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General information about Bridge Expansion Joint

Introduction

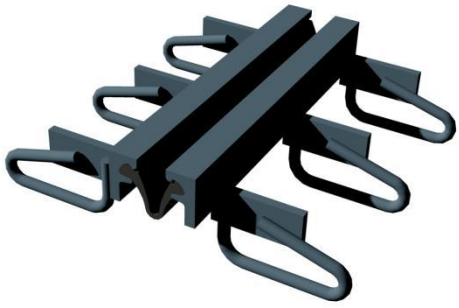
Bridge expansion joints are essential components that ensure uninterrupted traffic flow between structures while accommodating movement caused by shrinkage, temperature variations, and other forces in reinforced and pre-stressed concrete, composite, and steel structures. These joints play a critical role in distributing loads and ensuring safety over gaps between bridge decks or abutments.

In addition to their structural function, expansion joints must minimize noise, particularly in urban settings. Water tightness is also crucial to prevent water ingress into the substructure. Design considerations should aim for ease of replacement with minimal disruption to traffic.

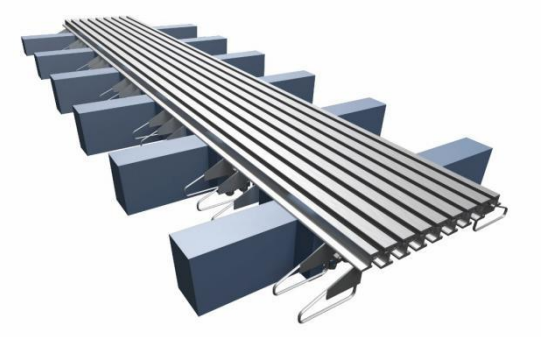
Types of Expansion Joints

Various types of bridge expansion joints accommodate movements ranging from 10 mm to 2,000 mm. The following six major types of expansion joints are part of IEC's supply scope:

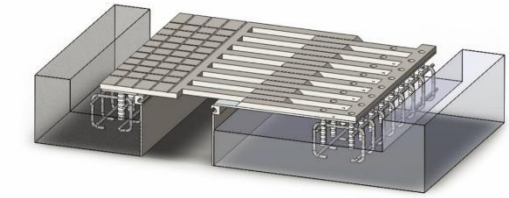
1. **Stripseal Joint (Single-Gap or Nosing Joint)**
2. **Modular Expansion Joint (MBJS as per AASHTO)**
3. **Finger Expansion Joint**
4. **Mat Expansion Joint (Reinforced Rubber)**
5. **Asphaltic Plug Expansion Joint**
6. **Railway Expansion Joint**



Stripseal expansion joint



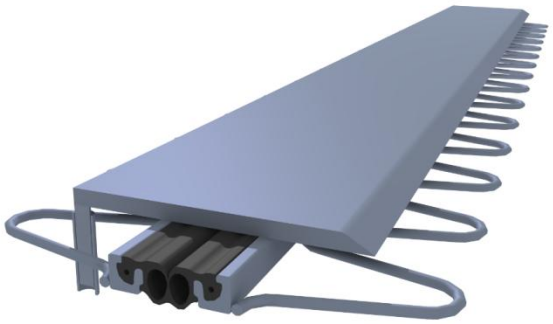
Modular expansion joint



Finger expansion joint

Mat expansion joint (Reinforced rubber)

