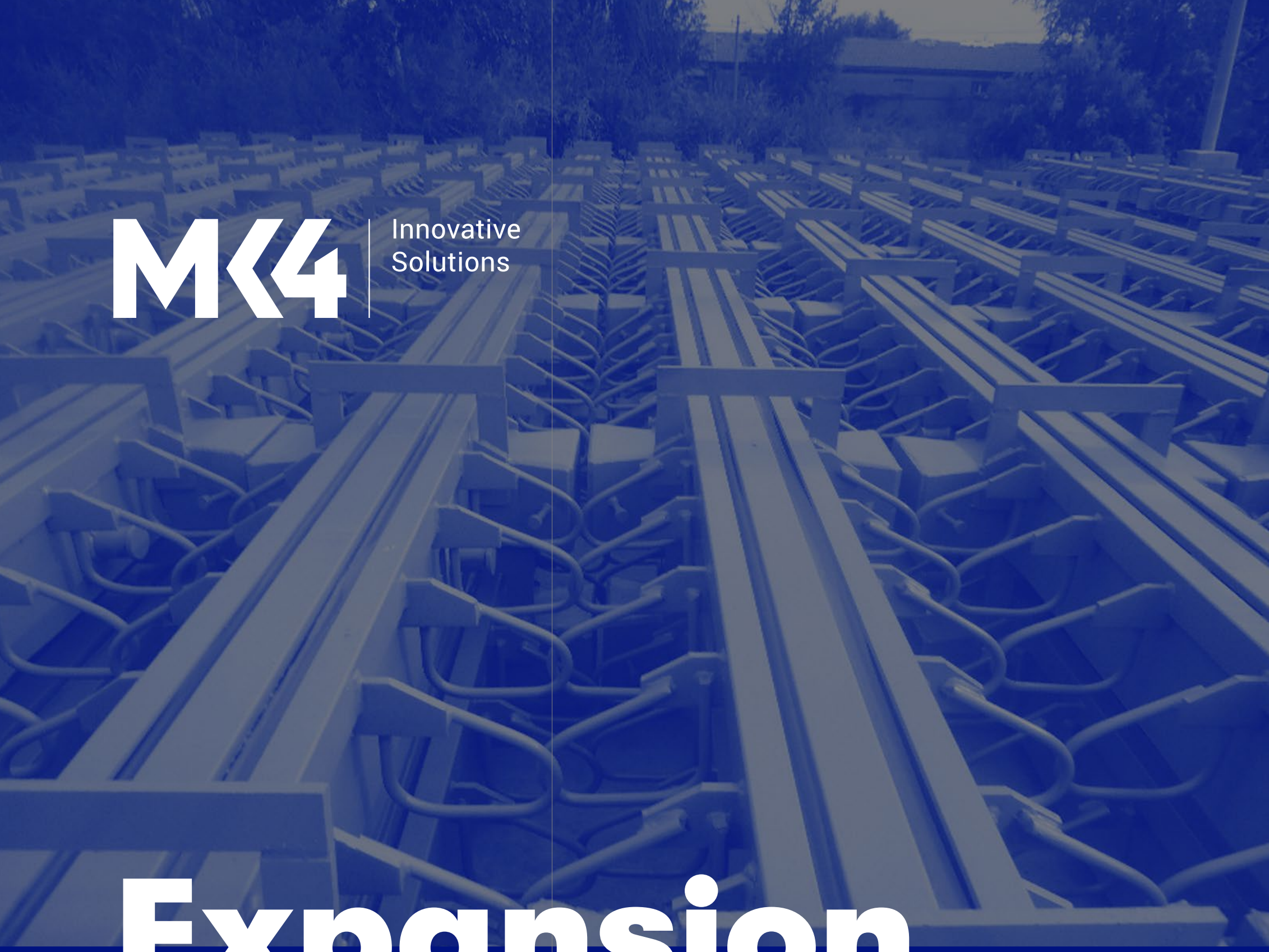

MK4 | Innovative Solutions

Expansion Joints

- → Modular expansion joint
- → Pedestrian expansion joint
- → Rubber expansion joint
- → Simple expansion joint
- → Finger expansion joint

