MAURER

MAURER Guided Cross-Tie

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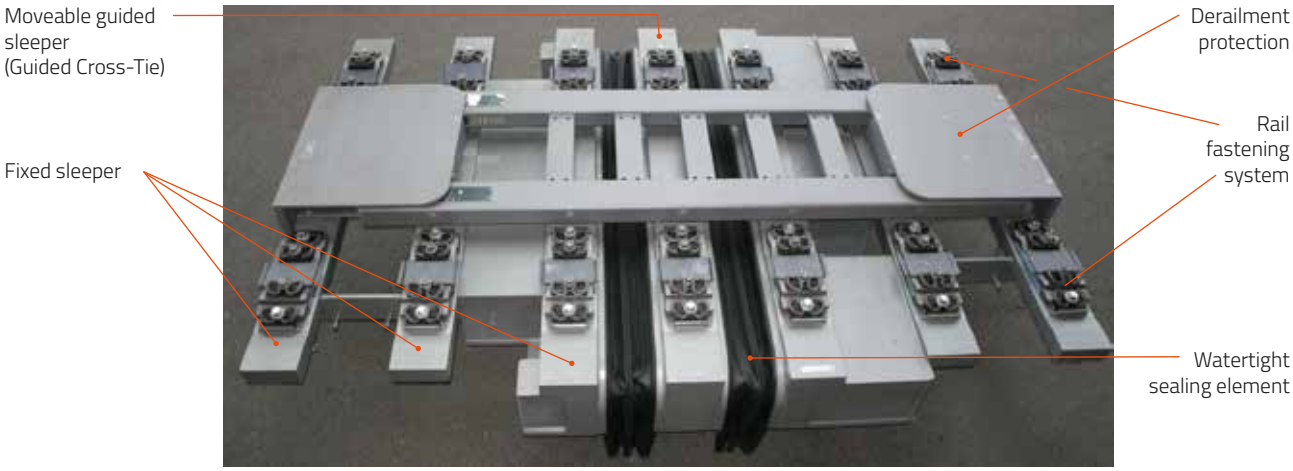
Description and Designations

The MAURER Guided Cross-Tie (CT) is a state-of-the-art, extremely safe, and durable system to bridge structural gaps, which was specially developed for installation in railway bridges between superstructure and abutment or on separating piers. This design derives from the well-known MAURER Swivel Joist Expansion Joint for bridge construction, established for more than 40 years ago and has been consistently adapted to the requirements of railway traffic and bridges. For railway bridges, movements resulting from traffic loads play a major role due to concentrated load application via the rail. These loads lead to rapid movements in the bridging area which are accommodated by the Guided Cross-Tie.



Main characteristics

- Unrestrained accommodation of superstructure displacements and torsions independent of the direction and axis
- Minimum curve radius of 130 metres is possible
- Fatigue-resistant connections (> five million load cycles)
- Redundant design in the event of derailment or unexpected damage caused by external influences
- Durable and low-friction sliding support
- Watertight
- Homogeneous stress pattern due to equal distances between the sleepers (non-floating support)
- Delivered completely assembled

Functions

- Bridging the rails over the structural gap
- Transferring traffic loads into the adjacent structural elements
- Accommodating displacements and torsion of the superstructure units caused by temperature, traffic, earthquakes, wind, creep and shrinkage (concrete)
- Compliance with the permissible forces and distances of the rail fastening system

lateral movements

torsional movements

vertical movements

Advantages

- Extremely high traffic safety during operation and following an earthquake
- Longevity (> 60 years)
- Maintenance-free
- No traffic disruption during inspections (possible from below the expansion joint)
- Fast and simple installation within one or two days, as no on-site assembly is necessary

