



TENSACCIAI

COMPANY PROFILE

HISTORY

WHERE WE ARE

WHO WE ARE

PRODUCT LINES

POST-TENSIONING

STAY CABLES

GROUND ANCHORS

BEARINGS

ANTI-SEISMIC DEVICES

EXPANSION JOINTS

PROJECTS

HISTORY

1951	Beginning of activity.
1964	In the sixties Tensacciai undergoes a phase of remarkable growth in Italy. Post-tensioning is just at the beginning of its history and its application is still experimental.
1970	A programme of technological renewal begins with the adoption of the steel strand.
1980	Tensacciai develops new tensioning systems and equipment in the field of ground anchors, combining innovation with versatility and ease use.
1990	New subsidiaries established in Brazil, India and Australia and in Europe sister companies in Portugal, Greece and the Netherlands.
2000	The company's internationalization process continues
2011	Tensacciai is acquired by Deal – world leading solutions provider in the field of bridge construction - and becomes part of Gruppo de Eccher. Tensacciai is now member of an organisation capable of designing, manufacture and install systems everywhere in the world, through specialised technicians, engineers in the technical department and quality control. Working procedures are assured by ISO9001 certification.
2014	Tensacciai merges with Rome-based Tecniche Idraulico-Stradali S.r.l. (TIS) - a leading company with experience in designing and producing structural bearings, expansion joints and anti-seismic devices since 1973. The merge of Tensacciai Tesit and Tis creates TENSA
2015-2023	New subsidiaries are established to execute major infrastructural projects in several Country, among which (the ones opened and closed at the present date are not listed): Tensa America (Miami), Tensa India (Mumbai), Tensa Romania (Bucharest), Tensa Denmark (Copenhagen), Tensa Russia (Moscow), Tensa Norway .
2026	Tensacciai Srl is dedicated to continuously enhancing the quality of its products and optimizing the efficiency of its methods.

WHO WE ARE – MAIN AFFILIATES

DEAL

Engineering & Special Equipment for Bridges
& Viaducts



General Contracting & Restoration

TENSACCIAI

Stay-cables, post tensioning, bearings, joints & anti-seismic devices

DE ECCHER INTERIORS

Interior Decoration & Furnishing

SPIC

Domestic Bridges & Viaducts

IRIDE

Real Estate Development

HISTORY

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POST-TENSIONING

STAY CABLES

GROUND ANCHORS

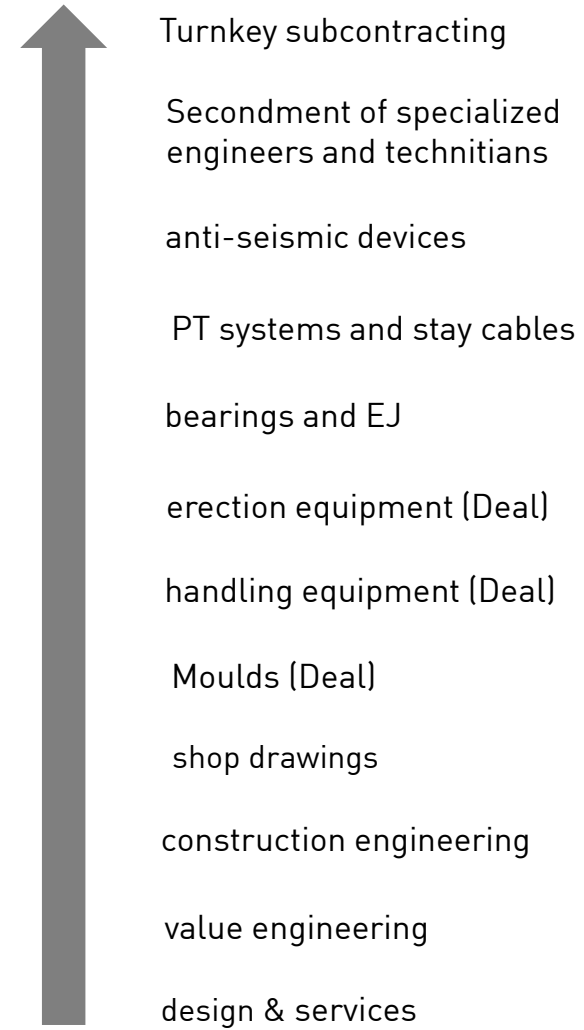
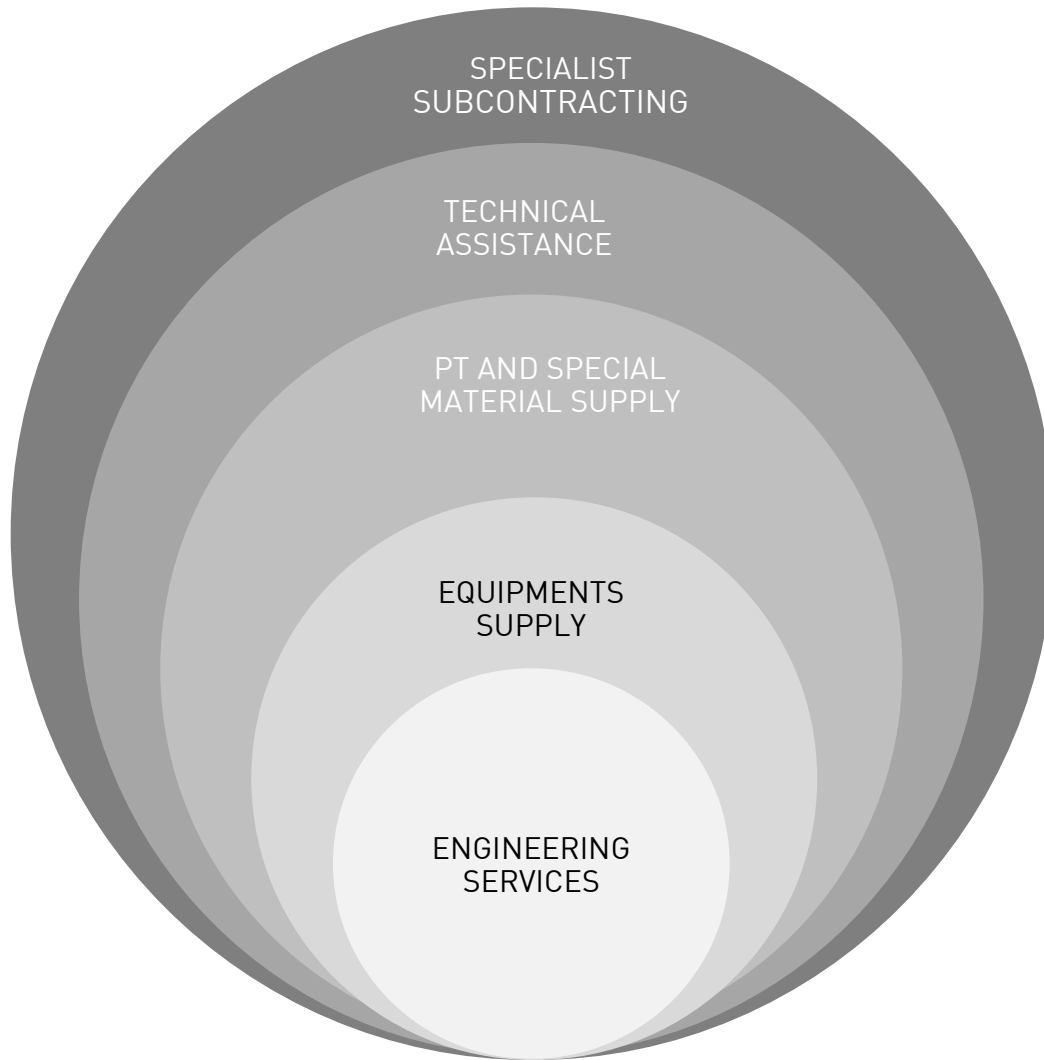
BEARINGS