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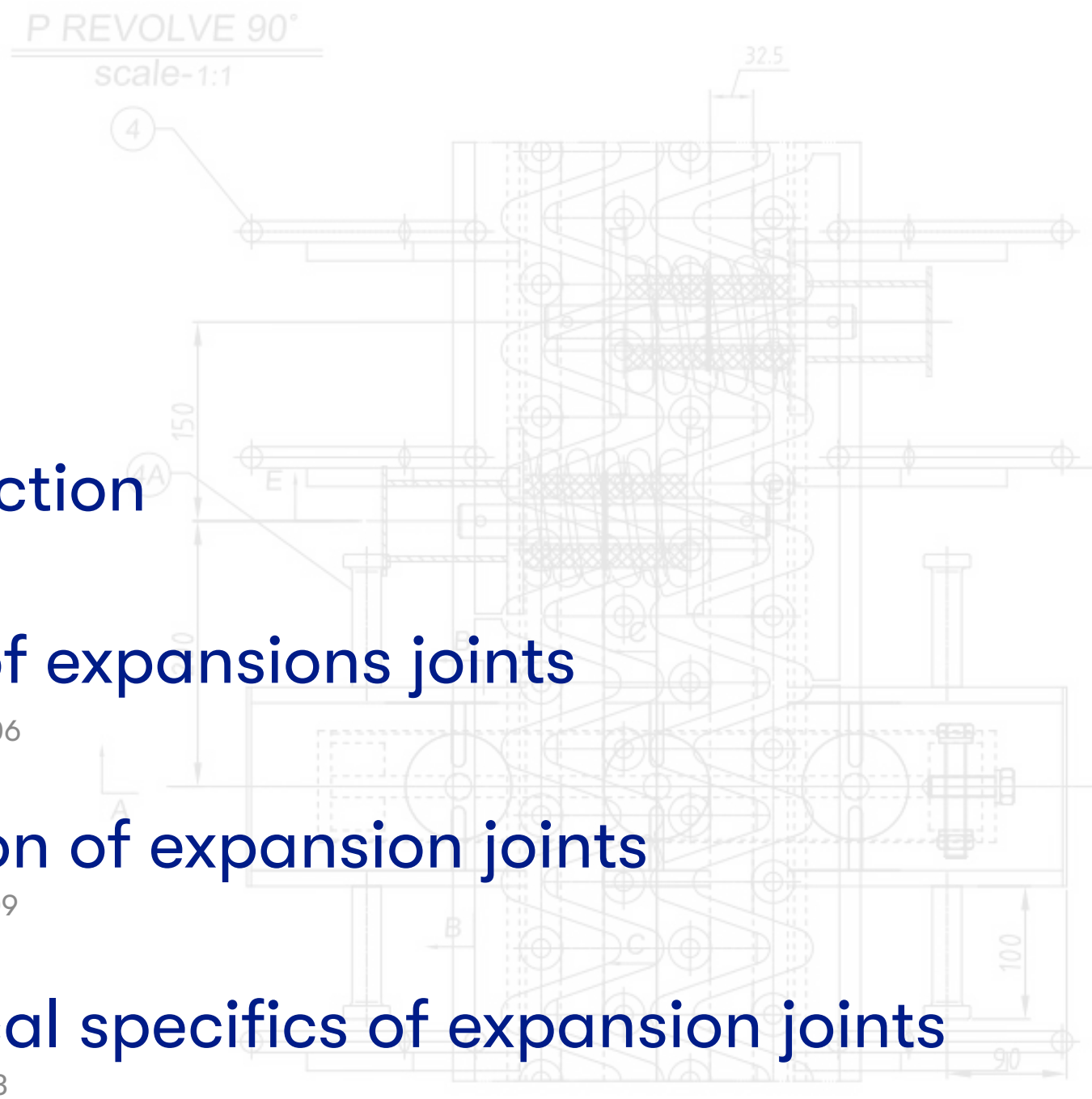


Introduction

MK4 Expansion joints is a device which allows relative movements between two deck of a structure. To succeed, a joint must accomplish the following functions:

→ Assure freedom of deck's movements.
→ Provide continuity to the wearing course and be capable to support the traffic loads.
→ Be able to avoid noise, impacts and vibrations.
→ Have good sealing properties and allow surface water evacuation.

The proper execution of an expansion joint is essential to achieve a lasting job that complies with the regulations of the technical building normative.

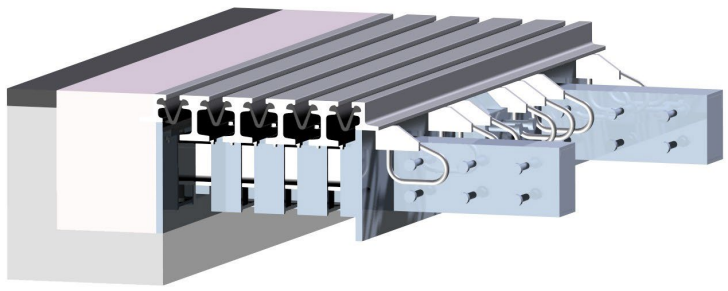
Expansion joints provide a continuous road surface to all users of a road or railway while at the same time ensuring water tightness as well as allowing every displacement or rotation expected at the structure. The aim of the present PTD is allowing the PM to select the most suitable model of joint according to the project specifications.

→ A30 Montreal- Canada

Types of expansions joints

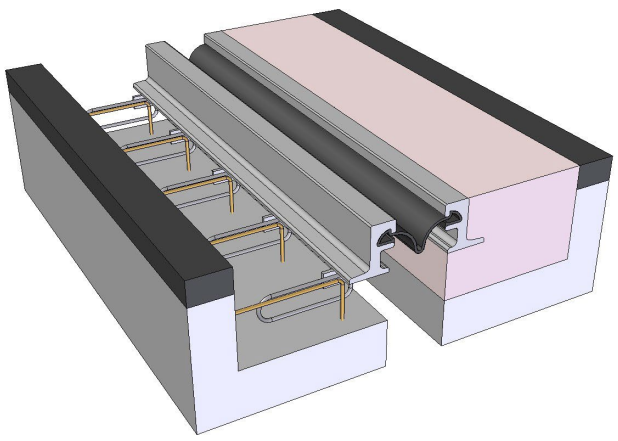
→ **MEJ |** Modular Expansions Joints

High performance steel bridge joint where total movement gap is divided into individual gaps, where expansion/contraction is ensured by a rubber V-shape profile linking two steel beams. Center beams ensure bearing capacity and road surface continuity towards traffic loads, while rubber profiles ensure water tightness and movement capacity.