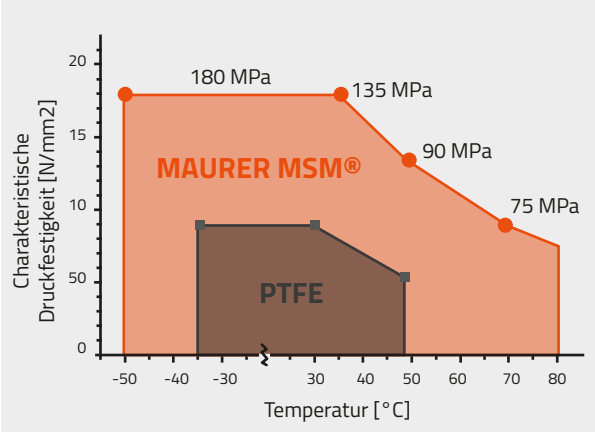
Plan view of Guided Cross-Ties during installation

MSM® Sliding Material

Using the sliding material MSM® guarantees a durable and low-friction sliding support of the moveable sleepers.

Main characteristics

- Patented high-performance sliding material for structural bearings according to EN 1337-2
- Multiple service life at double compressive stresses to PTFE
- Without environmentally harmful components such as fluorine or chlorine
- Resistant against chemical contamination and ageing



Compressive strength-Temperature-Diagram for PTFE and MSM®

Boundary conditions for design

Max. axle load	250 kN
Line load	100 kN/m
Track radius	≥ 150 m
Slope	≤ 40 ‰
Service life	60 years
Temperature	-30 °C to +50 °C

Types of trains according to EN1991

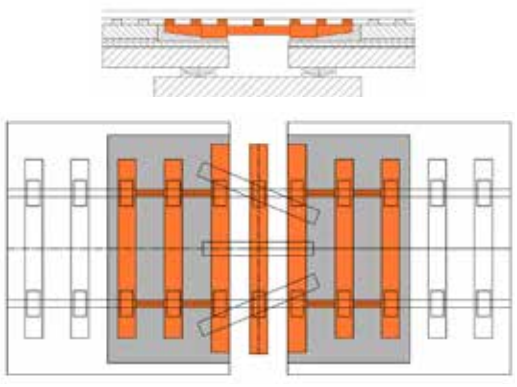
Type of train		Axle load [kN]	Axle base [m]	Speed [km/h]
Type 4	High-speed train	170	3.00	300
Type 3	High-speed train	200	3.00	250
Type 1	Passenger train	225	2.20	200
Type 7	Freight train	225	1.80	120
Type 5	Freight train	225	1.80	80
Type 11	Freight train	250	2.00	120

Composition of traffic according to EN1991

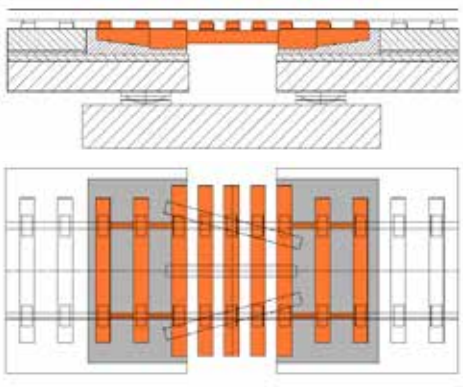
Type of train	Axle load [T.]	Trains/day [--]	Traffic volume [million T./year]
Heavy goods transport	25	51	24.8
Local transport	≤22.5	207	25.3
Regular service	≤22.5	67	24.95

