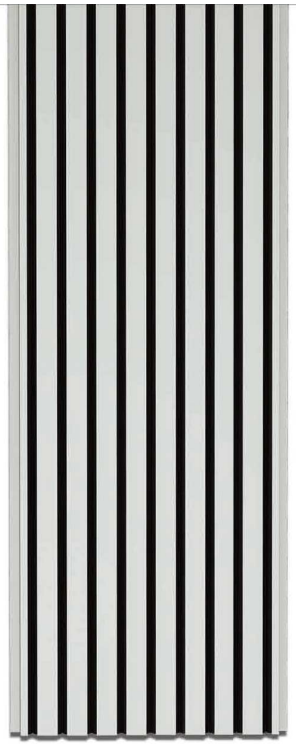
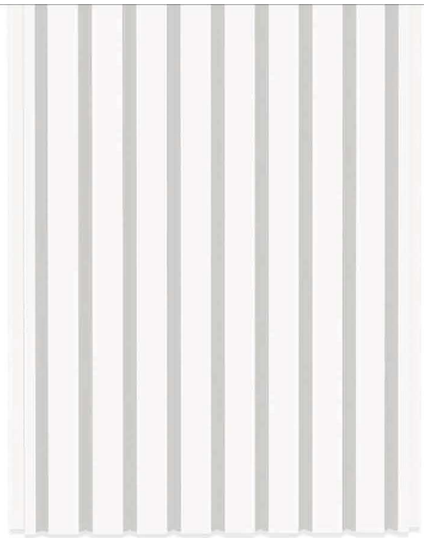
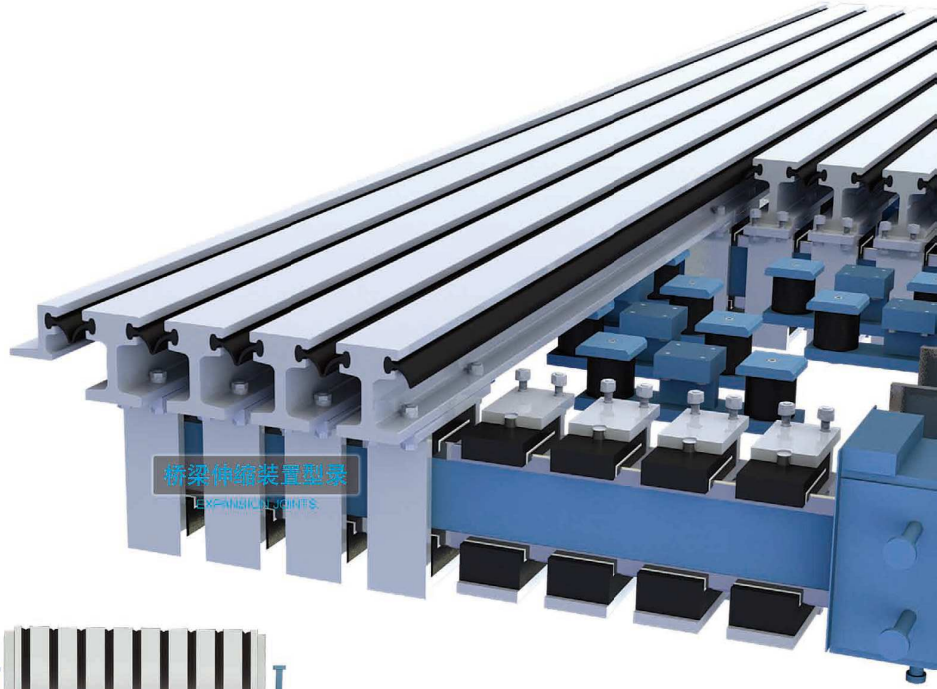
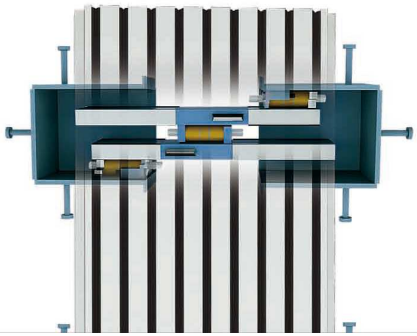
EXPANSION JOINTS

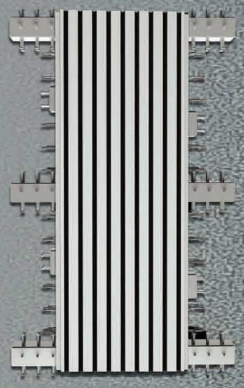








Our design and technical support:
Suzhou Haider Engineering Materials Technology Co., Ltd



GENERAL INTRODUCTION ON BRIDGE EXPANSION JOINT

HAIDER has professional experience in bridge expansion joint for more than 10 years, with large scale and professional capacity for rolling section steel, rubber vulcanization, machining and installation. The annual capacity of producing and installing is about 200,000 meters. The large displacement and various damping and noise reducing expansion joint designed and developed all by HAIDER have gained many National Patents.

Various road and railway bridge expansion joints produced by HAIDER have been widely used in key highway and railway project and exported aboard. HAIDER has been awarded as First Tenth Enterprise of Bridge Expansion Joint in China by China Quality Certification Center and User's Satisfied Enterprise by China Quality Control Association.