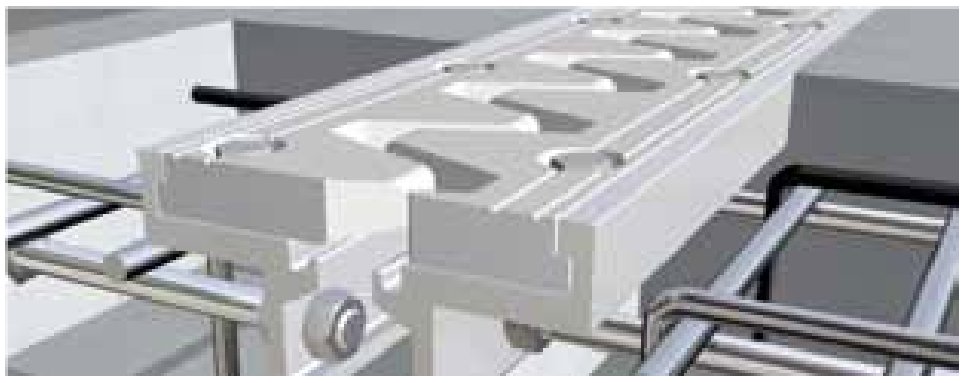
→ **SEJ |** Simple Expansion Joints

Simple Expansion Joint is a mechanically sealed joint with an extruded elastomeric seal retained by various options of profiled steel extrusions, referred to as edge beams. The elastomeric seal, usually named strip seal, is mechanically locked into the cavity of steel extrusions to prevent the ingress of water or debris. At the side of steel extrusions, anchorage is affixed to be attached to the structure elements by a typical method of pouring high-strength concrete mortar, or other elastomeric mortar. This armored joint system is designed to cater for movement ranging from 0mm to 100mm, while movements and rotations in all three axes are possible without any restraints.



→ **FEJ |** Finger Expansion Joints

High performance steel expansion joint allowing absorption of deck movements whilst bearing the traffic loads and avoiding traffic disturbances. The steel fingers provide a robust surface for traffic with low noise, and can be tailored to allow a great variety of movements.

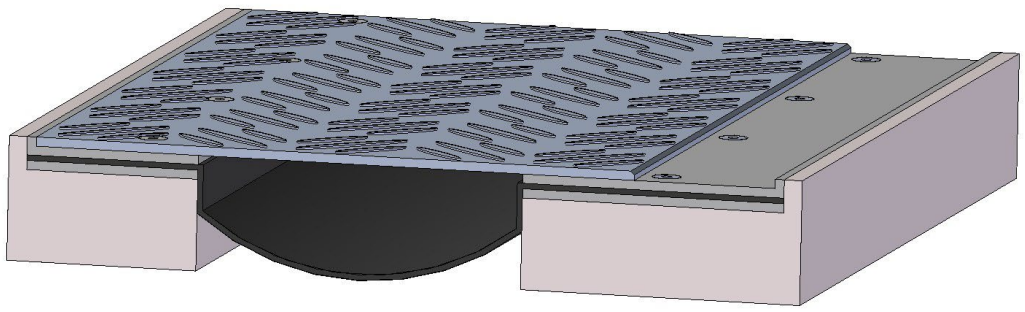


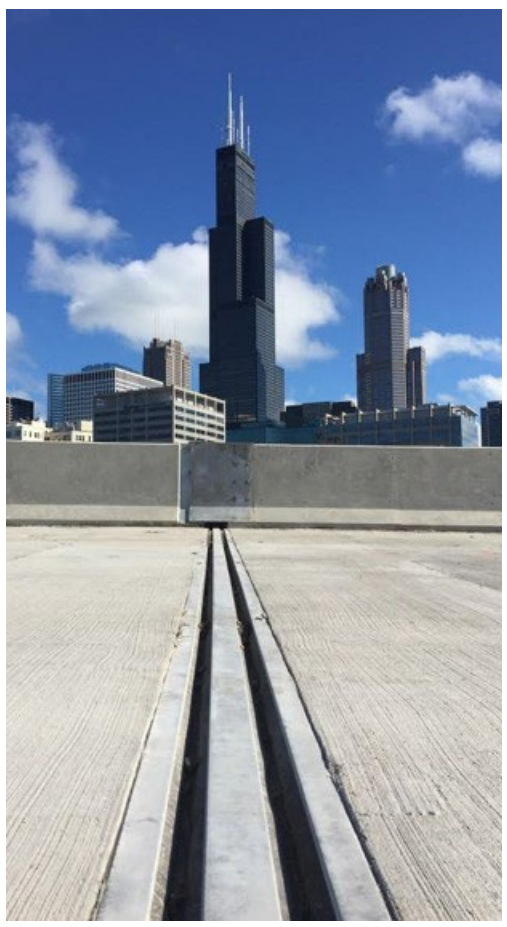
→ **REJ |** Rubber Expansion Joints

High performance elastomeric expansion joint allowing absorption of deck movements and water evacuation, bearing the traffic loads and avoiding the traffic disturbances. The continuous rubber surface (with or without metal plates) ensures water tightness at the joint level, without any need for additional water removal devices below surface level. Thus, rubber expansion joints can be installed on the thinnest structural slabs and bridge decks.

→ **PEJ |** Pedestrian Expansion Joints

Pedestrian expansion joint is a mechanically sealed joint designed for pedestrian traffic on bridge kerbs as well as pedestrian bridges. It consist on a steel plate or elastomer slab providing a continuous surface for the users which can slide over another steel plate inserted on the kerb surface. An elastomeric seal is mechanically locked into the cavity of steel extrusions to prevent the ingress of water or debris. Below the steel plates, anchorage is affixed to be attached to the structure elements by a typical method of pouring high-strength concrete mortar or other elastomeric mortar. This armored joint system is designed to cater for movement matching those of the main expansion joints, with an exterior surface conveniently treated to prevent possible trips and slips by the users.





Selection of expansion joints

PARAMETER	TYPE OF EJ				
	MEJ	SEJ	FEJ	REJ	PEJ
Horizontal Movement	Any direction	Any direction	Mainly longitudinal	Any direction	Any direction
Movements (mm)	<2000mm	<80mm	<1000mm	<1200mm	<2000mm
Noise Level	High (7.5dB) Subtype S, low (2.5dB)	Medium-high (6dB) Subtype S, low (2.5dB)	Low (3dB)	Medium (5dB)	Low (2dB)
Bridge deck thickness	<350mm	<250mm	<200mm	<200mm	<200mm
Cleaning	Easy	Easy	Difficult	Easy, snow ploughs can demage it	Easy
Ease of maintenance	Little need, lane by lane possible with special design	Little need, easy	Easy for fingers, chance of lane by lane	Easy, chance of lane by lane	Easy
Service Life	High (20-25 years for the rubber)	High (20-25 years for the rubber)	Medium-High (20-25 years for the fingers)	Low (5-10 years) Unless supervised at installation	High (50 years)
Type of Traffic	All (beware steel surface for braking)	All	Inconvenient for 2 wheels	All	Pedestrians

3.2 | **Design Considerations**

First item to consider must be the range of movements, which limits the types of joints which can fit in the project.

