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**MODERN SLIDING FINGER EXPANSION JOINTS –
MINIMISING TRAFFIC MANAGEMENT PROBLEMS**

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Abstract: *One of the most critical components of a bridge is the expansion joint, which must allow traffic to cross the bridge structure while still permitting movement of the bridge deck due to thermal effects, wind, traffic loading, seismic effects and so on. The expansion joint should provide a watertight connection for the lifetime of the bridge, as a lack of watertightness could reduce the durability of the main bridge structure, possibly resulting in the need for major remedial works. Mageba recognises that a bridge's expansion joints, due to their relatively delicate construction and severe loading conditions, will certainly need to be replaced several times during the lifetime of the bridge, and has therefore developed its expansion joint system Tensa®Flex Sliding Finger to minimise traffic disruption associated with expansion joint renewal works. This system is made of a rubber/steel composite which, due to its structural design, does not require major anchoring to the structure. This means that parts can be replaced, without causing major disruption to traffic, on a lane-by-lane basis. Furthermore, the simple but very effective waterproofing and drainage design of the joint system guarantees 100% watertightness throughout the lifetime of the joint. Where an existing defective expansion joint needs to be replaced, mageba uses its patent-pending Mini-Fly-Over system, which allows traffic to cross the bridge during the daytime without any disruption, while the construction works are carried out at nighttime on a lane-by-lane basis. With its many advantages, including easy replaceability of parts, shock-absorbing design and resulting protection of bridge parts, low noise emissions and 100% watertightness, this joint system is at the forefront of expansion joint technology, and is particularly suitable for densely populated and heavily trafficked areas.*

1. INTRODUCTION

1.1 Functions of bridge expansion joints

One of the most critical components of a bridge is the expansion joint, which must allow traffic to cross the bridge structure while still permitting movement of the bridge deck due to thermal effects, wind, traffic loading, seismic effects and so on. A bridge's expansion joints are relatively delicate structural components compared to the overall bridge. Furthermore, they are among the most highly stressed components of the bridge as they are particularly susceptible to the impact of traffic and the effects of bridge movements. The joints also have to provide a watertight connection throughout the lifetime of the bridge, since, should the joint lose its watertightness, the structure beneath will become contaminated with corrosive agents such as de-icing salts. As a consequence of the lack of watertightness, the durability of the main bridge structure could be at risk and major remedial works would then be necessary.

1.2 Design philosophy

Historically, bridges were designed as very robust structures, all parts of which were capable of withstanding the loads and the environmental conditions to which each bridge would be subjected, for the entire lifespan of the bridge. In more recent times, bridges have been constructed to be more slender and cost-effective, and ever greater spans and structural demands mean that a modern bridge will generally require a certain amount of renewal of its parts during its lifetime. Mageba recognises that a bridge's expansion joints, due to their relatively delicate construction and severe loading conditions, will almost certainly need to be replaced several times during the lifetime of the bridge, and that to keep disruption during joint renewal works to a minimum, it must already be recognised in the design of the original expansion joint that it will have a finite life and will at some point need to be replaced. Therefore mageba has developed its expansion joint system Tensa®Flex Sliding Finger so as to minimise the difficulties and traffic management problems associated with expansion joint renewal works.

2. NEW SLIDING FINGER EXPANSION JOINT SYSTEM

2.1 Product description

The Tensa®Flex Sliding Finger system, as illustrated in Figure 1, is made of a rubber/steel composite and due to its structural design, does not require major anchoring in the structure. Furthermore, its flexible and shock-absorbing design protects the bridge structure underneath from fatigue-related problems and reduces noise emissions to an absolute minimum. The simple, but very effective waterproofing and drainage design of the joint system guarantees 100% watertightness throughout the lifetime of the joint. The design of the system allows the individual elements of the joint to be replaced in a very short period of time (for example, in one night) on a lane-by-lane basis. The features of the Tensa®Flex Finger system therefore make it particularly suitable for densely populated and heavily trafficked areas.