Expansion joint device of Bridge

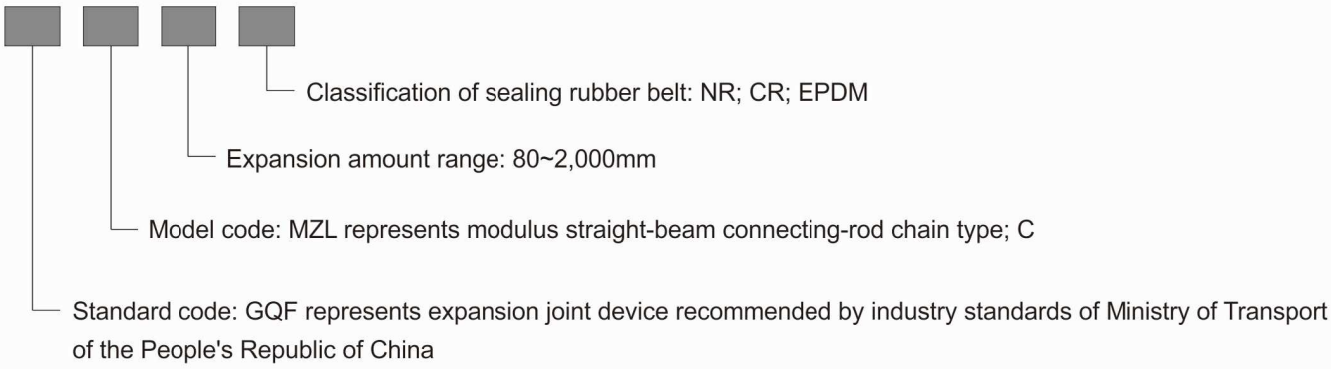
Expansion device of bridge is for smooth access of vehicles through deck and conforms to requirements of superstructure deformation of bridge, which is a collection of various devices composed of rubber and steel materials set at expansion point of bridge. It is passed to beams via power transmission bearing structure. Second is to adapt to change of vertical and horizontal displacement of bridge and angle change of warping at beam end.
Expansion device can be divided into the followings in accordance with materials used and purposes: modulus, comb-type and seamless expansion device.

Module Expansion Joint Device

Module expansion joint device is an upgrading product promoted in the market in 1990s, mainly assembled with domestic hot-rolled compromise steel materials and sealing rubber belt. It is of reasonable structure and long service life and convenient for installation and maintenance, which is better than mat rubber expansion joint.
Module expansion joint device is divided into two forms: single expansion joint device and multiple expansion joint devices.

I. Code Representation and Significance

Code representation shall be consistent with those specified in Traffic Industry Standard of the People's Republic of China.



Example 1: GQF-C60 (CR) represents adopting type C recommended by industry standards of Ministry of Traffic. The expansion amount shall be 60mm CR sealing rubber belt bridge expansion device
Example 2: GQF-MZL480 (EPDM) represents type MZL recommended by industry standards of Ministry of Traffic. The expansion amount shall be 480mm EPDM sealing rubber belt bridge expansion device

II. Scope of Application of Rubber Compound

1. Expansion device with CR adopted which is applicable to regions with a temperature of -25℃~+60℃.
2. Expansion device with NR adopted which is applicable to regions with a temperature of -40℃~+60℃.
3. Expansion device with EODM adopted which is applicable to regions with a temperature of -40℃~+60℃.

III. Technical Condition for Design and Manufacturing

1. Design load: C20 load of vehicles specified in the Technical Standard of Highway Engineering JTJ88 (1995) is adopted for design.
2. Compromise steel materials which are applicable to this structure shall be 16Mn bridge special steel. The tensile strength of steels shall be not less than 480Mpa. The allowable bending stress shall be not less than 210Mpa.
3. Other steels of accessories can be applied to steels with strength no less than Q235.

IV. Calculation of Expansion Amount

The following factors shall be considered when selecting expansion amount range:

1. Influence of temperature variation;
2. Drying shrinkage and creep effect of concrete bridge;
3. Displacement influence brought by beam end rotation due to dead and live load;
4. Bearing displacement influence caused by braking force;
5. Vertical variation influence of shifting end of bridge due to large longitudinal slope;
6. Jointing method dislocation influence of skew bridge and curved bridge;
7. Influence of other potential factors, such as installation and construction error of shrinkage device, errors during processing, prestress after installation and loss of prestress.

It is difficult to calculate expansion amount accurately now with various factors above considered. Therefore, it is reasonable to reserve enough surplus in the design (select dimension of expansion device and see Table 1 for calculation of expansion amount)

The determination of calculation of expansion amount of expansion device will directly affect dimension selection of expansion device. Application effects of expansion device will be directly affected in case of improper selection of expansion device dimension. Clearance among bridges shall also be considered when selecting expansion device dimension to ensure anchoring between expansion device and both ends of beam ans slab to achieve best effects. Therefore, enough surplus shall be reserved when selecting the expansion amount to ensure application effect and durability of expansion device.