→ Noise can be a selling point in urban areas, otherwise it's not important.

→ Deck thickness is usually not a problem, but can become key when the slab is too thin (i.e. precast slabs <300mm). Installation of expansion joints with a fully passing gap is possible (the joint gets installed as a cantilever extension of the slab).

→ When comparing different type of joints, it is important to consider the whole service life and not just the costs at installation. Different joints have different performance, and joints more expensive to install are usually cheaper to maintain in the long run.

→ "Chance of lane by lane" means that, with the right selection of modules size and/or design considerations, it is possible to set up the joint in such a way that later on it will be able to be replaced closing just one lane to traffic. Not every road can be fully closed for repairs, especially urban ones, so planning this issue in advance can be a good selling point.

→ PEJ should be encouraged for urban and pedestrian bridges. If a full PEJ isn't possible, we can provide steel cover plates for pedestrian traffic areas over the other types of joints.

→ Aluminum joints are lighter than steel made ones, but they can't have infinite service life due to fatigue. Target service life (total or before replacement) must be considered before offering an aluminum joint.

→ Skew angle is not an issue, but make sure that the fingers of the FEJ are aligned to traffic.

3.3 | Design Standards

Expansion joints can be designed under several standards, the most usual ones being the European Technical Approval Guideline (ETAG-032) and the AASHTO. Several other national standards around the World are based on their formulas and procedures, and in MK4 we have the required expertise to adjust our standard expansion joints models to fulfil the requirements of any of them.

The choice of one particular standard over another one does have a very significant impact in terms of dimensions, components, and associated joints of an expansion joint and therefore must be carefully considered when there is no country-specific code to follow in a particular project. MK4 expansion joints are designated with:

TYPE-SUBTYPE-MAXIMUM MOVEMENT. For example:
MEJ-N-0160 | For a Modular Expansion Joint of the normal type with a maximum longitudinal movement capability of 160mm.
For example:

MODEL	MOVEMENT	TYPE
Modular Expansion Joint | MEJ	Total movement M longitudinal direction in mm | 160	A

3.4 | Accessories

Sinus plates to reduce traffic noise up to 80% Up-turns to prevent water slipping under the joint from the edges.

Technical specifics of expansion joints

4.1 | World MEJ - Modular Expansion Joint

Working principle and main components

1· **Center beams:** Take traffic loads down to the support beams. They are made of I-shape steel sections with a specific connection to hold the sealing elements

2· **Edge beams:** They are made of Z-shape steel sections which ensure contact surface with the adjacent asphalt concrete

3· **Support beams:** They are made of steel I shape elements with stainless steel toping plate which ensures good sliding properties with center beams. They are spaced every 1,2-2m

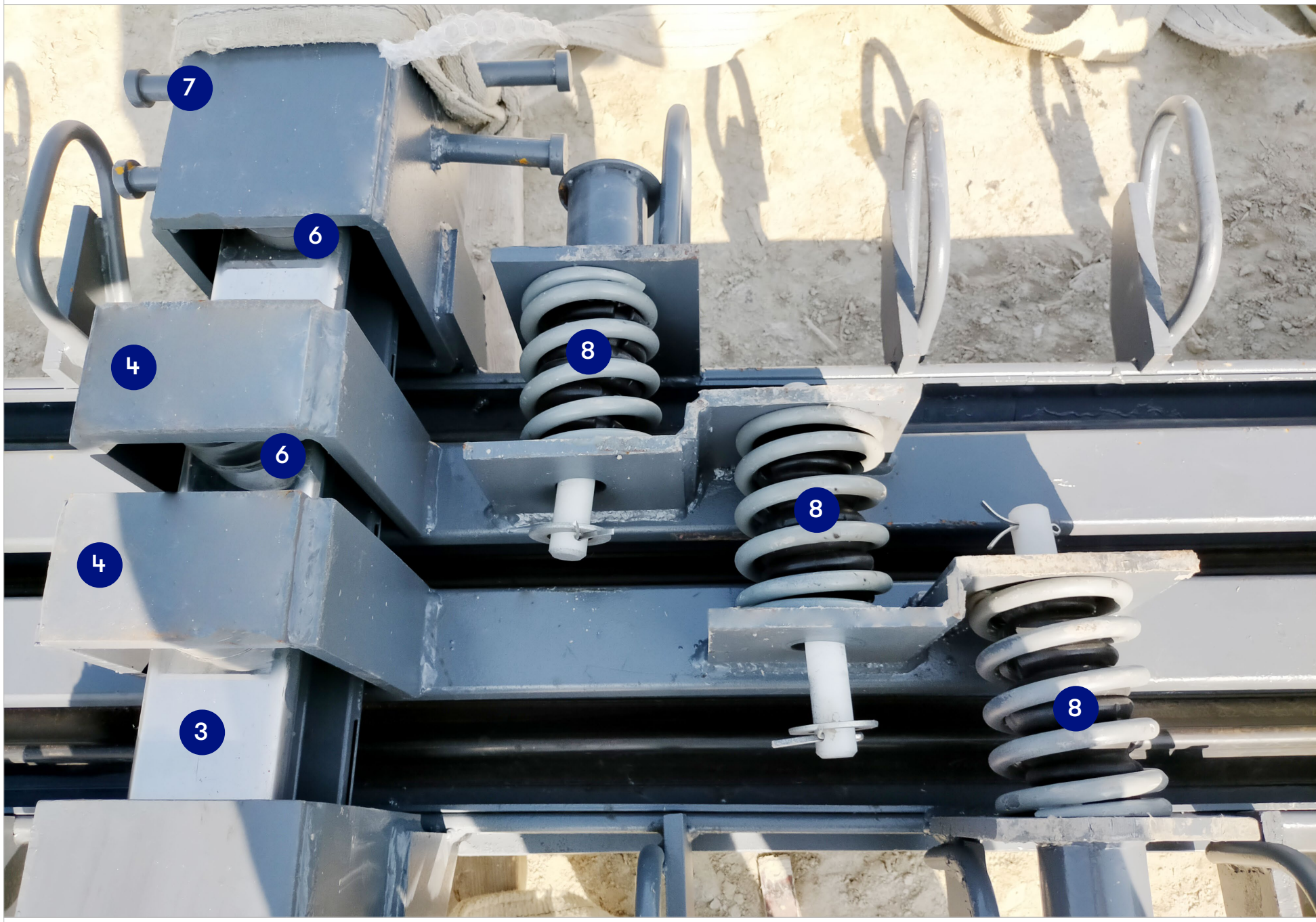
4· **Yokes:** these elements connect center beams with support beams. They have sliding elements with PTFE finishes to ensure good sliding agaings Stainless Stell of the support bar.

