A FLYOVER FOR MAINTENANCE WORKS

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ABSTRACT

Temperature caused elongations dictate the use of expansion joints to bridge the gaps between sections of deck. Lazy tongue modular expansion joints, which had been installed for many years on bridges and were once considered state-of-the-art, have in the meantime become destroyed by wear and tear. Closing motorways to traffic during essential replacement works, however, would almost certainly entail excessive traffic jams and diversions unthinkable for any local authority. This circumstance gave salience to the idea of building a ramp allowing expansion joints to be replaced whilst at the same time avoiding traffic disruptions. The Waagner-Biro Flyover Ramp provides the unique alternative to closing major roadway networks and has proven vital in maintaining the steady flow of traffic during repair works.

Fig.1. The flyover ramp during its first installation in 2001

Fig.2. The exchange of an expansion joint underneath the ramp

1. INTRODUCTION

Expansion joints which are by virtue of their principal function a source of weakness need replacing and maintaining on a regular basis. The presence of wear and tear has taken a heavy

toll on the performance of expansion joints, in particular lazy tongue modular expansion joints, which after many decades in use have become partially deteriorated. Some of these joints have been knocked out or otherwise shown to fail prematurely. For instance, sealants and drainage membranes blocking the ingress of water have been torn out or become clogged up by gravel and pebbles (Fig. 5). Fatigue cracks have been shown to emerge on heavily trafficked sites. Poor detailing and higher than expected loads from increased traffic flows have concurred to affect the performance of expansion joints, specifically temperature induced movements. Maintenance work is thus duly required, in which case today's more common finger expansion joints are substituted for the obsolete lazy tongue joints. Bridge owners are, however, inclined to forego sizeable replacement and/or maintenance works and therefore only approve of makeshift repairs (Fig. 6), since the replacement of joints would inevitably entail closures of lanes and entire sections of motorways to traffic. The excessive diversions in the wake of such replacements would be unthinkable for most municipalities.

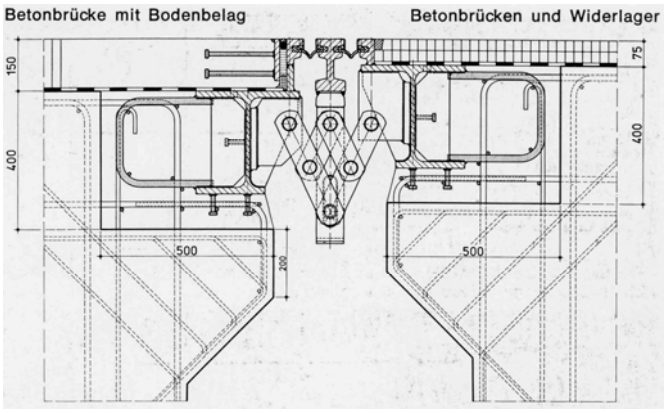

Fig.3. The rubber profiles and the small stones between the bearing rails [2]

Fig.4. The new finger expansion joint [1]

2. THE IDEA

The major urban motorway "Süd-Ost-Tangente" in Vienna is supported along a length of approximately 2.7 kilometres and in part 20 metres above ground by bridge structures carrying vehicular traffic across the river Danube up to the northernmost districts of Vienna. The motorway was initially designed for 30,000 vehicles a day travelling in each direction. Today, with an average of over 90,000 vehicles per day and trucks accounting for about 14%, the closure of even one lane of Europe's most heavily trafficked motorway would entail excessive traffic jams and diversions. Given that even accidents of a lesser magnitude can bring urban traffic to a standstill, repairing joints, let alone replacing them, can prove to be very costly once all the associated traffic regulation and delays are taken into account. The vulnerability of this motorway to repair works gave rise to the idea originated by the head of the Municipal Department of Bridge and Foundation Construction in Vienna[1], DI Hufnagel, who suggested that a ramp be built allowing expansion joints to be replaced underneath it

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whilst at the same time avoiding restriction of the flow of traffic and enhancing road safety: “The shortest diversion would be a ramp beneath which works can be carried out. The ramp must be erected in off-peak hours in the night and at least one lane out of three has to be kept open for flow of traffic during its assembly and disassembly.” This idea challenged and captivated alike Waagner-Biro Brückenbau engineering staff’s interest: The flyover ramp was born.[2]