V. Documents Provided by Users to Factory

1. Cross sectional drawing of bridge: includes detailed design data of longitudinal slope, cross slope, pavement, safety belt and location and dimension of guardrails;
2. Construction and installation time and range of variation of temperature during installation of expansion device;
3. It shall be specified in case of special requirements by users. for example,Location of beam form and prestress anchorage;

in this way, the factory ensures to process and manufacture, implement assembly, fixing and ex-factory in accordance with user requirements to avoid unnecessary rework and achieve high quality service. Positioning ex-factory shall be half of the maximum expansion amount of products in case of no temperature is provided during installation.

Single Expansion Joint Device

I. General Terms

Single bridge expansion joint is a new bridge expansion device composed of a steel side beam , a whole length of rubber sealing strip. Products are applicable to highway, city viaduct and flyover bridge projects with heavy traffic.

II. Structural features and functions

In case of any displacement due to temperature difference for bridge beam, rubber sealing strip fixed in the trench of side beam mechanically is available to free expansion to prevent water and dust. Impact force of traveling vehicles will be passed to bridge structure via side beam and welded anchorage components. The product is of reliable connection and smooth combination with deck, watertight sealing, flexible expansion and smooth traveling as well as long service life, which is suitable for bridge with an expansion amount of 0-120mm.

III. Major materials

Side beam of steels:
Domestic 16mn steel via hot extrusion is adopted, which is of good impact resistance, fatigue resistance, rust resistance, distortion resisting and welding, so as to ensure the service life of expansion joint.
Sealing rubber strip:
CR or EPDM or NR shall be adopted for manufacturing, which is of good aging resistance, distortion resisting and water-proofing property. The design of sealing rubber strip includes single-layer (SE and bird-shaped series) and double layer rubber strips (EFEseries) and they are of different specifications to adapt different expansion amount.
Anchoring system:
Various anchoring parts including anchors and anchor plate are designed to achieve reliable connection between expansion joints and bridge and for bridge engineer to select according to design thickness of bridge deck. The company can design and manufacture for special purpose.

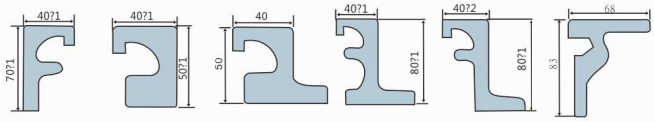
IV. Type

Main type of single joint include: GQF-C\E\F\Z-60~80, RG-60~80 and SD-80~120.

V. Expansion resistance:

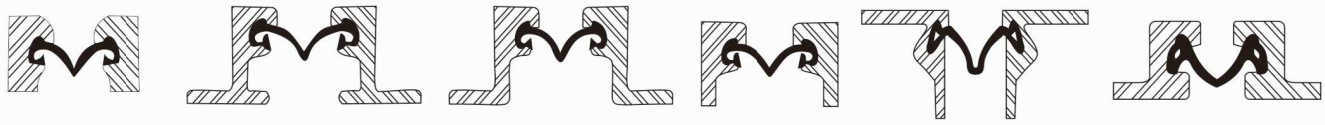
Compression force shall be 0.1KN/m during shrinkage
Longitudinal shearing force within operating range of shrinkage joint shall be 2.0KN/m

See the figure below for compromise steel section of expansion joints



F-steel C-steel RG-steel E-steel Z-steel M-steel

below for common section steel and sealing strip adopted for single joints



C-steel and rubber strip | Maurer section steel and rubber strip | MZL section steel and rubber strip | F section steel and rubber strip | SD section steel and rubber strip | RG section steel and rubber strip

Multiple Expansion Joint Devices

I. General

Multiple joint is composed of side beam, medium beam, displacement control box, pressure bearing, compaction bearing, anchorage components and sealing rubber strip. The displacement shall be 0~80mm for each unit. Number of groups shall be determined in accordance with actual displacement requirements of bridge. The maximum displacement can reach 2,000mm now.

Major forms:
SSFB direct supporting expansion device
XF inclined supporting device
MZL connecting-rod chain type expansion device

II. Features

1. Firm and reliable
Side beam and medium beam of expansion device are made from rolling of 16Mn steel, which is capable of bearing vertical load and horizontal impact of large traffic flow and large tonnage vehicles. Firm welding of between embedded reinforcement of abutment, beam and anchorage components, which can transfer vehicle load to abutment reliably. Reasonable structure and durability can run on bridges with designed capacity of C20 and G120.

2. Flexible expansion
The displacement control system of expansion device is composed of elastic components or inclined supporting components such as rubber spring and teflon bearing. The displacement of each group is even with less expansion friction resistance.

3. Smooth deck and comfortable traveling
The device will ensure the free expansion displacement of beams and form and make the deck joint to be smooth and comfortable for traveling of vehicles.

4. Waterproof and anti-corrosion
It shall be installed into the rubber sealing strip in the trench of each steel beam. It shall be processed as per bridge width, which can form good elastic deformation, water-proofing and dust proof; it can effectively protect the inner structure of expansion device and bearing at beam bottom from erosion.

5. Large displacement and convenient selection
The displacement of the device is designed and manufactured as per modulus from 80~2,000mm. Design and construction department of bridge can select at its own discretion in accordance with actual expansion amount of superstructure of bridge.