5· **Seal:** Rubber profile which provides movement capacity and waterthighness. Every seal accounts for an expansion capacity of 60-80mm.

6· **Sliding bearings:** this element is made of elastomer (allowing rotation and vertical displacement) and vulcanized PTFE allowing longitudinal displacment

7· **Casing for support beam:** This element houses the support beam and slinding bearings. Dowels ensure good anchoring to the neighbouring structure.

8· **Spring system:** this elastic system regulates the relative movement of the center beams between them and over the support beams. They also damp the punctual impact loading from traffic over a certain center beam



4.2 | World SEJ - Simple Expansion Joints

→ **Edge beams:** They are made of steel sections which ensure contact surface with the adjacent asphalt concrete. Can be made on different shapesdepending on the deck's material and dimensions, which can be seen in the following pictures

→ **Elastomeric Seal:** Rubber profile which provides movement capacity and waterthighness. The elastomeric seal can be effectively inserted into the cavity of the edgebeams without any screwed or bolted connections. Some of the examples are the following

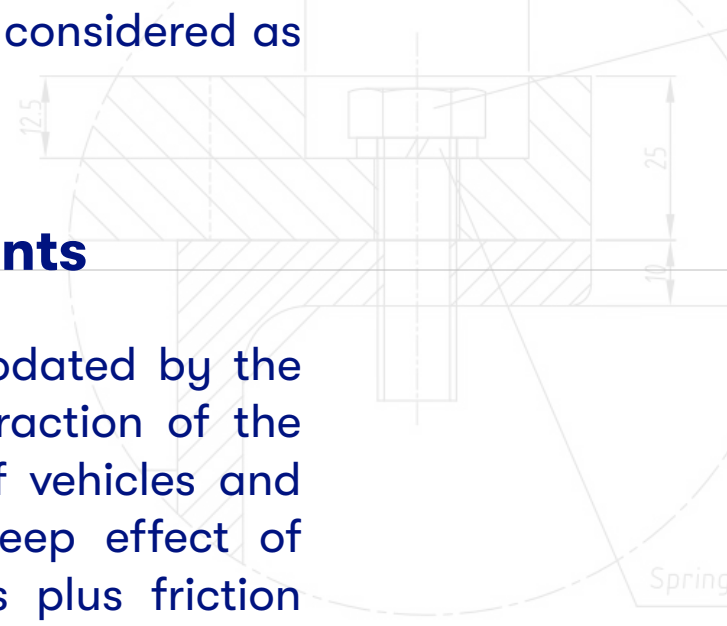
→ **Anchorage:** Edgebeams are rigidly connected to the main structure by anchors directly welded to the edgebeams. The traffic loads transferred from edgebeam to anchorages then to substructure. The anchorages are embedded in high strength mortar to assure the maximum resistance of traffic load.

4.3 | World FEJ - Finger Expansion Joints

Finger joints can be presented in 2 different sub-types, depending on the project specific needs and movements.

→ **Cantilever Joints FEJ-C:** Adequate for small to middle movements (60-500 mm), their fingers don´t touch the opposing side of the gap. They allow small transversal movements (±10 mm) and can be installed on non horizontal decks more easily than the other sub-type of finger expansion joint.

→ **Sliding Joints FEJ-B:** their fingers slide on the other side of the gap, thus allowing for greater sliding distances and more robust finger design for super heavy traffic. Their transversal movement capability is very small, so they should better be considered as longitudinal movements only joints



4.4 | World REJ - Rubber Expansion Joints

Horizontal movements of the deck are accommodated by the elastomeric joint, originating expansion or contraction of the elastomeric band. Live forces due to braking of vehicles and permanent reactions due to shrinkage and creep effect of concrete are transmitted by the anchor heads plus friction between the rubber and the concrete.

→ **Basic component:** Joint module (BxLxA) constituted of two bonded/vulcanised elements: rubber band [1] and steel plates [2]

→ **Basic accessories:** Anchor bolts [3], consituted of a nut+fitted rod+ washer

4.5 | World PEJ - Pedestrian Expansion Joints

→ **Pedestrian Slabs:** They are made of steel sections which ensure contact surface with the adjacent kerb surface.

→ **Elastomeric Seal:** Rubber profile which provides movement capacity and waterthighness. The elastomeric seal can be effectively attached to the bridge gap with screwed or bolted connections, or else extended between the surface plates and base plates for extra water isolation (SPEJ-C only)

→ **Anchorage:** Edge beams are rigidly connected to the main structure by anchors directly welded to the pedestrian slabs. The traffic loads transferred from edgebeam to anchorages then to substructure. The anchorages are embedded in the kerb's mortar to guarantee an adequate connection between joint and structure.