Asphaltic Plug expansion Joint

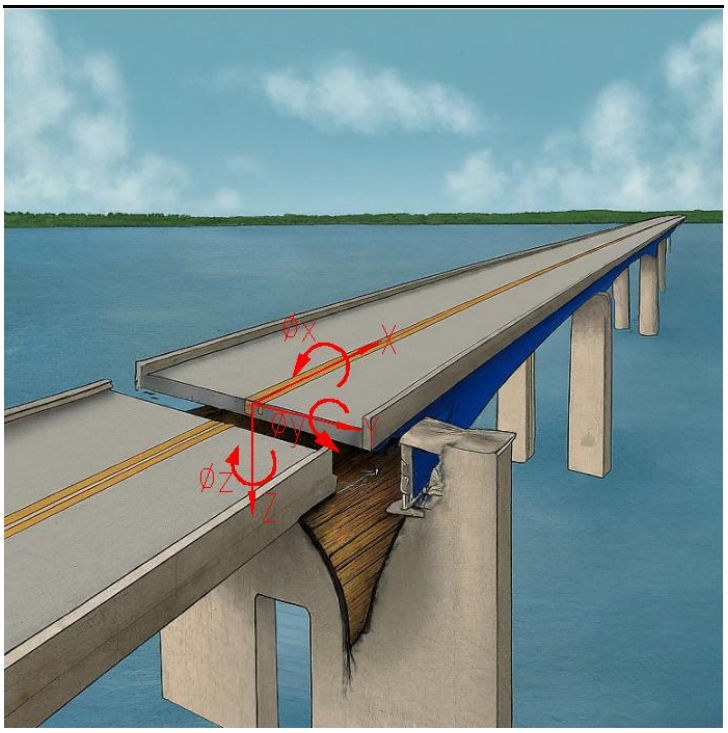


Railway expansion joint

Calculation of movements of expansion joint

The movement of expansion joints depends on bridge size and bearing arrangement. Typically, joint design focuses on horizontal translation orthogonal to the joint. However, all translations and rotations must be considered to ensure displacements remain within the joint's limits.

Movement can result from temperature variations, external loads, and the natural shrinkage or creep in concrete or composite structures. These movements should be calculated during the structural analysis phase and are generally the responsibility of the consultant or designer.



An illustration showing the location and function of bridge expansion joint
(permissible movement/rotation in 6 degrees)

Corrosion prevention

Corrosion prevention is vital for ensuring the longevity of expansion joints and protecting the entire bridge structure. At IEC, standard corrosion prevention procedures for stripseal, modular, or finger joints include:

- **Exposed Steel Surfaces**:
  - Blast cleaning to Swedish Standard SA2.5 for derusting
  - Hand cleaning to remove dirt, rust, mill scale, or oil stains
  - Coating applications:
    1. Primer: Zinc-rich epoxy paint (min. 60 µm)
    2. Final coat: Acrylic aliphatic polyurethane paint (min. 80 µm, applied 2-3 times)
    3. Total dry film thickness: 240-320 microns (finish coat: 60 microns)
  - Coating color per RAL 7042 unless otherwise specified
  - **Hot-Dip Galvanizing**: Available upon request according to ISO 1461:2009 standards, or as part of a duplex system for added reliability.
- **Non-Exposed Steel Surfaces**:
  Similar procedures as for exposed surfaces, but with two coatings and a minimum thickness of 120 microns.
- **Temporary Devices**:
  Epoxy paint (min. 50 µm) applied post-shot blasting, with colors such as blue or red.
- **Bolts**: Treated with Dacromet.

Painting of modular expansion joint at IEC workshop for NOH2 project in Doha Qatar, 2018

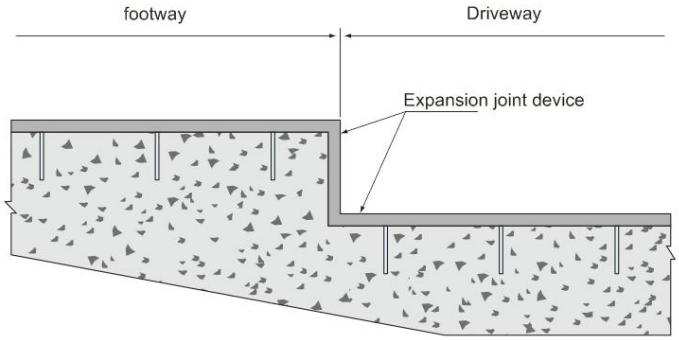
Painting of finger expansion joint at IEC for Tama Bridge over Nile, Egypt, 2019

paint film thickness 243 microns (C5-Ml)
for E-ring road project in Doha Qatar, 2018

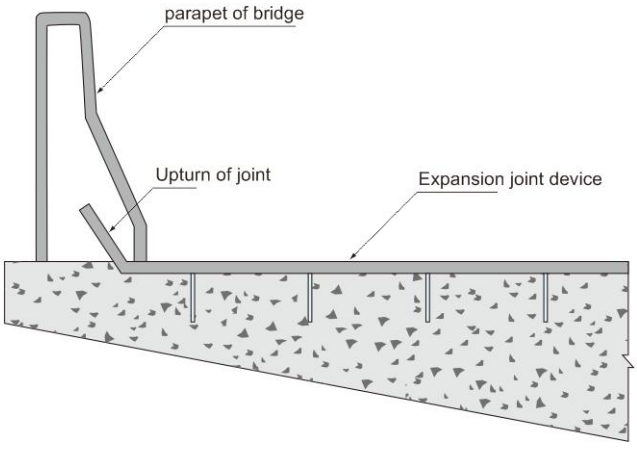
Hot-dip-galvanized treatment
for NOH2 project in Doha Qatar, 2018

Sidewalk and parapet design

Many joints must be designed to integrate with sidewalks or parapets. For modular joints, an upturn design allows them to extend into parapets or sidewalks.