6. Expansion resistance
The compressive force shall be 1.0KN/m during shrinkage
The tensile strength shall be 4.0KN/m during stretching
Longitudinal shearing force within operating range of expansion joint shall be 2.0KN/m

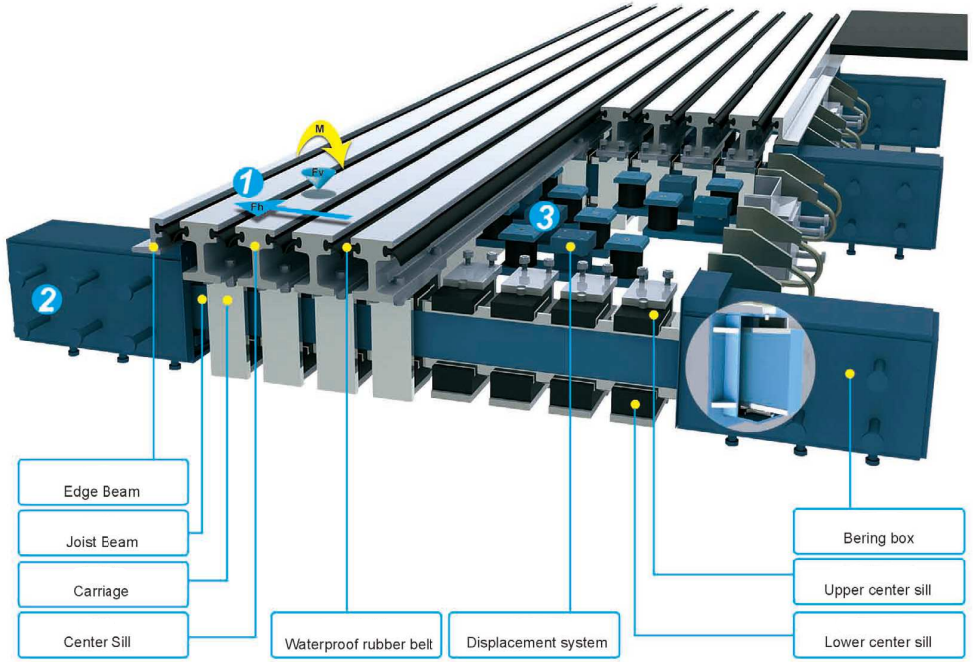
ZL series section steel expansion joint is special designed large displacement expansion joint for heavy high-density traffic based...

ZL

ZL series section steel expansion joint is special designed large displacement expansion joint for heavy high-density traffic based on characteristics both home and aboard and is classified as national level initiative invention key project.

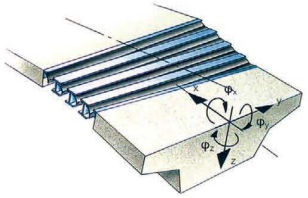
ZL series section steel expansion joint is designed on the basis of dynamic anti-fatigue principle. The displacement control system is a cooperation of elastic supporting system of single support beam and serial shear spring. It has characters of high bearing capacity, good anti-fatigue ability and even displacement control ability.

ZL series section steel expansion joint has the advantages of strong three-dimension displacement ability, compact conformation, easy to maintenance, long service life, etc. It suitable for all types of highway bridges, especially for suspension bridge, cable-stayed bridge and continuous concrete girder bridges.



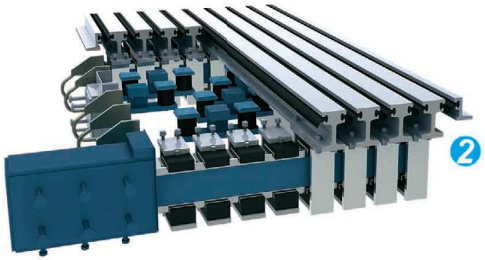
1 BEAR SYSTEM

THE BRIDGE MOVEMENT DIAGRAMMATIC SKETCH



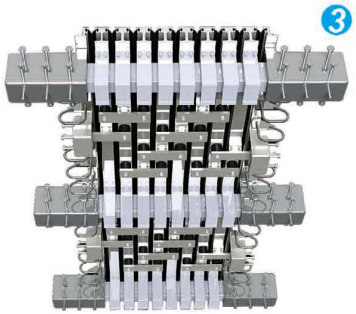
Vehicle passing through the expansion joint will caused impact load of level, vertical and torsion. Vertical force and torsion force through the center beam, edge beam, joist and elastic bearing and level force through displacement spring, using the damping property of rubber to cushion the load, transfer the load to the girder and abutment.

When the bridge structure under the influence of temperature changes, bridge will moves to direction of Ux, Uy and Uz. The sphere elastic bearing of ZL expansion joint meet the needs of three-dimensional movement.



DISPLACEMENT CONTROL SYSTEM

The displacement springs distributed in series and symmetrically under center sill push the center sill moves in uniform motion to control the uniformity of the joint width. The symmetric structure provides double protection.



CONNECTION

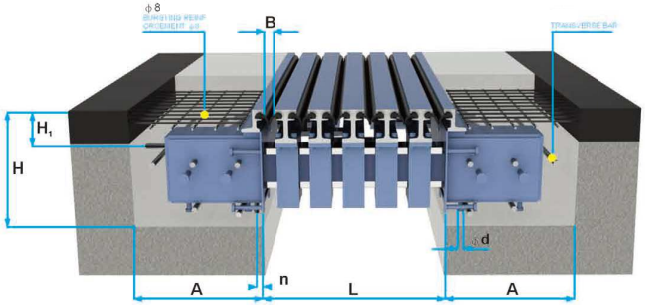
Expansion joint inner system connected by high-strength screws which can effectively avoid the centralized stress generated by welding, to ensure the service life of expansion joint under heavy high-density and its replaceability.