Installation

→ For installation procedure, please refer to MK4 installation manual.

→ If the required gap depth is equal to the deck thickness, formwork below the bridge will be necessary and the joint shall be installed as a cantilever extension of the deck. Connection to the reinforcing bars will require special design by MK4 Technical Department.

5.1 | Main steps for REJ / MEJ models are as follows:

→ Saw cut asphalt surface in a width A+G+B and remove the asphalt and concrete. Keep the existing bridge reinforcement bars. When finish, clean the recess from debris with compressed air debris

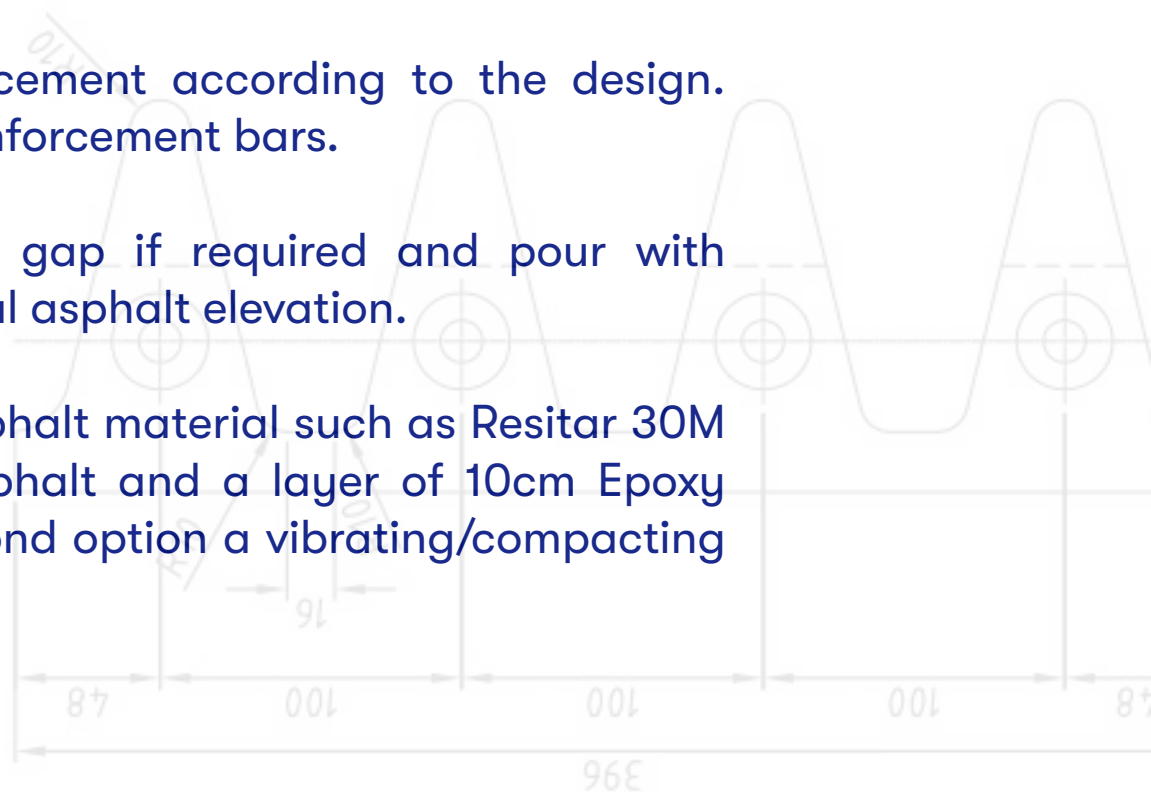
→ Pour leveling mortar (Sikagrout 314 or Sika patch 5 or Masterflow 928(BASF) or similar max height 3cm).

→ Set the joint to the predetermined expansion gap and lower it by crane into the recess. Steel support blocks should be previously placed. In transversal beams areas, the existing reinforcement bars should be bended if interference. Where necessary joint assemblies must be bolted or welded to form continuous length.

→ Install longitudinal reinforcement according to the design. Connect new and existing reinforcement bars.

→ Install formwork for joint gap if required and pour with concrete up to 5cm below final asphalt elevation.

→ Place final layer (Epoxy asphalt material such as Resitar 30M or equivalent, or mix hot asphalt and a layer of 10cm Epoxy based material). For this second option a vibrating/compacting machine is required.



5.2 | Steps for SEJ /MEJ

→ The necessary Modular EJ will be identified and will be checked with the one received at the jobsite. It is important to verify that there are no damages caused by the transport to the jobsite or during the storage in the jobsite. Storage must be done on wooden beams (approx. 12cm x 12 cm) placed horizontally and under the joist boxes to avoid tensions and torsion within the EJ.