EXPANSION JOINTS

ANTI-SEISMIC DEVICES

PROJECTS

WHAT WE DO



MORE THAN

300 MAJOR INFRASTRUCTURES
SINCE 1975

≈ 100 CABLE STAYED BRIDGES
SINCE 1995

IN OVER
COUNTRIES 40

ACTIVE MEMBER

MAIN ORGANIZATIONS



TC104 / SC2 - Execution of concrete structures

TC 250 / SC3 - Design of steel structures



TG5.3 - Prestressing materials and systems

TG5.5 - Cables for cable-supported structures

TG5.13 - Grouting of tendons in prestressed concrete

TG5.14 - Durability of post-tensioning



CRT70 - PT Systems Qualification Testing and Certification Committee

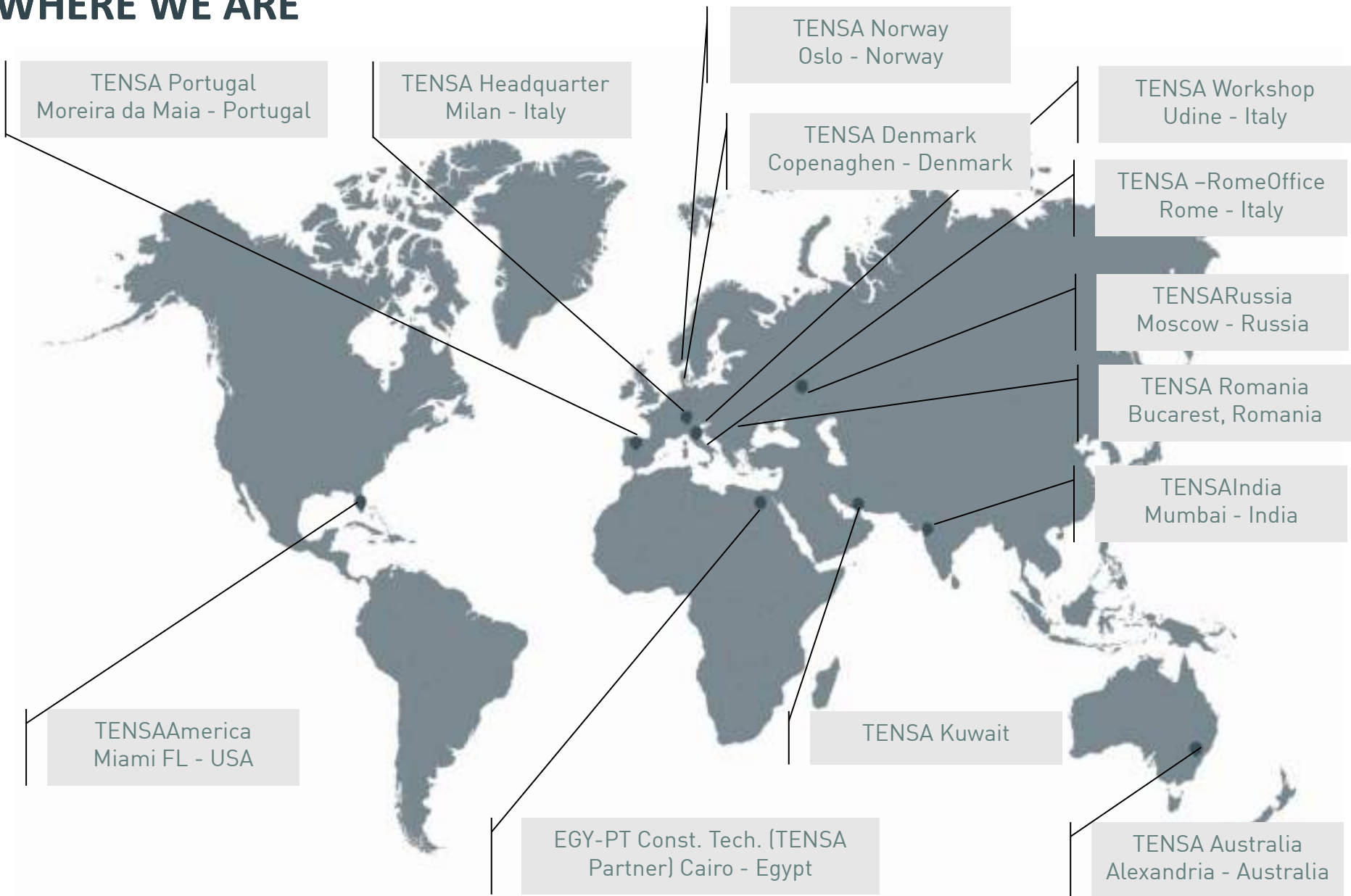
M50 - Multistrand and Bar Post-tensioning Committee

M55 - Grouting Committee

DC45 - Cable Stayed Bridge Committee



WHERE WE ARE



QUALITY MANAGEMENT CERTIFICATIONS

ISO9001-2015
Quality management systems

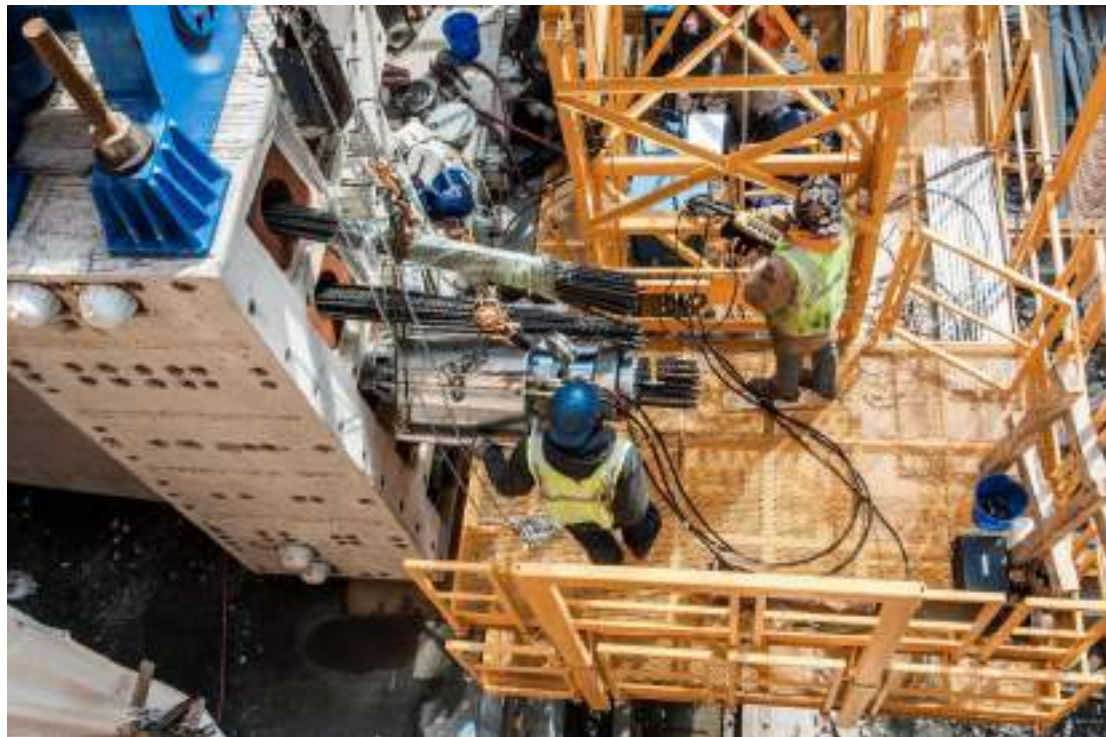
ISO14001-2015
Environmental management systems