WATERPROOF STRUCTURE

The special design of waterproof structure provides the full protection for the substructure of bridge from rainwater.

ZL series section steel expansion joint is special designed large displacement expansion joint for heavy high-density traffic bound.

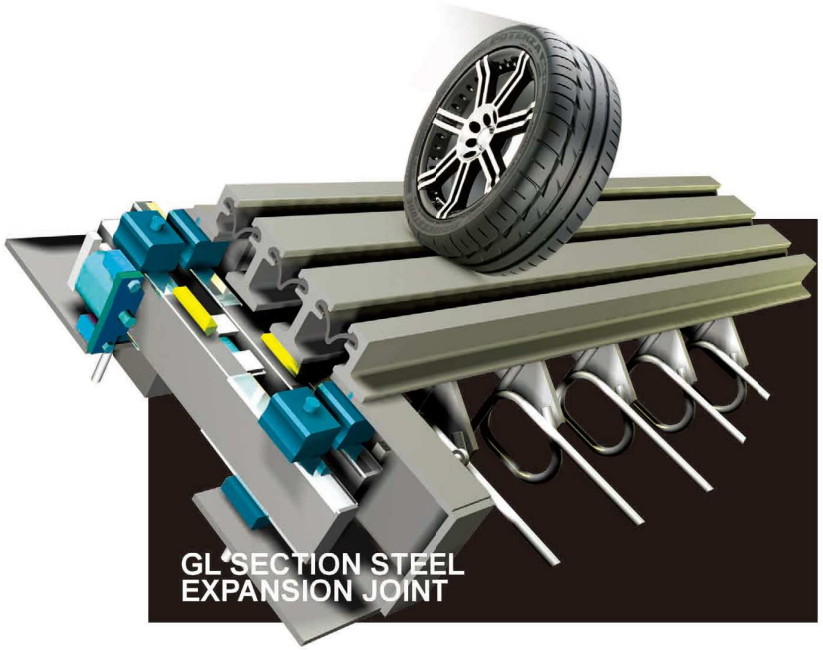
ZL



The design of preformed groove in steel expansion device

THE MAIN DESIGN PARAMETER OF EXPANSION JOINT

Specification	Numbers of joints	Displacement	Clearance	Size of preformed groove		Steel bar size		
	N	B	L	A	H	H_1	n	d
ZL160	2	160	110-270	440	400	145	90	16
ZL240	3	240	190-430	440	400	145	90	16
ZL320	4	320	270-590	480	400	145	90	16
ZL400	5	400	350-750	520	400	145	90	16
ZL480	6	480	422-902	560	420	145	90	16
ZL560	7	560	510-1070	600	420	145	90	16
ZL640	8	640	590-1230	640	440	145	90	20
ZL720	9	720	670-1390	680	450	145	90	20
ZL800	10	800	750-1550	720	460	145	90	20
ZL880	11	880	830-1710	760	500	145	90	20
ZL960	12	960	910-1870	800	500	145	90	20
ZL1040	13	1040	900-2030	840	540	145	90	20
ZL1120	14	1120	1070-2190	880	560	145	90	20
ZL1200	15	1200	1150-2350	920	590	145	90	20
ZL1280	16	1280	1230-2510	960	590	145	90	25
ZL1360	17	1360	1310-2670	1000	620	145	90	25
ZL1440	18	1390	1390-2830	620	145	145	90	25
ZL1520	19	1520	1470-2990	1080	650	145	90	25
ZL1600	20	1600	1550-3150	1120	650	145	90	25
ZL1680	21	1680	1630-3310	1160	680	145	90	25
ZL1760	22	1760	1710-3470	1200	680	145	90	25
ZL1840	23	1840	1790-3630	1240	720	145	90	25
ZL1920	24	1920	1870-3799	1300	720	145	90	32
Zl2000	25	2000	1950-3950	1340	750	145	90	32