→ MEJ over wooden beams for inspection

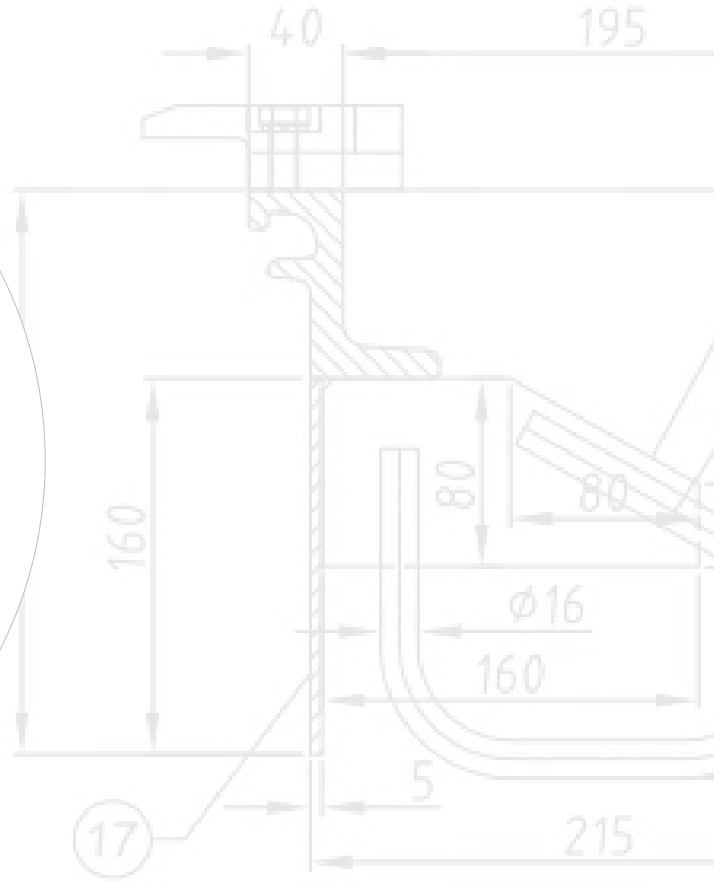
a) The length of the Modular EJ will be checked against the width of the deck where to install.

b) The presetting value needs to be confirmed (for example, at 15°C) and the movement per °C needs to be asked to the design engineer of the jobsite.

→ Initial situation of the rebar and concrete.

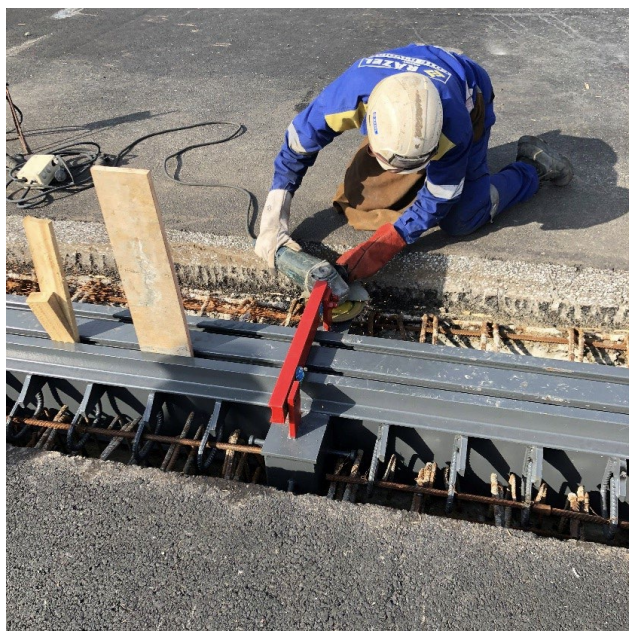
→ EJ safely lifted with crane and inserted in position

→ Adjustment of the rebar to host the joist box as needed.



→ Expansion joint being adjusted to the definitive position. Aluminium bar checking alignment with the road.

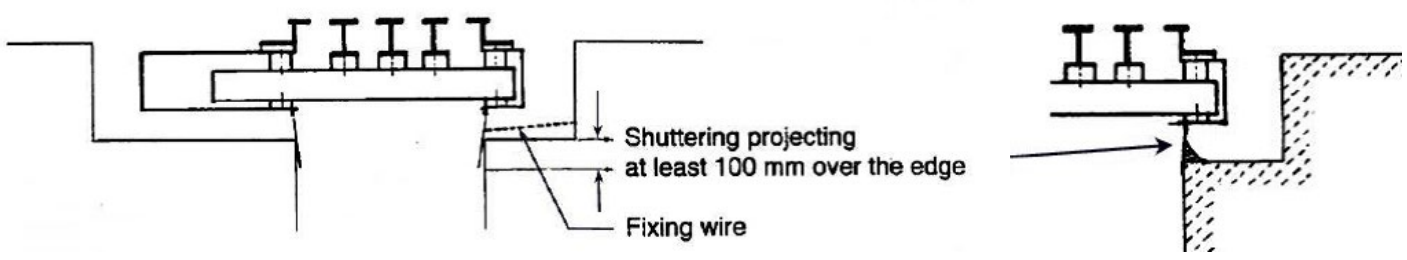
→ New rebar welded to the existing one as a temporary support of one side of the EJ.



→ Cutting the lifting hooks.

→ Then, we can remove the I Beams and proceed with the current temperature adjustment.

→ Final situation of the installed EJ prior to installation of rebar and concrete.



→ Sketch of shuttering plates and sealing installed in the recess box.

MEJ during concreting

Quality Control And Testing

→ Quality Control

Tight tolerances permit long term success. MK4 develops a checklist of tolerances to be recorded for each joint. This checklist is like a birth certificate; it describes every step of production, every critical measurement to be recorded, and this document is provided to the client as proof of complete quality control.

→ Elastic Connection

MK4 Modular expansion Joint Design does not weld the Center Beam to the Support Bar, instead using Elastic components, MK4 design creates and Elastic Connection. This eliminatesa fatigue problem of welds and permits damping of the modular joints through the elastomeric component. control.

→ Corrosion Resistance

All exposed steel components of each EJ are protected against corrosion through sand blast cleaning and being either hot dipped galvanized or painted with an inorganic zinc paint system. Method depends on the specifications of each individual project.