Standard sizes

Guided Cross-Tie CT-2 with maximum longitudinal movement of 800 mm

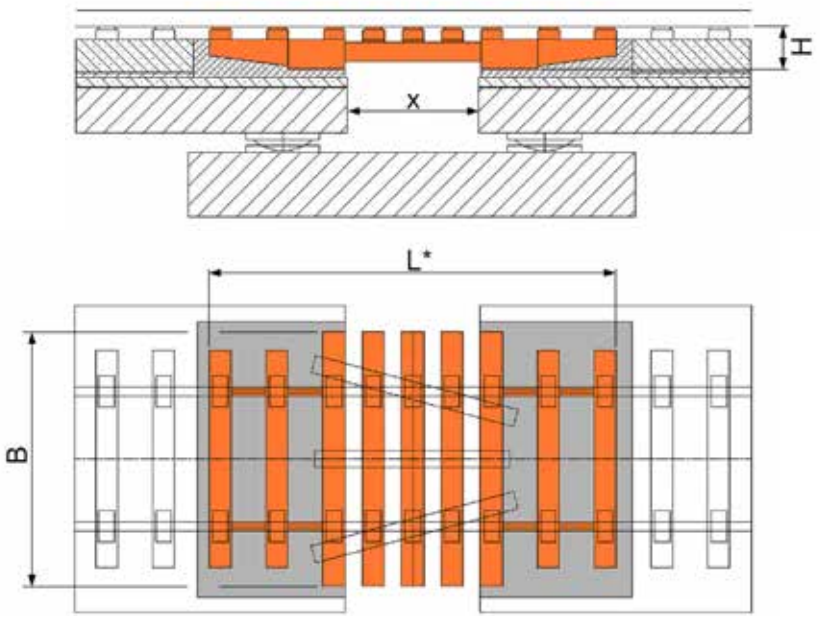


Guided Cross-Tie CT-4 with maximum longitudinal movement of 1600 mm



Dimensions CT2 and CT4

	Number of gaps	$d_{x,b}$	$d_{x,E}$	L	B	H	x	d_y	δ_x	max d_z
		[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mrad]	[mm]
CT2	2	400	800	3700	2660	510	500	≤±4.5	≤±1.8	-1.4 bis +2.5
CT4	4	800	1600	4200	2960	510	1000	≤±7	≤±3	-3 bis +4



L : Length of the Guided Cross-Tie in centre position

B : Width of the Guided Cross-Tie

H : Height of the Guided Cross-Tie

$d_{x,b}$: Maximum capacity for longitudinal service movements

$d_{x,E}$ [1]: Maximum longitudinal movement due to an earthquake

d_y [2]: Maximum lateral movement

δ_x [2]: Maximum torsional movement

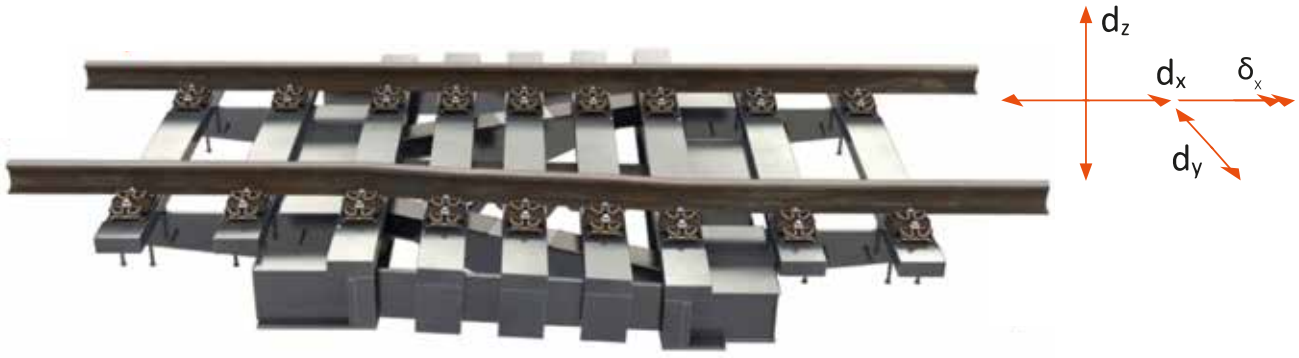
d_z [2]: Maximum vertical movement

x : Recommended minimum structural gap

* in centre position

[1] Maximum longitudinal movements due to earthquakes while complying with a maximum distance of the rail fastening system of 650 mm according to EN1991-2 and RIL804. Greater distances can be considered on a project basis, but may result in a change to the geometry.

[2] The indicated movements refer to the capacity of the rails, since the expansion joints can accommodate significantly larger movements. The previous example is given for the movement capacity at -30°C (maximum distance of rail fastening system) and maximum loads. All combinations of permissible deformation values at the bridging gap are included in the MAURER user manual. If the values at the bridging gap are complied with, it is only necessary to provide proof regarding the additional rail tensions according to EN1991-2 section 6.5.4 and the torsion according to EN 1990 section A2.4.4.1.