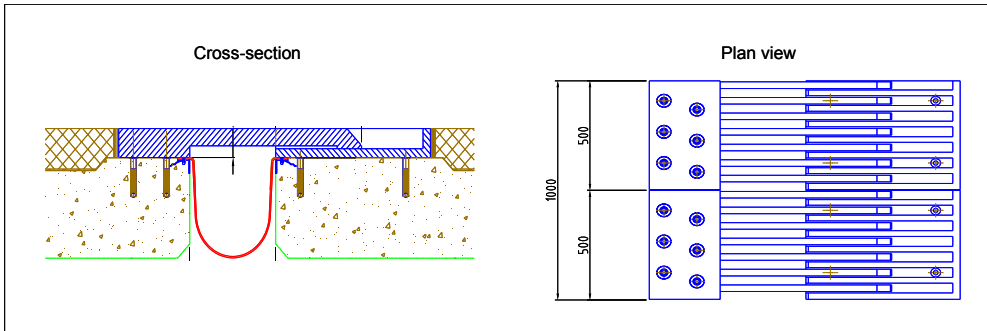


Figure 1: Cross Section and Plan View of Tensa®Flex Sliding Finger

2.2 Materials and movement capacities

The Tensa®Flex Sliding Finger expansion joint is a flexible metal-elastomeric bonded system which consists of two asymmetric parts. The lower part has fingers which are welded to a base plate, and is anchored to one side of the gap that is to be bridged. The upper part has cantilever fingers which slide between the fingers of the lower part, allowing the bridge deck to expand and contract. The fingers of the upper part are pre-tensioned and therefore apply a permanent pressure to the opposing sliding surface of the lower part. The flexible arrangement of the system also reduces the effect of loading (especially heavy traffic) on the structure. This expansion joint system can facilitate expansion and contraction movements of up to 800mm. The system is anchored to a specially prepared concrete subsurface, and is therefore easily replaceable.

2.3 Behaviour under traffic

The pre-tensioning of the fingers allows vertical structure movements, ensuring that they will not protrude above the driving surface (e.g. due to settling or torsion of abutments). Therefore, and in contrast to cantilevered finger joints, the mageba Tensa®Flex Sliding Finger does not constitute a hazard to over-rolling traffic under such vertical bridge movement. The ability to absorb vertical movements is described in Figure 2.

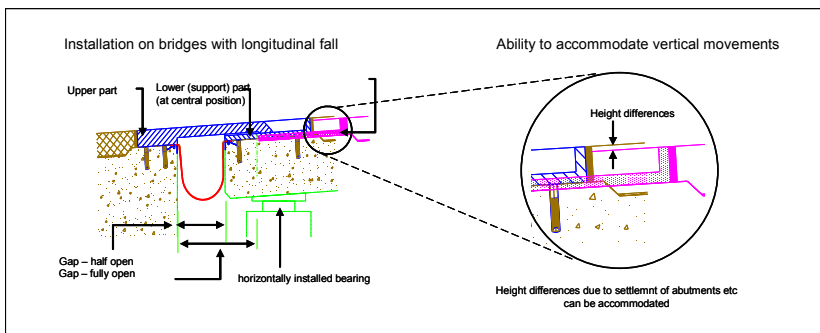


Figure 2: Vertical movements facilitated by the Tensa®Flex Sliding Finger System

2.4 Clever anchoring systems

There are two possibilities for connecting the Tensa®Flex Sliding Finger to a structure, depending on the surface to which it is anchored.

For connection to concrete, a plugged anchoring system is suitable (see Figure 1). The concrete subsurface must be smoothed with a tolerance of $\pm 1\text{mm}$, in order to allow installation of the joint without further preparation. The completed concrete subsurface has to match the joint's predefined inclination. This method of installation does not require a steel substructure which may be susceptible to corrosion. Additionally, the development of rock pockets and trapped air in concrete is prevented. Holes are drilled for heavy anchor systems, and the finger plates are installed after the hardening of the adhesive and application of the sealant of the anchors.

For anchoring to a steel substructure (such as the two-part steel trough shown on the concrete bridge in Figure 3), the joint can be delivered together with the steel substructure as one piece. The Tensa®Flex / steel subsurface system is positioned, aligned, welded to reinforcement, and set in concrete. If need be, additional finger elements can be bolted to the steel substructure within a few hours (approx. 3-4 hours per 15m joint). It is also possible to make these steel substructures from chrome steel.



Figure 3: Anchoring of Tensa®Flex Fingers on steel substructure

2.5 Low noise emission

As the joint has, on the one hand, no impact areas and, on the other, no mechanically moving parts, the system has a very low noise level. Measurements carried out during the bridge renovation of the Seez Viaduct on the A3 motorway at Walenstadt (St Gallen, Switzerland) showed that the noise levels were reduced by up to 18dBA compared to conventional expansion joint systems.

The low noise emission behaviour of the joint has very great advantages for bridges that are located near densely populated areas.