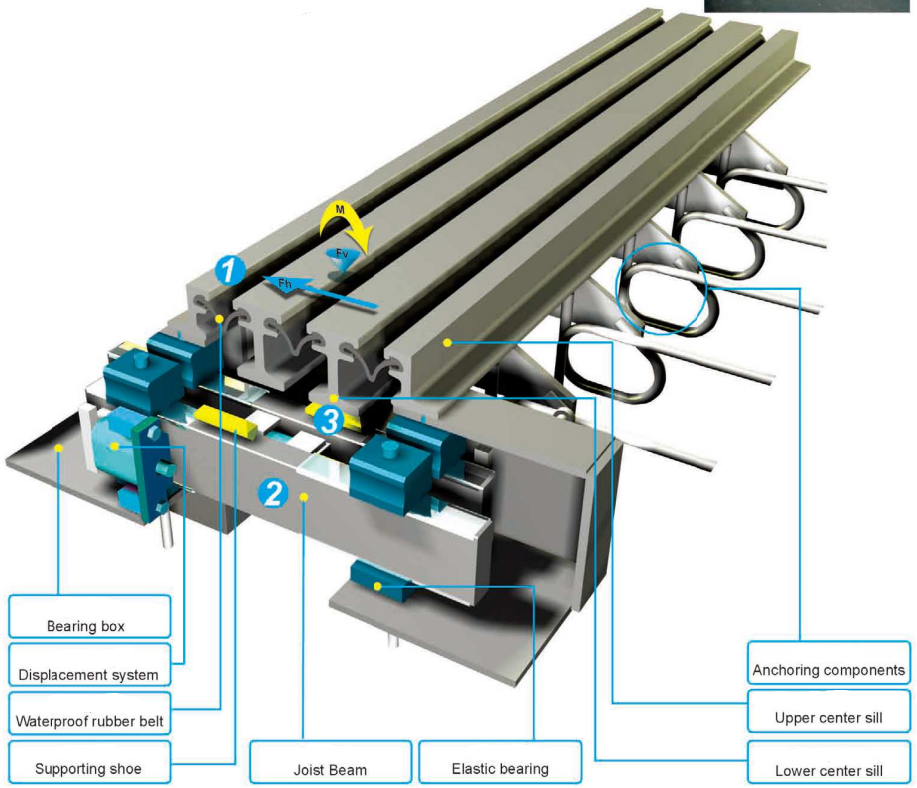


The design of GL series section steel expansion joint is in accordance with Dynamics of anti-fatigue theory. Elastic bearing systems consist of multiple units and connected in series by.

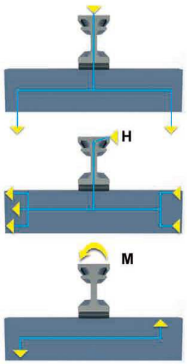
GL

The design of GL series section steel expansion joint is in accordance with Dynamics of anti-fatigue theory. Elastic bearing systems consist of multiple units and connected in series by springs to form displacement control system and have advantages of strong capacity of bearing, anti superior fatigue, displacement control in uniform motion and so on.

GL series section steel expansion joint has the advantages of long service life, compact, easy to maintain, driving comfort, etc.

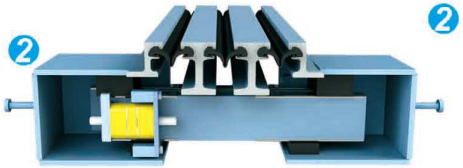


1 BEAR SYSTEM



Vertical force and torsion force through the center beam, edge beam, joist and elastic bearing and level force through displacement spring, deliver loads to the girder and abutment.

In each of the bearing box, there are several joist beams each of which welded with edge beam to form an independent supportive displacement control unit, pre-pressed elastically in the bearing box. Elevating angle by the deformation of elastic support bearing in the bearing box and achieving the level translational movement by the translation of joist beam to adapt to the deflection of the beam caused by bridge movement.

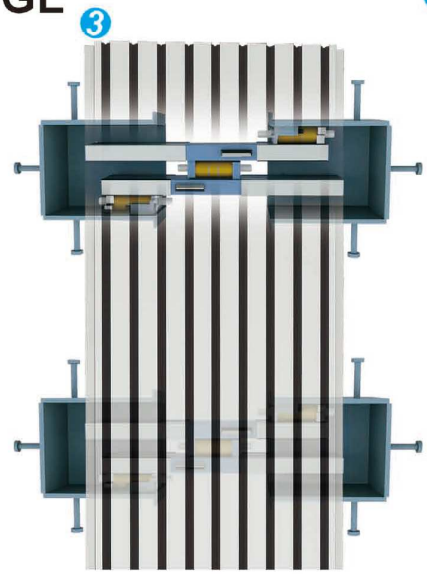


DISPLACEMENT CONTROL SYSTEM

Between joist beams there are displacement springs by which the displacement units connected into series, to achieve the uniform control of displacement units by the uniformly deformation of the springs as the change of beams.

The design of GL series section steel expansion joint is in accordance with Dynamics of anti-fatigue theory. Elastic bearing systems consist of multiple units and connected in series by.

GL

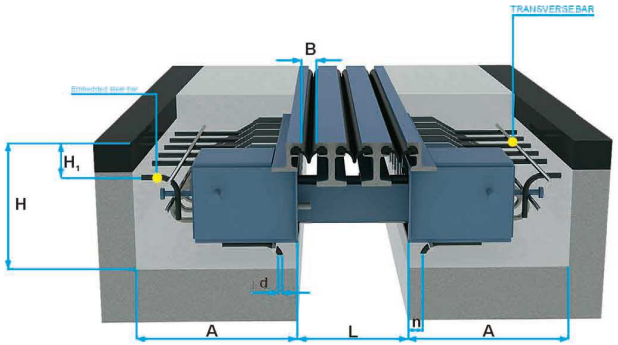


CONNECTION

With supporting shoe each center sill connect to joist beam to form a independent bearing and displacement control unit steady and reliable.

WATERPROOF STRUCTURE

The special design of waterproof structure provides the full protection for the substructure of bridge from rainwater.