ISO45001-2018
Occupational health and safety management system



WHO WE ARE

- CONSOLIDATED TURNOVER 2023: 54 Million EURO
- CONSOLIDATED TURNOVER 2024: 56 Million EURO (projected)
- HUMAN RESOURCES: 200 People (Engineers, high skilled Technicians and professionals Employees), excluding local branches



WHO WE ARE

COMPANY DIVISIONS: Post-Tensioning & Stay Cables; Bearing, EJ and Seismic Devices

MANUFACTURING & TESTING FACILITIES: Workshop for bearings, joints and antiseismic devices



HISTORY

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PRODUCT LINES

POST-TENSIONING

STAY CABLES

GROUND ANCHORS

BEARINGS

EXPANSION JOINTS

ANTI-SEISMIC DEVICES

PROJECTS

STAY CABLES

STAY CABLES & SUSPENDED BRIDGE

TECHNICAL CAPABILITY

TENSA STARTED DEVELOPPING ITS TECHNOLOGY FOR CABLE STAYED AND SUSPENDED BRIDGES IN THE LATE 80S

FIRST CABLE STAYED BRIDGE COMPLETED IN THE EARLY 90S IN ITALY

TENSA HAS COMPLETED MORE THAN 80 CABLE STAYED BRIDGES DURING THE LAST 27 YEARS USING THE PARALLEL STRAND SYSTEM



STAY CABLES & SUSPENDED BRIDGE

TECHNICAL CAPABILITY

MAXIMUM STAY CABLE CAPACITY
INSTALLED:

**169 NO. 15.7MM STRAND (I.E. 47,151KN
NOMINAL BREAKING LOAD) FOR NEW
CABLE STAYED BRIDGE OVER CRATI
RIVER – ITALY**



STAY CABLES

SYSTEM DESCRIPTION



ACCORDING TO A PRINCIPLE OF MODULARITY , STAYS WITH DIFFERENT DIMENSIONS CAN BE DESIGNED, STARTING FROM THE SMALLEST ONE, 4 TSRA15, UP TO THE BIGGEST AND COMPLEX ONE, 169TSRA15.