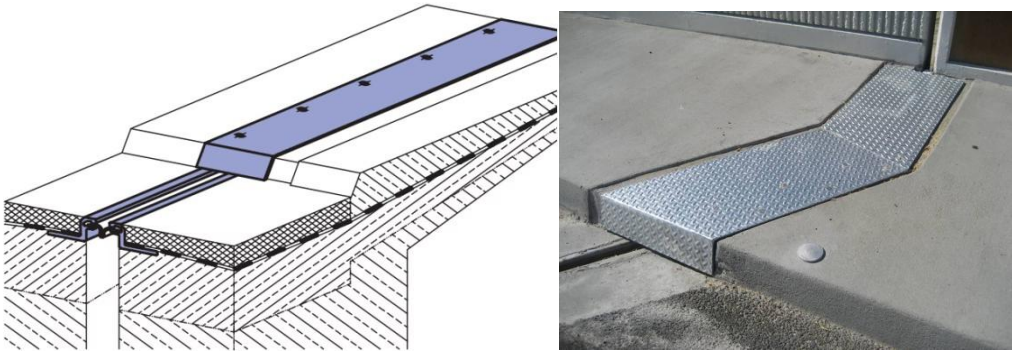
Upturn design of modular joint so they can extend upward into parapet or sidewalk



how the upturn extends into the reserved void in the parapet

Cover plate over the modular expansion joint in the parapet area

To ensure a safe passage for pedestrians or cyclists, a thin galvanized steel cover plate is installed over the expansion joint on sidewalks. This plate is bolted on one side, allowing the other side to move freely and accommodate expansion.



A typical design of a cover plate for the sidewalk area over the expansion joint upturn

For detail designs, consult IEC specialist engineer.

Handling, packaging and storage

Bridge expansion joints are protected during transit and storage. Proper lifting methods, including the use of cranes for strip and modular joints and forklifts for finger joints, ensure safety and prevent damage. Joints should be stored in clean, dry environments free from contaminants.

Packed for Irbid Ring, Amman, Jordan, 2016

Packed inside container for Rayyan Road, Qatar, 2020

Packed in closed wooden/steel case or frame for container loading

Applied codes/standards

IEC's expansion joints are designed to meet load requirements as specified by various international standards, including:

- Chinese Specifications
- AASHTO LRFD
- European Standards (ETAG 032)
- Indian Standards (IRC:SP:69-2011)
- BD 33/94 Specifications

IEC's expert engineers are capable of customizing designs to meet unique project specifications.

Installtion&Maintenance

The installation and maintenance processes for various types of expansion joints share some commonalities but also exhibit significant differences. For detailed guidance tailored to your specific needs, consult IEC engineers.

IEC Finger Expansion Joint

A super-large supported finger expansion joint with an overall movement capacity of 1440mm was supplied and installed by IEC for Chishui River Bridge, Guijin Expressway, Guizhou, China in 2023

Finger expansion joints are widely used in bridge construction due to their ability to accommodate significant movement while minimizing noise and providing a smooth driving experience. These joints consist of interlocking steel "fingers" that allow the bridge deck to expand and contract with temperature changes and traffic loads.

According to the American Association of State Highway and Transportation Officials (AASHTO) Bridge Design Specifications and the European code ETAG 032, finger joints can be broadly categorized into two primary types:

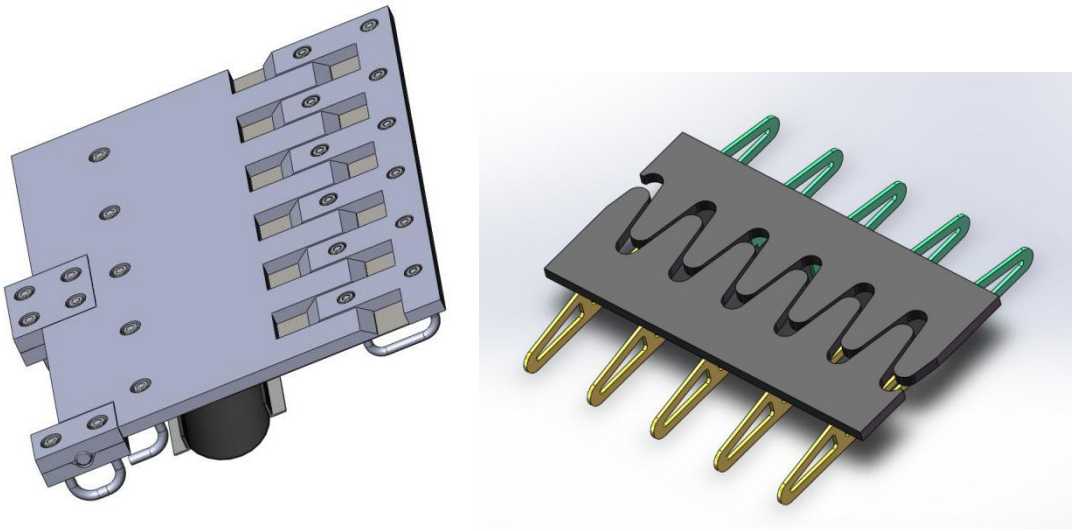
- **Cantilever Type**: In this design, the joint is positioned symmetrically over the gap between the bridge sections. Both sides of the joint have movable finger plates that interlock, allowing for expansion and contraction.
- **Supported Type**: This type features fixed finger plates anchored to the substructure and movable plates that slide over them. The movable plates are supported throughout their movement, even at maximum expansion. This design can accommodate larger movements but may require more attention to debris removal.

