Special Requirements of Large Modular Expansion Joints

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1. Introduction

Large bridges require expansion joints which can facilitate correspondingly large movements of the bridge deck relative to its abutments, and as the field of bridge engineering develops, with ever-increasing spans, the demands on expansion joints for such bridges continue to increase. Modular expansion joints are often best suited to satisfy these demands, but face a number of particular challenges in the case of very large bridges. This paper investigates these challenges, and outlines the project to supply the world's largest expansion joints for the Run Yang Bridge in China.

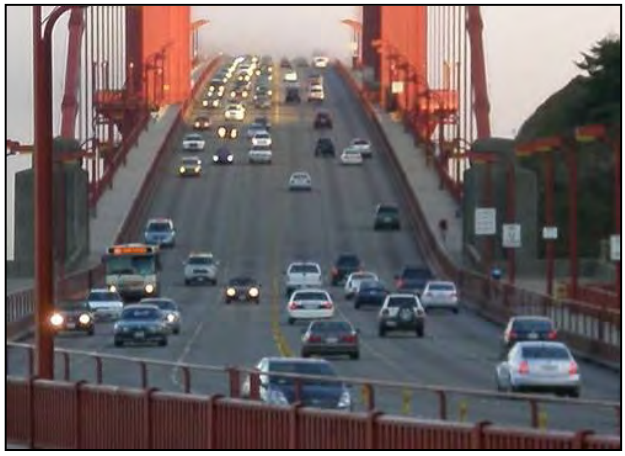

Figure 1: Extreme traffic loading

2. Extreme loading and movement demands

Extreme loading conditions and total movement requirements are probably the most significant factors influencing the overall performance and life cycle costs of an expansion joint. An expansion joint may be subjected to over 200 million axle loads, and total movement of several hundred kilometers, during its lifetime, while facilitating individual movements of over 2,000mm. This combination presents great challenges for the designers of modern expansion joints.

3. Special needs of expansion joints with extreme movement capacities

The paper considers the particular requirements of large scale expansion joints, as follows:

3.1 Special sliding material

Normal sliding material, used to facilitate the sliding of the moving parts of a modular expansion joint, would not withstand the extreme movements demanded by very large expansion joints, and a suitable alternative must be specified.

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3.2 Asymmetrical control system

The symmetrical control systems used in normal modular expansion joints do not suffice when the movement capacity becomes very large, due to the friction and other forces which must be overcome as the joint opens and closes.

3.3 Durable control springs

The control springs which regulate the gap width between a joint's lamella beams are subjected to additional loading when installed in an expansion joint that must facilitate extreme movements, resulting in a requirement for optimised design of these components.

3.4 Noise reduction

Noise generated by traffic crossing an expansion joint becomes a more serious problem as the span of the joint increases, due to the increased duration of contact between the vehicle's wheels and the joint. Suitable surfacing to reduce the noise generated becomes a requirement in many cases.

Fig. 2: Noise-reducing plates on a modular joint

3.5 Anti-skid protection

As the span of a modular expansion joint increases, so too does the distance a vehicle will have to travel in crossing the joint with reduced ability to brake, especially in wet conditions. Large expansion joints therefore require some form of surface treatment to improve tyre grip.

3.6 Earthquake features

Depending on their location, large bridges can also be affected by earthquakes, and large bridge gaps being closed or opened beyond their design values would result in both the destruction of its expansion joints and possibly severe damage to the bridge structure itself. A solution to this problem is presented.

3.7 Automatic monitoring

Large expansion joints are proportionately more complex, with more moving parts, than smaller joints, with the result that the bridge owner may desire an automatic monitoring system to be installed to provide real-time information on the condition of the bridge, or other data.

4. The importance of the consideration of life cycle costs

The initial cost of expansion joints of large bridges is usually a very low percentage of the total cost of building the bridge. However, examples of bridges from all parts of the world show that maintenance and repair costs during the full lifetime of an expansion joint can easily reach multiple initial costs, even without considering the cost of traffic obstruction.

5. Reference Project: Modular expansion joints for the Run Yang Bridge

The project to supply the world's largest expansion joints (each of which would accommodate movement of 2,160mm) for the Run Yang Bridge in China in 2004 presented particular challenges due to the size of the joints. A description of the project and its challenges is presented.

6. Conclusion

The demands of very large bridges continue to require ingenuity and innovativeness from the engineers charged with designing and building these extraordinary structures, not least in the specification of the expansion joints which serve such an important function.