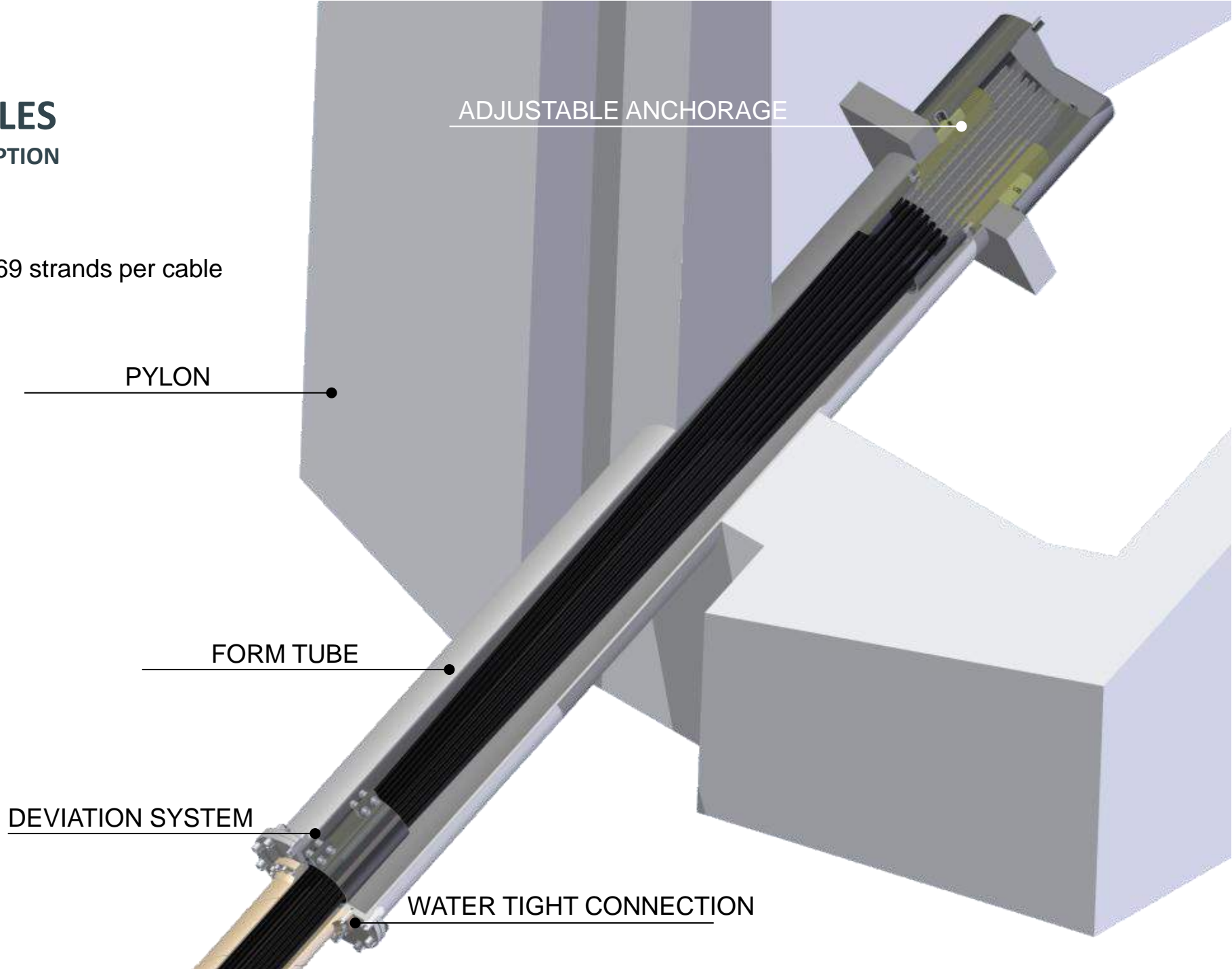
TYPICAL LAYOUT
TSR SYSTEM

STAY CABLES

SYSTEM DESCRIPTION

CABLE SIZE:

From 4 up to 169 strands per cable



ADJUSTABLE ANCHORAGE

PYLON

FORM TUBE

DEVIATION SYSTEM

WATER TIGHT CONNECTION

STAY CABLES

TECHNICAL CAPABILITY

TENSA STAY CABLES PROVIDES:

- PROPER LEVELS OF CORROSION PROTECTION TO THE TENSION ELEMENT (STRAND): 4 LAYERS OF PROTECTION