A simple set of images comparing the difference between a cantilever finger joint (left) and a supported finger joint (right)

Design Considerations:

- **Movement Range:** The choice between cantilever and supported types depends on the expected movement range of the bridge. Supported finger joints are generally preferred for larger movements.
- **Maintenance:** While supported finger joints can handle larger movements, they may be more susceptible to debris accumulation. Regular inspection and cleaning are essential to ensure optimal performance.
- **Safety:** The design of the finger joint should prioritize safety. Rounded finger plate heads and secure anchoring are crucial to prevent accidents.

Here are demonstration of different designs of the supported finger joints.



Various common designs of finger joint out of cost concerns

Either the cantilever structure or the supported structure has a lot of options in the designs. Selections largely depend on the safety concerns, movement/rotation requirement and the budget. Below images disclose some options of finger joints that IEC had supplied.

Numerous such finger joints have been supplied and installed by IEC in China (mostly supported structure)

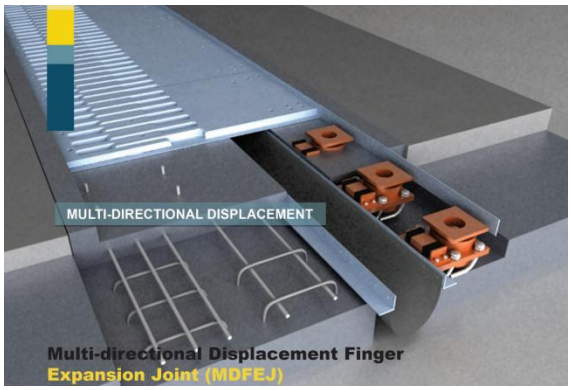
Additional Features:

- **Steel Extrusions:** Placing steel extrusions beneath the finger plates can enhance strength and water tightness.
- **Silicone Adhesive:** In harsh environments, an extra layer of silicone adhesive can be applied to further improve water tightness.

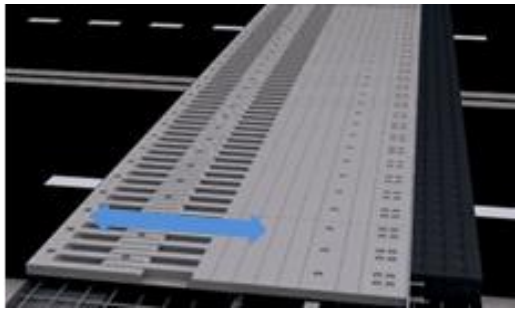
Finger joint over steel extrusions. An extra layer of silicone adhesive is poured into the exposed voids between the finger heads and rubebr seal beneath. This is catered for extreme waterproofing requirement.

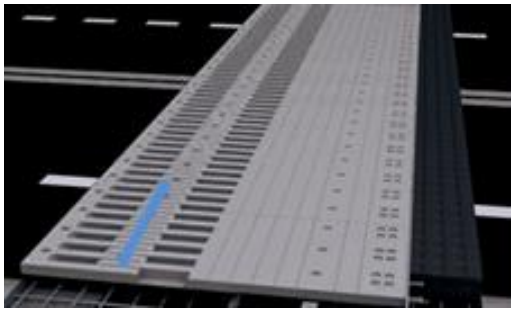
Advanced Designs:

For bridges with large spans and significant rotational movements, such as cable-stayed or suspension bridges, specialized finger joint designs are available. These designs often incorporate spherical bearings to accommodate multi-directional movement and rotation, which is named as Multi-directional and multi-rotational finger joint, the DXB series innovated by IEC. DXB joints combine the merits of conventional finger joints and high-rotational spherical bearings. Testing shows that the maximal horizontal and vertical rotation movement can reach more than 0.05/rad.