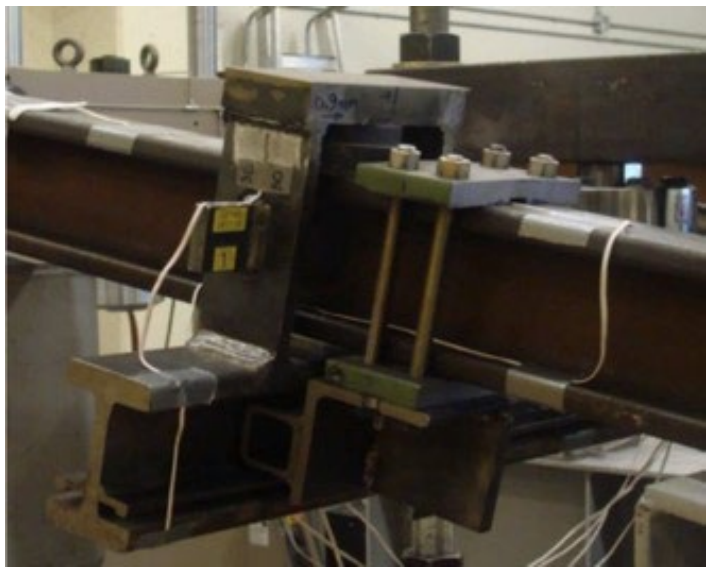
→ Parallel Support Bars

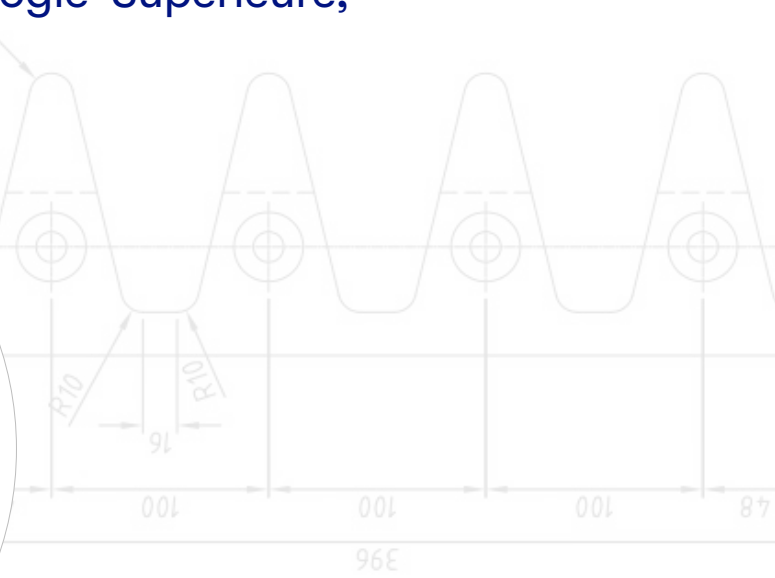
MK4 MEJ design has Parallel Support Bars that can be aligned with the wheel lanes. Parallel Support Bars provide sufficient clearance for concrete and reinforcing steel. Support bar spacing can be reduced for larger truck loading conditions.

Outside the box MEJ design accommodates easy replacement of all the smaller components such as Slide Bearings and Slide Springs. This is due to these smaller components being outside of any restrictive box, allowing accessibility for quick and easy replacement when necessary.

Testing of Modular Joints

Three specimens of the MK4 Single Bar Modular Bridge Expansion Joint (MBEJ) with welded stirrups were tested in fatigue according to the requirements of the NCHRP-402 Report, the AASHTO Bridge Construction Specifications and AASHTO LRFD 1998 Bridge Design Code. The fatigue testing was carried out at the Structures laboratory at École de Technologie Supérieure, University of Quebec.





→ Welded Stirrups

Test results were used to produce an experimental fatigue curve of the stirrup details with all points located above the AASHTO Fatigue curve for Category C welds. Hence it can be concluded that the fatigue resistance of the welded stirrup connection detail of the MK4 MEJ Single Bar System is compatible with (and qualifies for) the fatigue Category C of the AASHTO LRFD 1998 Bridge Design Code. (See Figure 8).

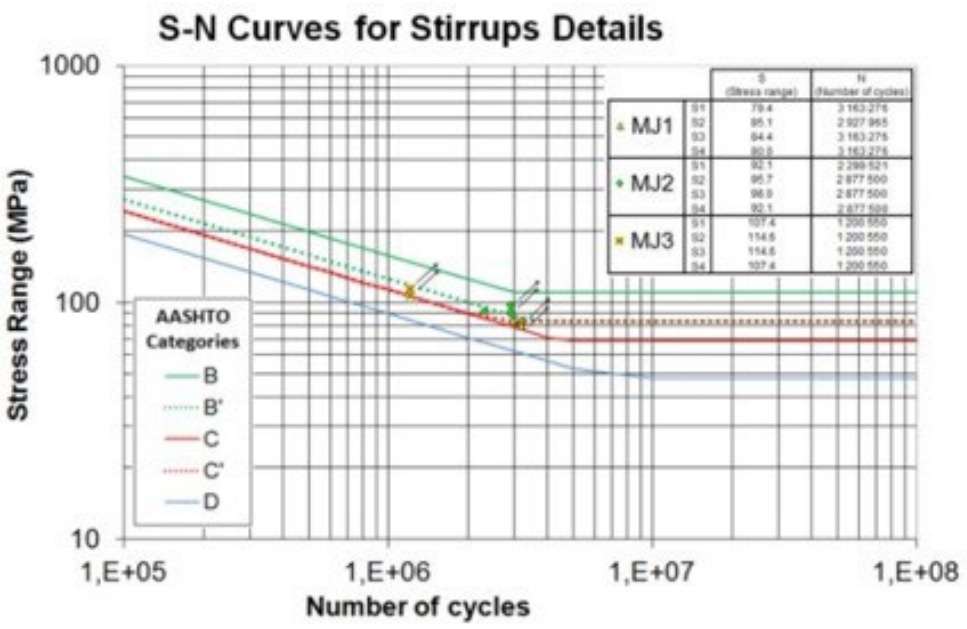


Figure 8 - Seq –N test points obtained for stirrups from Fatigue tests

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