer edge of the bottom slab.

In each temporary pier axis the superstructure was supported on hydraulic jacks to reduce forces and moments from building inaccuracies of the superstructure, which can not be excluded completely. Any deviation from the theoretical line does not result in a vertical displacement of the superstructure because these jacks are force-controlled. Hence, bending moments in the superstructure only at the permanent columns will result from inaccuracies of the superstructure. This method of support leads to a reduction of restraint bending moments by about 75 %, which in turn leads to a reduction of the necessary central prestressing.

Sliding surfaces were built on the temporary piers in the direction of the widening because it was necessary to slide the support jacks. In each sliding track a jack could be moved according to the launching and widening requirements of the superstructure. One jack could always be moved while the other supported the structure. Launching in the longitudinal direction could only occur when the main 4000 kN-jack with the sliding bearing is in action, as shown in Fig. 4.

A similar situation exists for the launching equipment on the abutment as shown in Fig. 5. Both the shifting cylinder and lifting cylinder have to be moved. A lateral sliding track was built under the lifting cylinder and a lateral cast-in place fixing rail was used to fix the set of jacks during backwards movement of the lifting cylinder. For each launching increment of the superstructure in the longitudinal direction the whole set of jacks was moved lateral, into the new position at an optimal location under the web.

The braking block was built with a width of 4.0 m so that a support was always possible during the widening of the box girder. A corrugated steel plate was built onto the braking