- FATIGUE AND STATIC ADEQUATE RESISTANCE (COMPLIANCE WITH INTERNATIONAL RECOMMENDATIONS: PTI, *FIB*)
- ISO9001:2008 QUALITY ASSURANCE SYSTEM
- INSTALLATION PROCEDURES ABLE TO GUARANTEE FULL FUNCTIONALITY



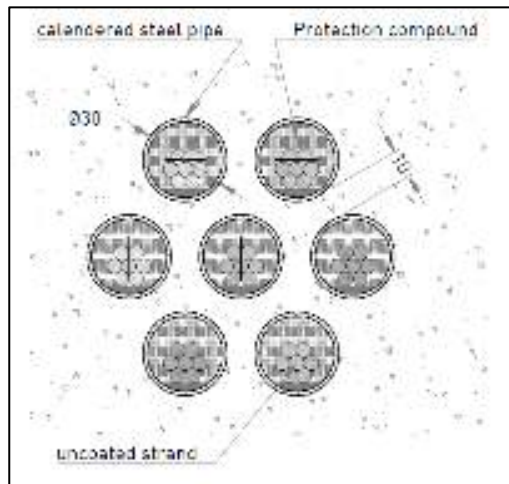
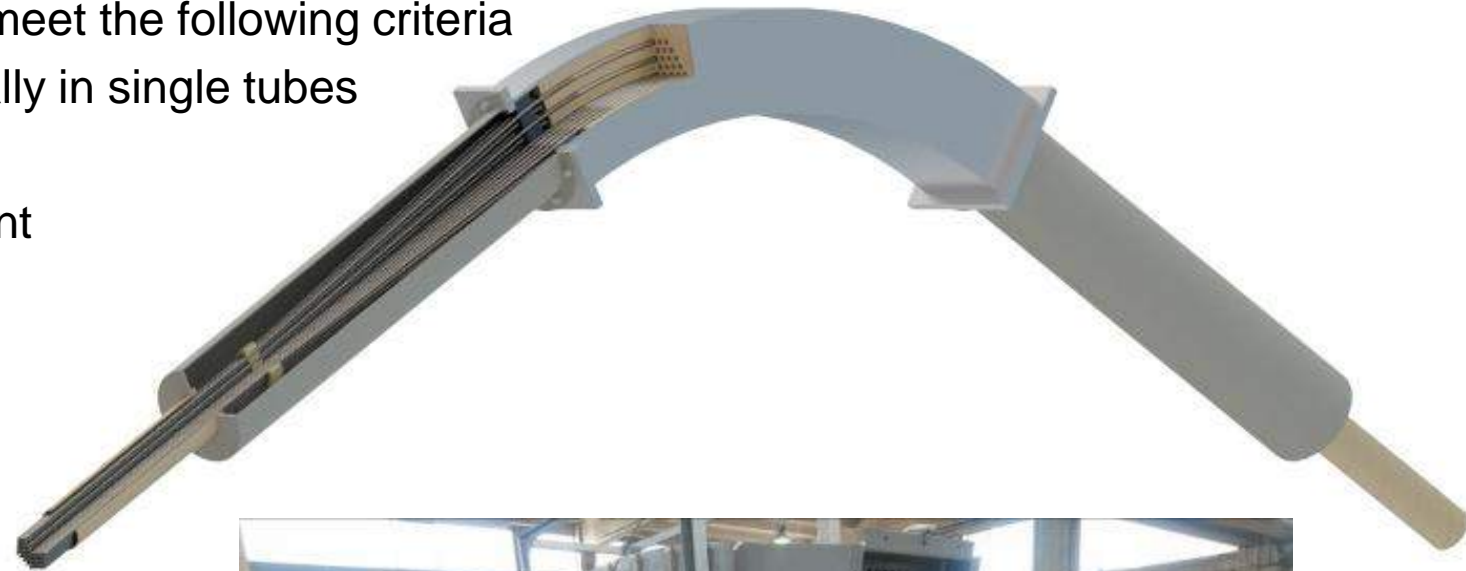
STAY CABLES

