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Seismic and Safety Design Criteria for Expansion Joints

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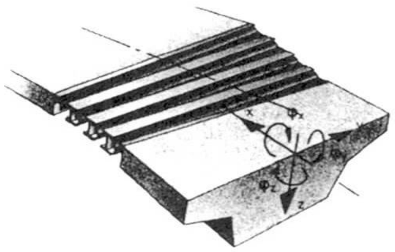
Summary

Bridge design has changed in the last years: Spans are becoming longer, loads are increasing and seismic design has become more and more important. This has an influence on the design and manufacturing of numerous parts of the bridge. Expansion joints and bearings are unique and require special solutions to fulfil the high demands and safety standards. The challenging design of these mechanisms requires advanced technology to take care of large movements in all directions, combined with high vertical and horizontal loads due to these increased dead loads, earthquake loads and accidental traffic loads e.g. braking ,skidding.

Seismic Design Criteria for Expansion Joints

Bridges are often the lifelines of infrastructure. If an earthquake causes major damage in cities or regions with such lifelines, it is important, that they stay intact. A key element of bridges are expansion joints. If an earthquake destroys or damages an expansion joint, the bridge can become impassable. Therefore expansion joints have to be designed earthquake resistant. Modern modular expansion as described below joints fulfil this requirement. They can adapt movements and rotations in all 3 directions and around all 3 axes. The lamella joints are built in modules, which are highly adaptable to the needs of the bridge designer. For large longitudinal movements the length of the joists and joistboxes can be designed accordingly. Joistboxes with a trapezoid shape can allow big transverse movements. Similar design is possible for big vertical movements. Such expansion joints have already been built with longitudinal movements of ±1000 mm and transverse movements of ±250 mm.

a)



b)

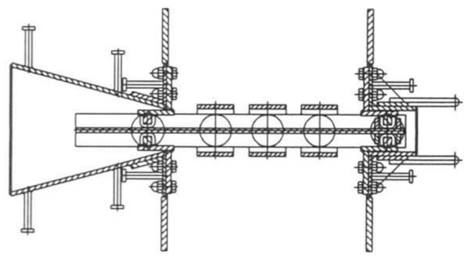
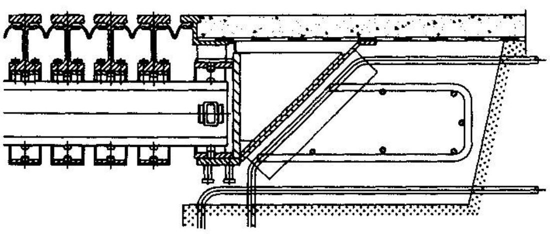


Fig. 1:Modern modular expansion joint
a) unrestrained movements and rotations in all 3 directions and around all 3 axes.
b) trapezoid shape of joist boxes for big transverse movements.



Expansion joints with fuse boxes prevent damage to the adjacent structures and are an economic solution, if small damage on joints are acceptable and if it is not a design requirement, that the joint is passable at any time after an earthquake.

Fig. 2: Fuse box of LR-Joint; Tagus Bridge.

With modern lamella joints it is possible to fulfil almost all technical needs and still find economic solutions. In order to obtain the most suitable solution, close contact between the bridge designer and the joint manufacturer at an early design stage is very important.

Safety Aspects of Expansion Joint Road Surface

Large modular expansion joints for extremely long span bridge structures require a special safety concept to ensure secure roll-over of all kind of traffic, while ensure safe transmission of braking force but preventing skidding of vehicles on the joint. The fully opened expansion joint at Tsing Ma Bridge or at Jangyin Yangtse River Bridge forms a 4.0m wide metallic structure (see Figure 3), consisting of about 50% gaps and 50% metallic lamellas.

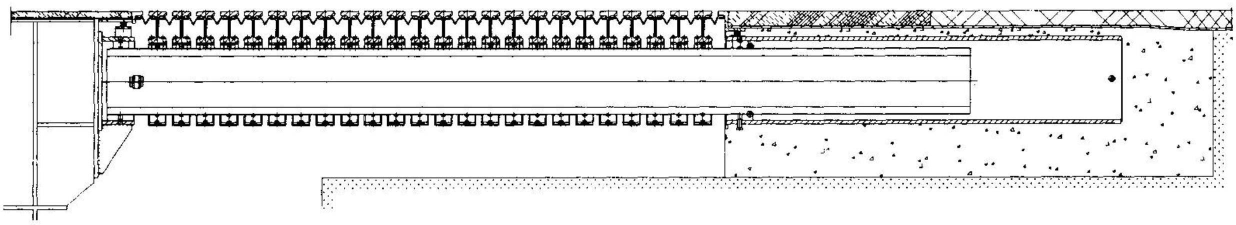


Fig.3: 25 gap modular expansion joint for Tsing Ma Bridge at Honk Kong; length up to 4 m.

While smaller expansion joints require only coating for corrosion protection very large modular expansion joints require special treatment of the metallic lamella surfaces. A friction coefficient of μ =0,5 must be assured for a service lifetime under all weather conditions, and neither pollution nor excessive radiation from sunlight should reduce the long-term quality of the special anti-skidding coating. The coating is a special surface treatment, proven and robust enough to guarantee minimal friction coefficient μ =0,5 for service lifetime under the most adverse traffic and weather conditions.

The horizontal load transmission system for braking forces, introduced by the traffic, has to be investigated and specially designed for large modular expansion joints. As well as other gap control and steering systems, the flexible controlling device has a reinforced water tight sealing strip as a special gap limiting feature. The horizontal braking forces are transferred and damped by the combined action of the sealing strip and the elastic steering system to the edge profiles. The new sealing strip was developed and tested at various occasions and has proven its key role in the safety concept and the design of the joint. The reinforced water sealing strip profile is strong enough to tie back the horizontal forces into the adjacent structures.

Special anti-skidding coating of the road surface of the modular expansion joint combined with the comprehensive horizontal load transmitting and gap limiting system can assure safe driving on very large expansion joints at any time.