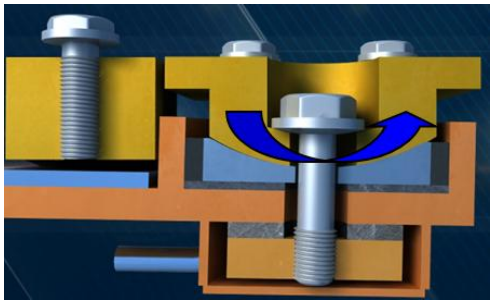


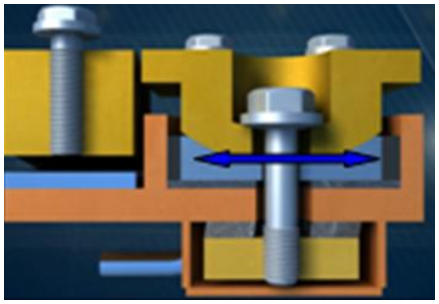
Spherical bearings are placed beneath longer finger joint plates to cater for large rotational requirements (DXB finger joints)





Longitudinal displacement transversal displacement





Vertical rotation horizontal rotation

IEC supplied a 800mm movement DXB finger joint system for Brive over Huanghe River in Jiqing, Shandong, China

Installation:

Finger expansion joints are typically delivered in prefabricated sections, simplifying installation. Proper installation is critical to ensure the long-term performance and durability of the joint. Consult IEC engineers for installation and maintenance.

Suitable applications:

IEC Finger joints are well-suited for the following applications:

- **Bridges with Large Movement Requirements**

Ideal for structures requiring large longitudinal and transverse movement capacities, such as long-span bridges and viaducts.

- **Heavy Traffic Bridges**

  Designed to handle high loads and frequent traffic, making them suitable for highways, expressways, and major urban bridges.

- **Extreme Environmental Conditions**

  Suitable for areas with wide temperature variations or harsh weather, as finger joints are durable and resilient.

- **High-Speed Roadways**

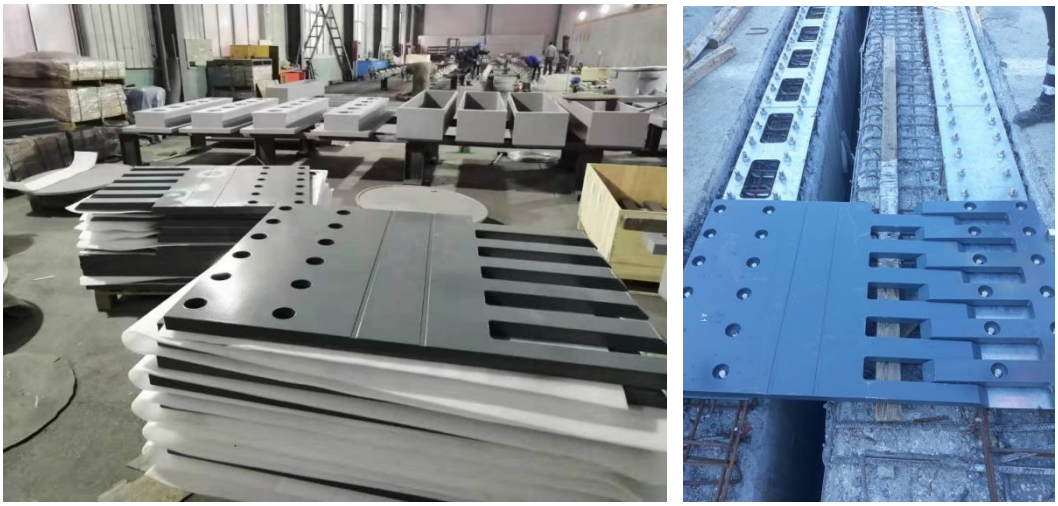
  Provide smooth transitions for vehicles, ensuring safety and reducing vibrations on high-speed roads.

- **Retrofit and Rehabilitation Projects**

  Commonly used to replace old joints on existing bridges requiring improved movement and load-handling capabilities.

Conclusion:

Finger expansion joints offer a reliable and low-maintenance solution for accommodating bridge movement. By carefully considering the specific requirements of a project and selecting the appropriate design, engineers can ensure the safety and longevity of the bridge structure.



Finger joints are packaged and installed for project of Tama Bridge over Nile River, Egpyt in 2018