SADDLE SYSTEM

TENSA Multi-tube saddle TSS-T

Saddle system designed to meet the following criteria

- Strands guided individually in single tubes
- Force transfer by friction
- Single strand replacement



Cross section



STAY CABLES

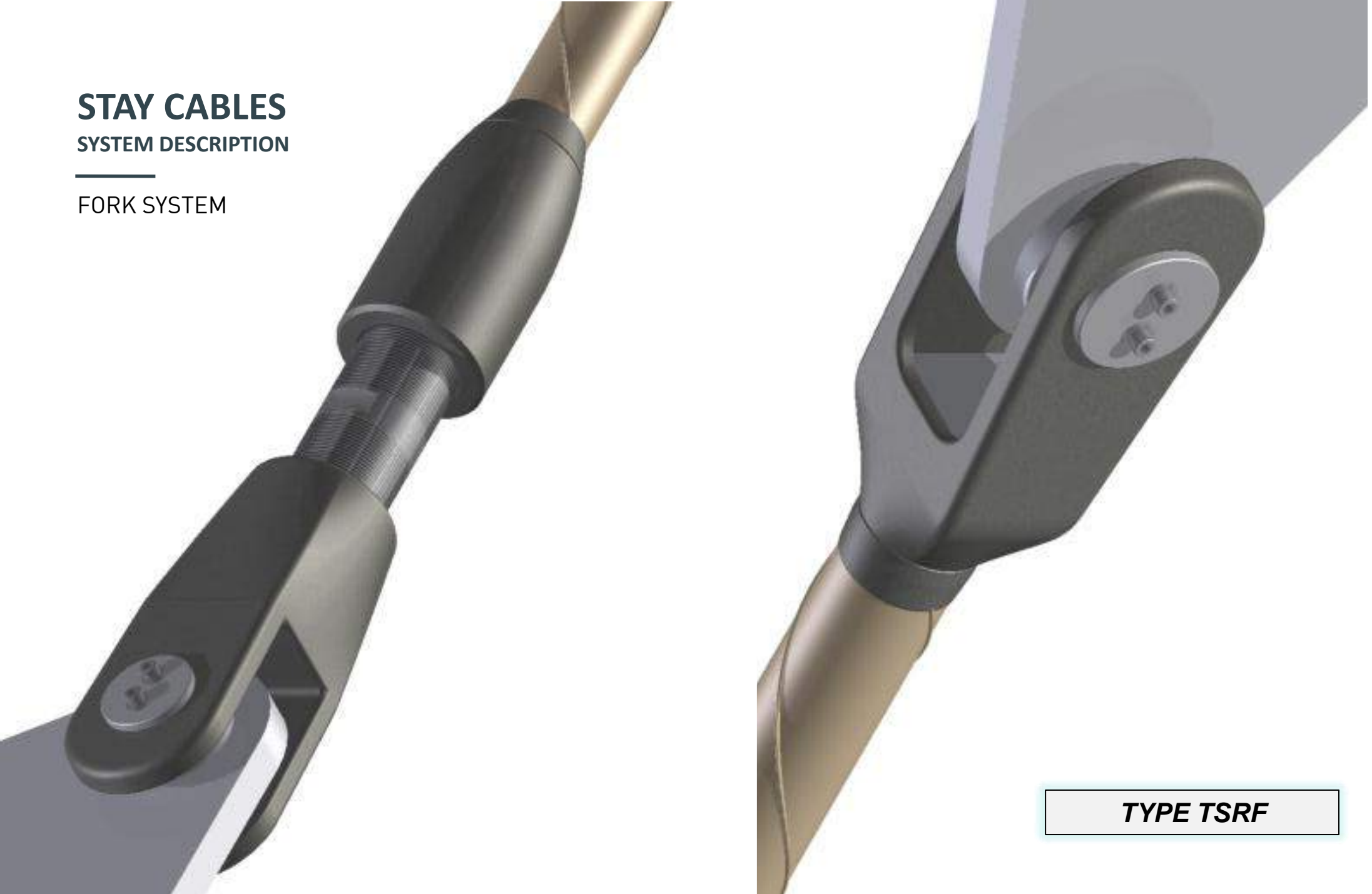
TESTING OF SADDLE SYSTEM



STAY CABLES

SYSTEM DESCRIPTION

FORK SYSTEM



TYPE TSRF

STAY CABLES

SYSTEM DESCRIPTION

FORK SYSTEM - APPLICATIONS

CABLE SIZE:

From 4 up to 61 strands per cable



CABLE STAYED BRIDGES
Cable Stays



SUSPENDED BRIDGES
Vertical Hangers

STAY CABLES

SYSTEM DESCRIPTION

FORK SYSTEM - APPLICATIONS



SUSPENDED ROOFS – COVERING STRUCTURES
Main Cables

STAY CABLES

TECHNICAL CAPABILITY

FOR THE FIRST TIME IN EUROPE TENSA HAS INSTALLED PARALLEL STRAND STAY CABLES FOR A BRIDGE FOR A HIGH SPEED TRAIN LINE. THE PROJECT IS THE CABLE STAYED BRIDGE OVER THE PO RIVER (HST - TAV - MILANO TO BOLOGNA) - ITALY - TRAIN SPEED DESIGN 350 KM/H



STAY CABLES & SUSPENDED BRIDGE

TECHNICAL CAPABILITY

IN 2017 HAS BEEN USED OUR SYSTEM FOR A RETROFITTING OF A STEEL BRIDGE FOR A HIGH SPEED TRAIN LINE, USING THE MAIN CABLES AS A SUSPENDED BRIDGE BRIDGE.