The Guided Cross-Tie was designed for a minimal installation height for 450 mm for the slab track according to RIL 804. Two connection options are considered: The expansion joint can either be anchored to the structure in a pressure-loaded way via continuity reinforcement according to RIL or it can be connected to the levelling concrete of the slab track via continuity reinforcement without breaking the protective concrete and waterproofing.

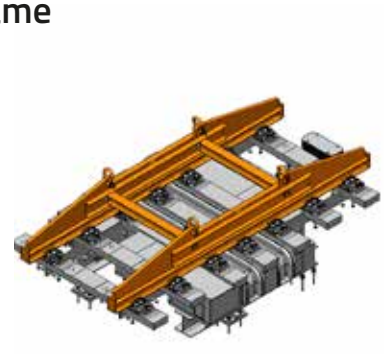
Accessories

Rail fastening system

The rail fastening system BSP FF-B-2 is intended for use in the slab track with increased capacity for vertical forces and lateral flexibility. It fulfils the requirements of EN13481-5.

Transverse movement capacity	± 2 mm
Dynamic vertical deflection	3.5 mm to 5.0 mm
Vertical height adjustment (in 1 mm steps)	-4/+26 mm
Track correction (in 1 mm steps)	± 16 mm

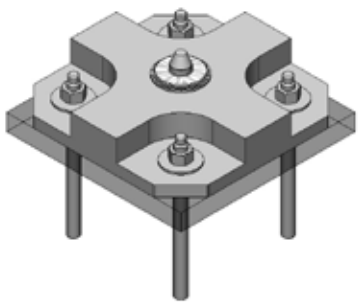
Transport and installation frame



The Guided Cross-Tie is supplied with a specially developed transport frame. Within the frame, the sleepers can be displaced in the longitudinal direction to enable quick and easy adjustments to accommodate the structural gap at the time of installation.

Mounting feet

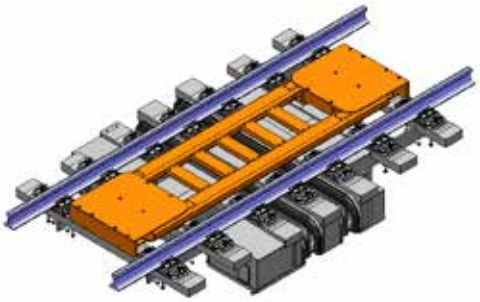
Six mounting feet are precisely measured and fixed in the structure prior to installation of the Guided Cross-Tie. The Guided Cross-Tie can then be quickly placed on the mounting feet in the correct installation postion. This procedure greatly speeds up installation (to one or two days) and saves operating time of heavy lifting equipment.