Preformed groove of steel expansion joint design

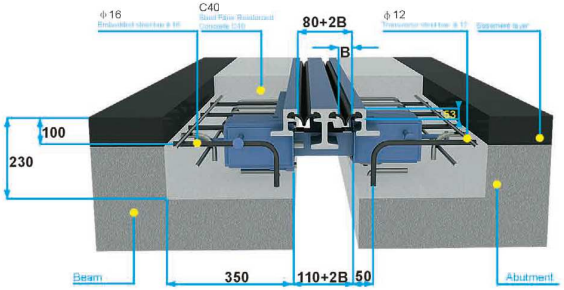
THE MAIN DESIGN PARAMETER OF EXPANSION JOINT

Specification	numbers of joints	Displacement	Clearance	Size of preformed groove		Steel bar size		
	N	B	L	A	H	H_1	n	d
GL160	2	160	110-270	350	350	135	90	16
GL240	3	240	190-430	440	350	135	90	16
GL320	4	320	270-590	530	400	135	90	16
GL400	5	400	350-750	610	450	135	90	16
GL480	6	480	430-910	690	470	135	90	16

QMSF160 section steel expansion joint is a modified shallow burial expansion joint with shallow groove, was national patent product, based on GL160 and suitable for projects of shallow groove and joint replacement.

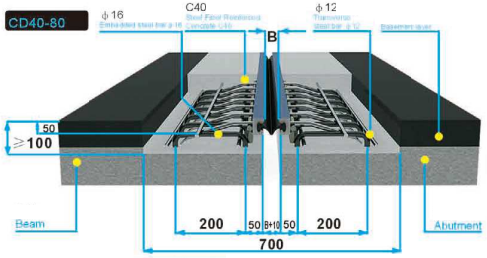
QMSF160 section steel expansion joint is a modified shallow burial .....

QMSF160



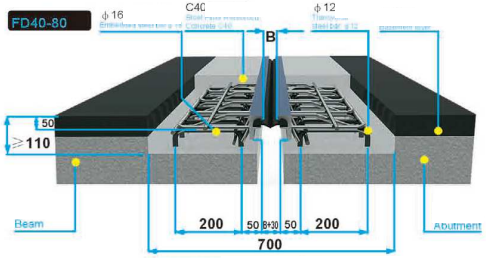
Preformed groove of steel expansion joint design

SHALLOW BURIAL SINGLE SECTION EXPANSION JOINT



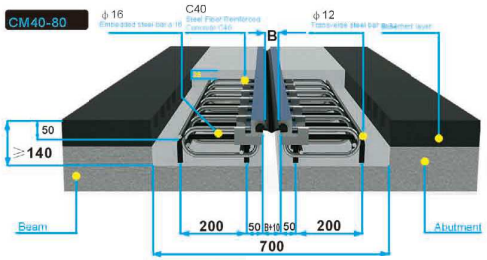
Cd40-80

Cd40-80 expansion joint installation sectional drawing



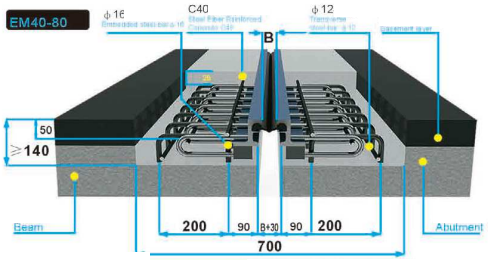
Fd40-80

Fd40-80 expansion joint installation sectional drawing



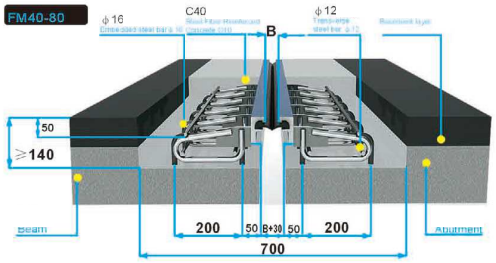
Cm40-80

Cm40-80 expansion joint installation sectional drawing



Em40-80

Em40-80 expansion joint installation sectional drawing



Fm40-80

Cd40-80 expansion joint installation sectional drawing

Installation and Maintenance of Modulus Bridge Expansion Device

I. Installation of expansion device

For the same excellent expansion device, different construction and installation quality will cause different application effects and durability. According to our investigation and research, it shows that the construction and installation quality of modulus expansion device is the last sector for ensuring the application effects of expansion device. Therefore, the following requirements are put forward concerning site construction and installation of modulus expansion device:

1. Construction company must reserve a slot for installing expansion device at the beam head (or slab head) and beam end, beam end and abutment in accordance with dimension specified in the design drawings. Anchorage reinforcement shall beem bedded as per drawing requirements. Anchor reinforcement shall be connected with beam end or abutment in a reliable manner. It shall conform to relevant regulations in construction specifications of bridge when implementing the welding of main reinforcement.

2. Expansion devices assembled by the factory shall be transported to construction site by dedicated vehicle. During the transportation of expansion device, construction shall be implemented under the guidance of manufacturer in case of splicing is required at the construction site due to restrictions of transportation length or other reasons. Expansion device shall be padded at least 30cm from the ground and shall not be stored in the open air when storage is required for expansion device at the construction site.