THIS PROJECT IS IN ITALY, CLOSE TO FERRARA.



STAY CABLES & SUSPENDED BRIDGE

TECHNICAL CAPABILITY

APPLICATION: RETROFITTING OF EXISTING BRIDGES

IN THIS SPECIFIC PROJECT, NR. 2 BUNDLE OF 27 STEEL STRANDS PER BRIDGE SIDE HAVE BEEN SUPPLIED, CONNECTED TO THE EXISTING BRIDGE THROUGH TIE RODS AND CLAMPS AND SADDLES.

THE BRIDGE HAS BEEN REINFORCED WITH A NEW STEEL STRUCTURE COMPOSED BY BEAMS UNDER THE DECK AND PORTALS ON THE PYLON.



STAY CABLES

TECHNICAL CAPABILITY

APPLICATION:

BRIDGE WITH THE LONGEST EXTRADOSED SPAN

ROSE FITZGERALD KENNEDY BRIDGE IRELAND

THE N25 NEW ROSS BYPASS PPP CROSS OVER THE RIVER BARROW ON A 3 TOWER EXTRADOSED BRIDGE EXTENDING FOR APPROXIMATELY 900 METRES IN COUNTY WEXFORD – MAIN SPAN 250M – THE LONGEST OF ITS TYPE



STAY CABLES

TESTING

Testing campaigns are continuously carried out in order to validate product development. Tests have been carried out not only over full scale assembled stay cables but also over single components, like wedges, anchorages and dampers.

Samples have been assembled using 15.7 and 15.2mm diameter steel strands, with class 1860 MPa.

Axial fatigue tests at 45% GUTS with a stress range of 200 MPa and inclined 10 mrad shims at the anchorages have been performed over small, medium and large size full scale TSR stay cable samples. These sample have also undergone tensile tests.

Bending fatigue tests with transversal displacement applied in the stay cable free length and subsequent tensile tests have also been carried out on large size TSR stay cable samples.

Leak tightness tests have been performed over full scale specimens both according to PTI recommendations (stay cable immersed in room temperature water after fatigue testing) and SETRA (CIP) recommendations (stay cable under 1000 transversal fatigue cycles and water subject to 50° C temperature cycles during six weeks time).

Tests have been performed in International third party laboratories according to main International Standards such as PTI “Stay Cables Recommendations for Stay Cable Design Testing and Installation”, FIB Bulletin 30 “Acceptance of stay cable systems using prestressing steels” and SETRA (CIP) “Cable stays – Recommendations of French Interministerial commission on Prestressing”.

STAY CABLES

TESTING

DYNAMIC (FATIGUE) TESTS



EMPA lab - Zurich



TUM University - Munich

STAY CABLES

TESTING

STATIC (RUPTURE) TESTS



EMPA lab - Zurich

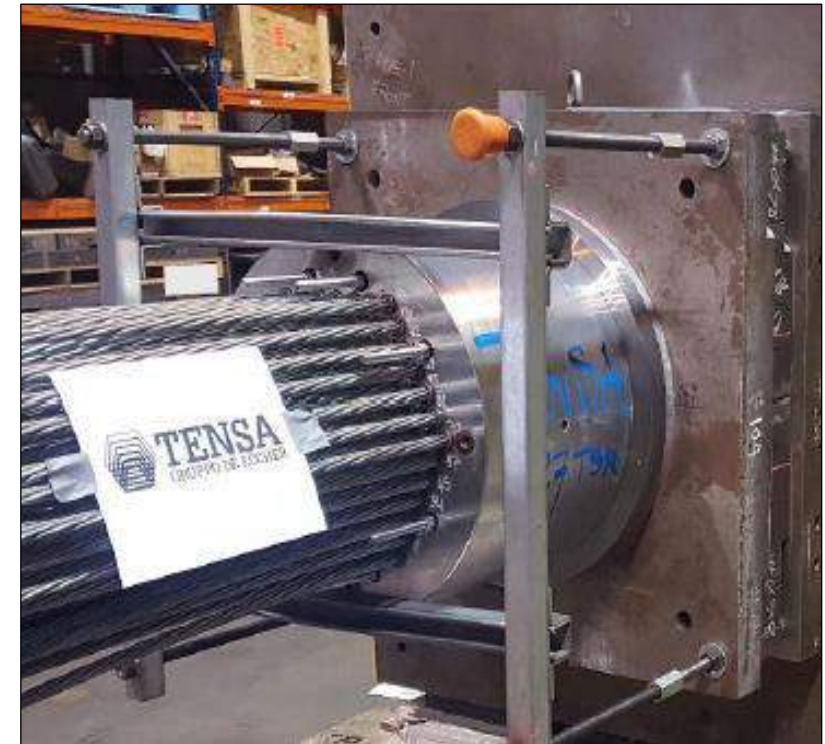


TUM University - Munich

STAY CABLES

TESTING

STATIC and FATIGUE TESTS



127TSR15S static and fatigue test - CTL in Chicago

POST TENSIONING

POST-TENSIONING

TECHNICAL CAPABILITY

TENSA STARTED TO DEVELOP ITS OWN POST-TENSIONING TECHNOLOGY IN THE EARLY 1970S.