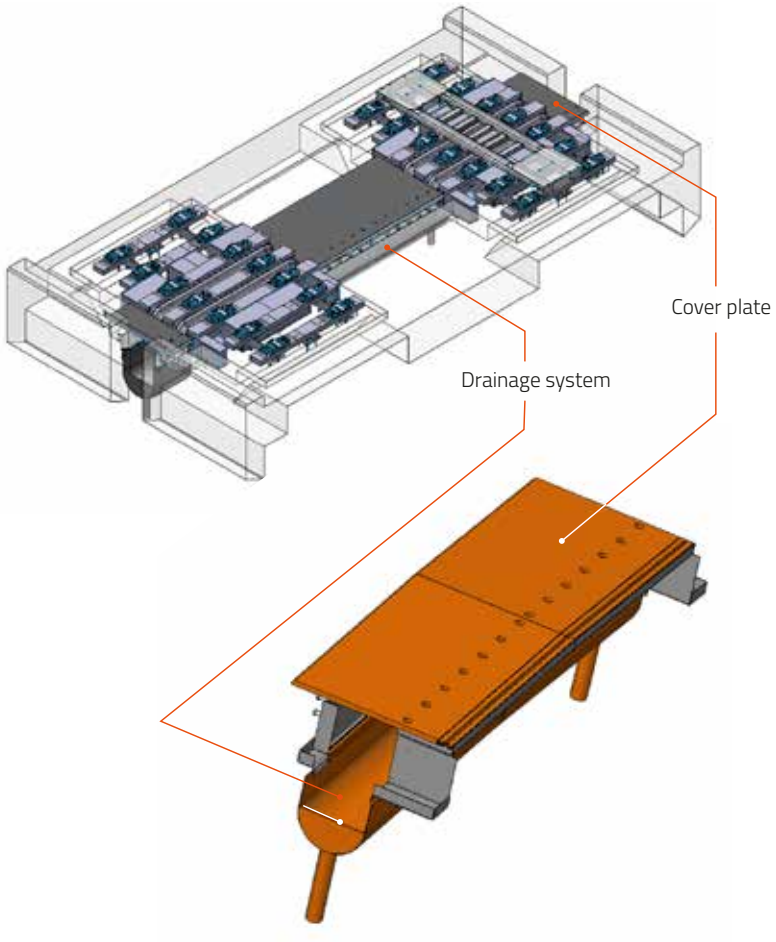
Derailment protection system

The derailment protection system ensures that the train is guided over the Guided Cross-Tie in the longitudinal direction in a controlled manner in the event of a derailment. The standard system is designed for a lateral load of 100 kN.

The derailment protection system does not rest on the moveable sleepers and can thus be freely swivelled and moved above the sleepers. Therefore, all required movement and rotation options continue to exist in the Guided Cross-Tie. The system is provided with a maintenance-free MSM®sliding bearing system to ensure low-wear and controlled sliding performance with minimum resistance.



Cover plate and drainage system



The cover plates serve as a protective covering over the structural gap adjacent to Guided Cross-Ties to enable safe access to the structure. The cover plate system can be provided with a drainage system which, together with the Guided Cross-Tie, guarantees watertightness over the entire width of the bridge deck.

Tests

The Guided Cross-Tie CT4 was successfully tested as a full-scale specimen and the test results also cover the CT2 type. The test requirements comply with the RIL 804 guideline and all testing was carried out by independent laboratories of the Technical University of Munich, which are certified as third-party inspectors.

Dynamic test

Static and dynamic loads were applied in combination with opening and closing movements of ±800 mm to evaluate the performance of the control mechanism and validate the design model. The passage of trains was simulated with a dynamic load of 180 kN. This load was applied by four unbalance exciters on top of the ballast concrete mass.

Slide path test

To validate the durability of the control system and load transmitting components, a Guided Cross-Tie was tested in a slide path test with an accumulated path of 10,000 m. For 3,500 m a superimposed load of ten tonnes was added to the test specimen.

References

Railway Viaducts 2 and 4 of the LRT project Toluca - Valle de Mexico, Mexico

Two large viaducts, up to 3,865 m in length, carry the new intercity train line between Toluca and Mexico City. Guided Cross-Ties were required due to large service and seismic movements.

Guided Cross-Ties

2 x CT2-860
10 x CT4-1328

Samuel de Champlain Bridge in Montreal, Canada

A two-lane bus line in the centre of the bridge was transformed into a two way railway line. Very large vertical movements and longitudinal seismic displacements at the structural gaps could only be accommodated with Guided Cross-Ties expansion joints.

Guided Cross-Ties with derailment protection system

4 x CT2-DP-370
8 x CT2-DP-860
4 x CT4-DP-1030

Quality and Standards

- EN ISO 9001, Quality management system
- DIN EN ISO 14001, Environmental management systems
- DIN EN ISO 3834-2, Quality requirements for fusion welding of metallic materials
- EN 1090-2, Execution of steel structures and aluminium structures
- Technical requirements for steel structures
- DIN EN 1991-1, Actions on structures
- DIN EN 1991-2, Traffic loads on bridges
- EN 1337-2, Structural bearings – Sliding elements
- ETA-06/0131 Spherical and cylindrical bearing with special sliding material made of UHMWPE (Ultra High Molecular Weight Polyethylene)
- AREMA – American Railway Engineering and Maintenance-of-Way Association
- Performance of tests at independent universities with notified body and the Deutsche Bahn AG
- Quality audits in cooperation with the client, if requested