3. The clearance at both ends of main beam (or slab) must be checked after completion whether conforms to design or not, whether the position of anchorage reinforcement or components is correct before the expansion device is installed on the bridge. Whether the model of expansion device is applicable or not shall be considered in case of non-conformance with design requirements. Remedies such as adjusting the dimension among gaps of expansion joints or replacing models of expansion device must be considered in case of failing to meet requirements and ensuring reliable anchoring.

4. It is required to check whether the "J" or "a" value of expansion device conforms to installation temperature before the expansion device is installed on the bridge. Or horizontal jack and fixtures shall be used for adjustment in accordance with actual temperature (in case of any discrepancy with temperature provided by the factory during installation) under the guidance of engineer until it conforms to design re
quirements. It can be fixed with dedicated fixtures after being checked and signed by construction and installation principle.

5. Concrete in the reserved slot shall be chipped and cleaned before the hoisting of expansion device. The reserved slot shall reach appropriate width and depth when cleaning the formation level to put modulus expansion device with large displacement. All surplus reinforcement must be removed to ensure the gas of beam ends to conform to design requirements.

6. Hoisting point has been marked with conspicuous color during the ex-factory of expansion device. Hoisting must be implemented in accordance with hoisting point at the construction site. Proper strengthening measures shall be taken when necessary to ensure safety and reliability. Hoisting device shall be set at the slot and expansion device shall be installed in the reserved slot slowly. The center line of expansion device shall overlap with that of the bridge. The maximum deviation shall not be more than 10mm; the width value of expansion device along the bridge direction shall be put on the gaps of expansion device symmetrically. Level or steel ruler shall be used for positioning to match the top surface elevation and grade elevation (-1-1.5mm).

7. After the correct positioning of expansion device, height shall be positioned for reinforcement with vertical welding above ϕ16 at expansion device box or anchor plate. Straightness shall be positioned for horizontal welding ϕ16 reinforcement. The anchorage reinforcement at one side of expansion device shall be welded with reserved reinforcement in the reserved slot to ensure that the expansion device is firm. Welding shall be implemented for every 2~3 anchorage reinforcements. Reinforcement shall be anchored on the other side in accordance with the above procedures. Un-welded anchor reinforcement can be welded after both sides are fixed to ensure reliable anchoring. During the welding of anchor reinforcement, attention shall be paid not to weld freely on the side beam and medium beam to prevent deformation of steel beam. Then lateral connecting horizontal reinforcement shall be connected. One side shall be welded in case of difficulty and caliper shall be loosened for free expansion. At this time, expansion device has taken effect. After the anchoring of expansion device, fixing steel plate at the top of expansion device shall be removed and fitting bolt shall be cut. Grinding wheel shall be used to grind smooth and zinc paint shall be applied.

8. After completion of the above procedures, necessary formwork shall be installed and formworks for beam end and expansion device shall be set (2mm steel plate or equivalent polystyrene plastic board can be used). Formworks shall be manufactured in accordance with dimension of expansion device and gap of reserved slot. Formworks shall be tight to prevent mortar from flowing into displacement control box or gaps of bridge.
9. According to design drawings, epoxy resin concrete or steel fibrous concrete with strength more than C40 shall be poured in the reserved slot of concrete or high-strength concrete with strength of C50 or more than C50 can be used to fill and tamp. Necessary measures shall be adopted when pouring concrete to ensure dense tamping. Iron plate and other plates shall be paved on the surface of expansion device for protection and shall be put into the displacement control box of expansion device where concrete flows. Concrete shall not be filled into the gaps of sealing rubber strip and surfaces. In case of the aforesaid situation, it is required to clean immediately and implement protection.
10. Attention shall be paid to curing after the concrete is poured. Traffic shall be blocked and can be available after concrete reaches required strength.
11. The water-proofing course and paving of bridge deck are generally completed with bridge deck works of the whole bridge. Temporary protection measures of adding covers shall be adopted for expansion device before paving to avoid crash and bearing direct vehicle load. Gaps shall occur on the bridge deck after the paving of bridge deck.

II. Maintenance of expansion device

Regular repair and maintenance are necessary steps to ensure normal operation of expansion device and prolong the service life. Therefore, the followings shall be implemented for maintenance:
1. Combine with daily maintenance work of highway bridges. Clean sundries such as sediment and stone waste in the sealing rubber strip regularly. Prevent leakage due to the damage of sealing rubber strip caused by stressing of expansion device to affect free expansion and large pebbles. Replace rubber strip duly in case of leakage.
2. Check whether the joints of side beam and bridge deck paving is damaged or has cracks to cause leakage regularly. Repair immediately in case of the situation above to avoid affecting anchoring strength among expansion device, beams and plates.
3. Check whether the top of expansion device is smooth regularly. Further check whether the sliding bearing or sliding compaction bearing is damaged in case of any abnormalities. Replace duly in case of damage. The convenience for replacing parts and components has been fully considered in the design. It is feasible via actual tests.
4. Duly check whether the components of displacement control system are damaged in case of any large uneven displacement among gaps of expansion device during daily maintenance. Duly replace parts and components in case of any damage. Adopt standard components for convenient replacement. Generally, the strength and applicable durability of displacement control system have been fully considered in the design and it is not easy to occur.
5. Expansion device belongs to steel structure. Though protection treatment has been done before ex-factory, affected by operating environment, after some time, rust may occur and maintenance department shall implement rust prevention treatment periodically to ensure the durability of expansion device.