Fig.5. The rubber profiles and the small stones blocking the sealants and membranes

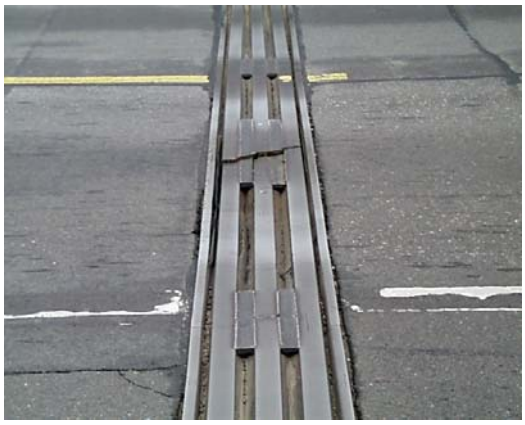

Fig.6. Makeshift repair of Expansion Joint

3. REQUIREMENTS

Simple though the idea may be, placing the flyover ramp on an existing bridge structure calls for a lot of requirements and limitations to be incorporated in the early design, the most important of which are listed as follows:

- Because the dead load of the flyover must be sustained by the bridge beneath it, it is essential that the flyover is made as light as possible.
- Just as important is rapid assembly and the need to minimise traffic restrictions during assembly.
- It is important that the flyover is able to accommodate temperature induced movements, either contractions or expansions, of the bridge underneath.
- The ramp has to be of sturdy and reliable construction. Road safety must be accommodated.
- A maximum slope of 5.5% to the road underneath has been proven to be vital in guaranteeing sufficient vision in spite of the ramp’s swell at mid length.
- Last but not least, sufficient space has to be provided beneath the bridge for the safe replacement of expansion joints and installation of the new ones. A 1.6 to 1.9 m high working area has been shown to be most effective in this respect.

[2] The technical term „*Flyover*“ refers to ramp and bridge constructions supporting traffic over roadways and motorways.

These requirements were subsequently adopted by our engineers in the early design yielding a prototype ramp, the development of which took from 1997 to 1999. The following features merit particular consideration:

- The modular ramp has been designed in such a way as to accommodate multiples of standardised deck and trestle elements and simple plug and bolt connections for quick assembly. The special profile of trestles and braces ensure the transfer of forces from live and wind load to the road surface – with no need for additional anchoring. The ramp has to be assembled in off-peak hours, preferably in the night and on weekends, whilst keeping one lane open for traffic.
- The light-weight construction of the ramp (approximately 200 kg/m²) is such that the additional dead load bears on the bridge structure beneath without compromising road safety.
- A sophisticated logistics concept based upon parts which are easy and light to transport and lift provides for smooth delivery of said parts to and from the assembly site.
- The ramps are most versatile unit constructions to suit any number of lanes and conditions prevailing at the assembly site. Additional parts are provided for curved roads. Tolerance on uneven patches and ruts in the pavement obviates the need for preliminary work on the road surface.
- Erecting the flyover ramp lane by lane affords the possibility of keeping at least one lane open for the flow of traffic whilst proceeding with assembly or disassembly works.

4. ERECTION

Good detailing of the stages prior to assembly will help go a long way to safeguarding a timely and, most importantly, smooth erection without the hassle to cope with clogged up roads and increased traffic management. In order for the assembly to be carried out expeditiously a predetermined sequence is to be strictly adhered to. In this regard it is worth distinguishing between steps taken prior to and during erection:

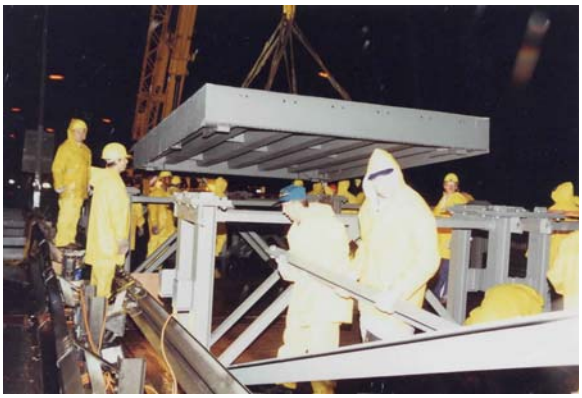

Fig.7. The first flyover deck unit is placed on the trestles arranged symmetrically on either side of the expansion joint