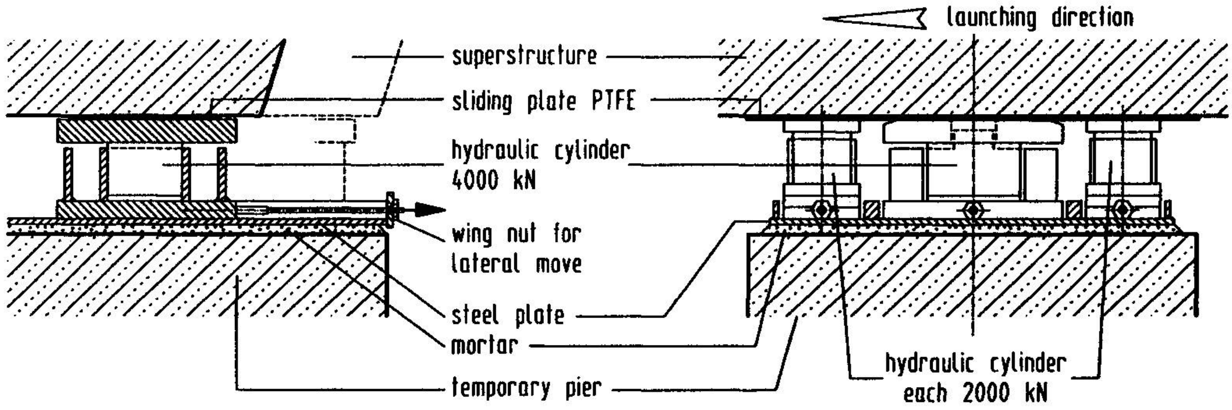

Figure 4. Launching bearing on a temporary pier

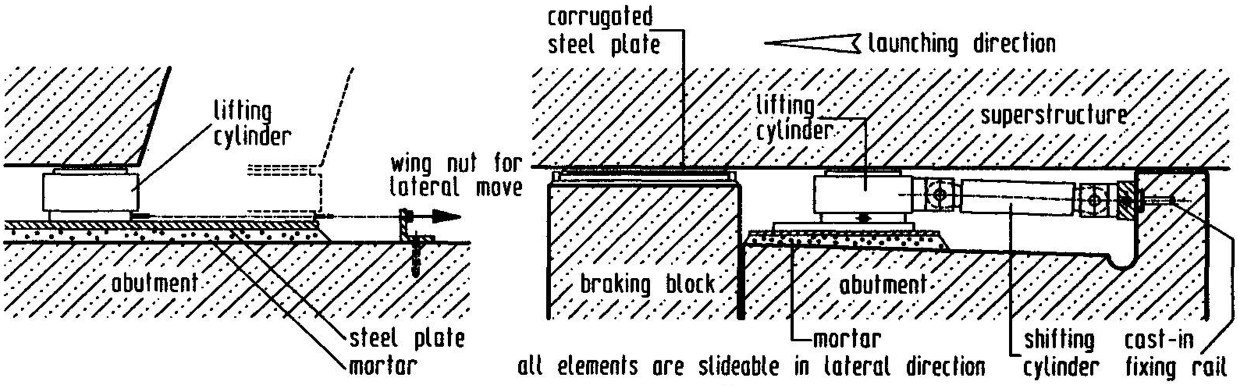

Figure 5. Launching jacks for shifting and lifting on the abutment

block to carry horizontal loads such as those due to temperature changes. During widening this corrugated steel plate was moved according to the web position while the superstructure was supported by the lifting jacks.

Owner:	Federal Republic of Germany
Consultant, Alternative design:	Köhler + Seitz, Nürnberg
Building Contractor:	Joint venture of Holzmann AG, München/ Bögl GmbH, Neumarkt/ Mayreder, Kraus & Co, Linz
Check Engineer:	Prof. Dr.-Ing. Kraus, München

5. MAIN BRIDGE RETZBACH-ZELLINGEN

A prestressed concrete bridge is presently under construction to replace an old truss bridge over the river Main between Retzbach and Zellingen near Würzburg. Fig. 6 shows that the spans increase from the Retzbach abutment towards the river and result in a 126 m-span able to give clearance for ship traffic. The height of the box girder also increases from the abutment towards the river because of both structural and aesthetical reasons.

Two regions concerning the height can be identified: the height increases monotonically from 2.19 m up to 3.09 m for the first six spans while, for the three river spans, the bottom of the box girder is described by parabolas, which leads to a height variation of the cross section between 3.09 m and 6.89 m over the two massive columns.

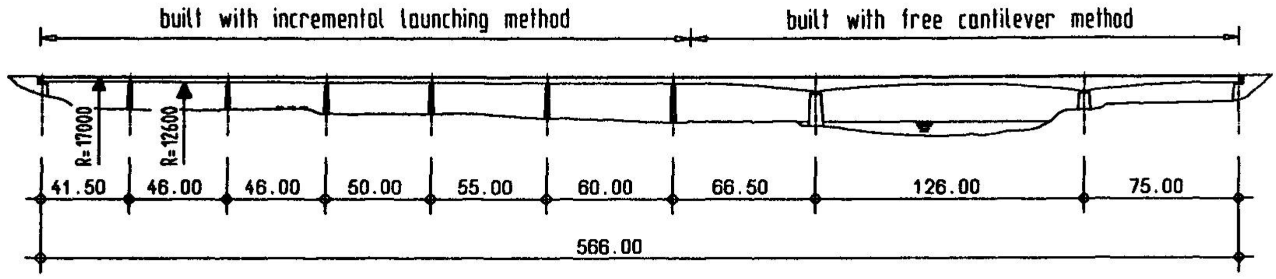

Figure 6. Elevation of structure of Main Bridge Retzbach-Zellingen (Retzbach abutment left)

While the three river spans are being built using the free cantilever method, which is not within the scope of this article, the first six spans with the variable height are being launched. This was made possible by choosing two different radii for the top and the bottom of the box girder. The central points of both circles are on one line going through the axis of the Retzbach abutment. That is, the tangents on both circles in the abutment are parallel with a distance of 2.19 m.

The bridge becomes launchable with the bottom of the box girder having a radius of R = 12 600 m while the radius at the top is R = 17 000 m. Hence, the distance between bottom and upper formwork has to be changed in each segment.

Owner:	Free State of Bavaria
Consultant:	Köhler + Seitz, Nürnberg
Building Contractor:	Adam Hörnig GmbH & Co , Aschaffenburg
Check Engineer:	Dr.-Ing. Helmut Kupfer, München

6. CONCLUSION

The incremental launching system is still an economic bridge building method. Old boundary conditions were surmounted by developing many new details, leading to the design and construction of launchable bridges which were more independent, less restricted and visually more appealing.

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