2.6 Renewal of existing expansion joints with new Sliding Finger Expansion Joints using revolutionary traffic management system

If an existing expansion joint is to be renewed when it reaches the end of its lifetime, the patent-pending mageba “Mini-Fly-Over“ system allows traffic to cross the site during day time, while the construction works are carried out at nighttime on a lane-by-lane basis. In this way, unhindered traffic flow during peak times can always be facilitated. Figure 4 shows a construction site where Tensa®Flex Sliding Fingers are currently being installed. The left side of the picture shows the Tensa®Flex Sliding Finger after installation.

The centre of the picture shows the 36 year old Modular Expansion Joint (before replacement with the Tensa®Flex Sliding Finger). The right side of the picture shows the Mini-Fly-Over, which permits completely unhindered traffic flow during installation.



Figure 4: Replacement of existing expansion joint with Tensa®Flex Sliding Finger, using the “Mini-Fly-Over” system to minimise impact on traffic.

3. REFERENCE PROJECT – FELSENAU VIADUCT, BERN, SWITZERLAND

The Felsenau Viaduct was built in 1973. It has a total length of 1,150m and is located north of the old city centre of Bern, crossing the river Aare (see Figure 5). The six lane carriageway carries approximately 100,000 vehicles per day.



Figure 5: Felsenau Viaduct, Bern

Due to the high traffic volume, the existing modular expansion joint with 7 x 60mm movement capacity developed signs of fatigue and had to be replaced. The design brief for the refurbishment had four key requirements:

1. Avoid any impact on traffic during the daytime
2. Close only one lane during the nighttime and at weekends
3. The new expansion joint should exhibit low noise emission characteristics
4. Short overall construction time.

Only the Tensa®Flex Sliding Finger in combination with the revolutionary mageba Mini-Fly-Over system could be used to accommodate the above-mentioned client requirements. The construction works were executed at weekends and during night shifts (see Figure 6).



Figure 6: Nighttime Installation of the Tensa®Flex Sliding Finger at the Viaduct

The total duration of the construction works was seven weeks with the work being carried out lane-by-lane, in six phases. Each phase was carefully planned, ensuring that the construction works were completed on time and within the budget.

The old modular expansion joint is still in place in Figure 7 (Stage 1). It is an expansion joint with 7 movement gaps, totalling 560mm movement capacity. The construction width

The final stage is shown in Figure 9 (Stage 4). When the concrete surface has hardened, the drainage system (5mm flexible EPDM channel) is positioned and fixed to the structure, with connection to the bridge's waterproofing membrane. Finally, the Tensa®Flex Sliding Finger is mounted on the surface. The small remaining gap between the Tensa®Flex Sliding Finger and the wearing course of the bridge is then sealed with Robo®Flex.

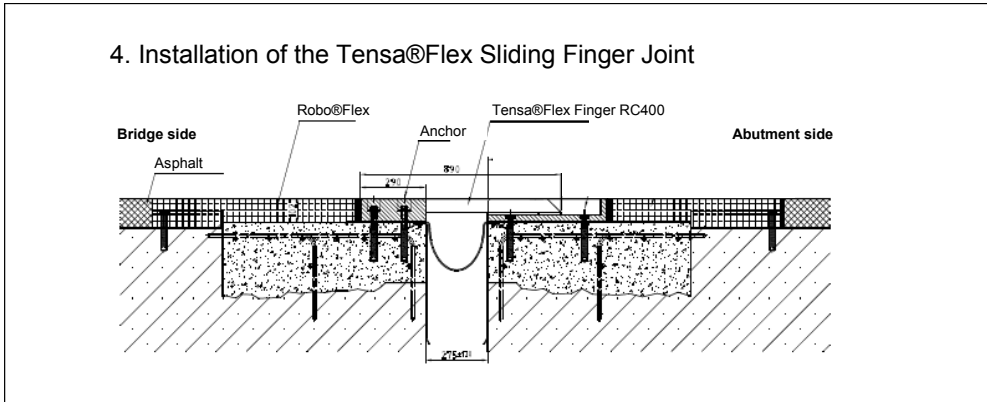


Figure 9: Construction Stage 4 of the Tensa®Flex Sliding Finger

4. CONCLUSION

Mageba has reacted to the modern demands of good traffic management, even when major expansion joint renewal works are being carried out. The Tensa®Flex Sliding Finger is ideally suited to meet these demands, as with its modular design it can be installed easily and quickly, without heavy lifting equipment. Replacement of old expansion joints can be carried out using mageba's patented Mini-Fly-Over System to minimise impact on traffic.

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