For ease of assembly, road surfacing either side of the joint needs to be removed using asphalt grinders. Two lanes out of three will need to be closed. Whilst the assembly site undergoes preliminary works, low bed trucks carrying the 3.35 m wide carriageway units and trestles to the site are positioned in a manner such that the respective trestles can be lifted and placed directly onto their respective spots spaced apart at regular intervals on either side of the joint. The steel deck elements are then installed at top of the trestles, for the alignment of which templates may well find application to minimise alignment time.

As soon as the mid position elements are placed, the remaining components can be arranged on the first two lanes either side of those elements positioned at mid length. Crash barriers are installed, braces are bolted and reinforcing parts are applied (Fig. 8). On account of the lack of available space, only one truck at a time can be positioned on either side of the expansion joint. Once all trestles and deck units are loaded from the first two trucks, the next two trucks will arrive at the site and be placed such that the next set of carriageway units and trestles can be added to the previously installed elements. For ease of handling all of the elements are clearly marked and assigned to designated trucks for delivery to the site. During assembly of the first two rows crash barriers which are orientated in the line of traffic are installed alongside the outer edge at deck level immediately above the top of the trestles (Fig. 9).

Fig.8. Simple bolt connections for securing elements

Fig.9. The first trestles and deck units including crash barriers are installed

Fig.10. Simple bolt connections for securing elements

When the first two rows are assembled and traffic is supported on one of these lanes, erection of the third row commences. The third lane deck elements are positioned and aligned in the very same way as has been explained above. To conclude, only the guard rail barriers remain to be switched over to the steel deck element for the third lane. The prefabricated profile of the deck end elements does not match the surface level of the supporting structure beneath. That is, the deck end leaves a step of 2 cm above the road surface level and therefore needs covering. The small obstacle is overcome by laying an additional asphaltic surface layer profiled as wedge to suit the prevailing roadway level. Once completed, the remaining carriageways are opened for traffic (Fig. 11).

5. WORKING CONDITIONS

With a working height ranging from 1.6 to 1.9 m, sufficient space is provided for the replacement of expansion joints and similar maintenance works. The removal of road surfacing prior to the replacement and repair works results in a further increase in working height by about 15 to 20 cm. The risk of injury by moving traffic to which workers on sites are inevitably exposed is eliminated by deploying the flyover ramp, thus enhancing the safety aspects considerably. Any annoyance which may be caused by excessive noise has been shown to stem in large measure from traffic moving on the carriageway of the opposite direction than from traffic supported by the ramp.

Fig.11. The last flyover deck unit is positioned.

6. NOMINATION FOR AUSTRIAN CONSULTING AWARD AND CONCLUSION

The development of the flyover ramp as “Bridge over the Bridge” ensuring the unrestricted flow of traffic during essential maintenance works of the supporting structure beneath it has marked a great success for all engineers and authorities that have been involved in its design and implementation since it was placed into operation for the first time in 1999. In this respect, Waagner-Biro Brückenbau has been nominated for Austria’s Consulting Award 2000 for its extraordinary engineering achievement in the design and implementation of the flyover ramp for Vienna’s “Süd-Ost-Tangente.” It is worth noting that even the local media and hundred-thousands of drivers passing the “Süd-Ost-Tangente” each week have meanwhile taken to the flyover ramp. Such has been the confidence in the ramp that the speed limit of 60 km/h (approx. 38 mph) applied to the ramp has been exceeded quite frequently in off-peak hours. Encouraging though it may seem, due to safety reasons and the exposed position two restrictions have been enforced: The velocity is limited to 60 km/h and changing lanes is prohibited on the flyover.

REFERENCES

[1] By kind permission of Reisner und Wolff

[2] By kind permission of Rheinstahl