OUR POST-TENSIONING SYSTEM IS SUITABLE FOR CONCRETE, COMPOSITE AND STEEL STRUCTURE.

A WIDE RANGE OF DIFFERENT SYSTEMS IS AVAILABLE



POST-TENSIONING

Tensacciai's own post-tensioning tendons have been employed in several projects in all five continents, in a wide range of applications from viaducts and bridges to tanks, buildings, foundations and special reinforced slabs.

Multi-strands tendons foresee a wide range of anchorages and systems for different applications:

Tensacciai's post-tensioning system is compliant with both the European Technical Approval (ETA) and CE markings.

Tensacciai's latest technological development is the electrically insulated tendon system, which was widely used in the 5 km high-speed train line viaduct "Piacenza" (Italy), currently the largest application of this kind globally.



POST-TENSIONING & FORM TRAVELLER



POST-TENSIONING - HISTORY

1964	Post-tensioning is at the beginning of its history and its application is still experimental. Tensacciai undergoes a phase of remarkable growth in Italy.
1970	A programme of technological renewal begins with the adoption of the steel strand.
1980	Tensacciai develops new tensioning systems and equipment in the field of ground anchors, combining innovation with versatility and ease use (multi-strand system).
1990 -2000	Tensacciai develops the sizes' range of its post-tensioning products together with technical solutions. Firsts Italian and French approvals on PT systems.
2008	Tensacciai obtains ETA 08/0012 for multi-strand MTAI PT system family.
2011	TENSA obtains ETA 11/0017 for monostrand 1C15 PT system and extends ETA 08/0012 to external PT system application.
2013 -2015	Wide testing campaign on Tensacciai PT system in the North America in accordance with AASHTO and PTI requirements.
2015	TENSA obtains ETA 15/0023 for PTSE slab, 1MT single strand, CU single strand coupler PT systems.
2016	Tensacciai extends ETA 08/0012 to couplers MTG and cryogenic applications
2017	New improvement in anchorage interaxis and edge distances.

Active member of:



TC104 / SC2 - Execution of concrete structures
TC 250 / SC3 - Design of steel structures



TG5.3 - Prestressing materials and systems
TG5.5 - Cables for cable-supported structures
TG5.13 - Grouting of tendons in prestressed concrete
TG5.14 - Durability of post-tensioning



CRT70 - PT Systems Qualification Testing and Certification Committee
M50 - Multistrand and Bar Post-tensioning Committee
M55 - Grouting Committee
DC45 - Cable Stayed Bridge Committee

POST-TENSIONING - HISTORY

2018 Tensa AMTS Post-tensioning system being approved by FDOT.

2021 Tensacciai obtains ETA 21/0989 for vertical passive anchorage

Active member of:



TC104 / SC2 - Execution of concrete structures
TC 250 / SC3 - Design of steel structures



TG5.3 - Prestressing materials and systems
TG5.5 - Cables for cable-supported structures
TG5.13 - Grouting of tendons in prestressed concrete
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POST-TENSIONING – ANCHORAGES TYPE



Internal MTAI live anchorage

The live anchorage **MTAI** is the most used and widely spread type of anchorage, whose compact geometry and reduced deviation angle provide a competitive advantage in all projects applications, combined with high performance standards and ease of installation.



MTG coupler anchorage

MTG system is the type of anchorage suitable for the coupling of tendons.

It is fully integrated with the MTAI system and allow installation of secondary tendon after the primary one has been completely installed.

POST-TENSIONING – ANCHORAGES TYPE



MTAID Electrically Insulated Anchorage

The **MTAID** anchorage for electrically insulated post tensioning is designed to meet the demand for a total and permanent protection of post tensioning tendons from corrosive agents



External MTAIE anchorage

This anchorage can be used in external tendons and comes in different versions depending on the project features:

- **Fully dismountable** , though the presence of an inner steel cone that separates strand and inner protective injection;
- **Restressable**, in case of unbonded system;
- **Not exchangeable**, bonded system without inner steel cone.

POST-TENSIONING – ANCHORAGES TYPE



Internal MTAIM dead anchorage for horizontal cables

The dead anchorage **MTAIM** is used for the point in which is not possible to stress directly or wedge-in the strands in the anchorages.



Internal MTDB dead anchorage for vertical cables

The dead anchorage **MTDB** is used for vertical cables in which threading and stressing shall be done from the top side with no access to the bottom anchorages in the base slab/foundation.

POST-TENSIONING – ANCHORAGES TYPE



Flat Slab PTS/PTSE PT anchorage

Bonded and Un-Bonded Post tensioning system for flat slabs or thin walls to be used with both metal and plastic ducts



Flat Slab TESIT 1C15 series PT monostrand anchorage

Mono-strand systems are used for post tensioning of concrete slabs, pavements, separation walls and special concrete structures such as underground car park, silos and tanks. They can be used for unbonded and bonded applications

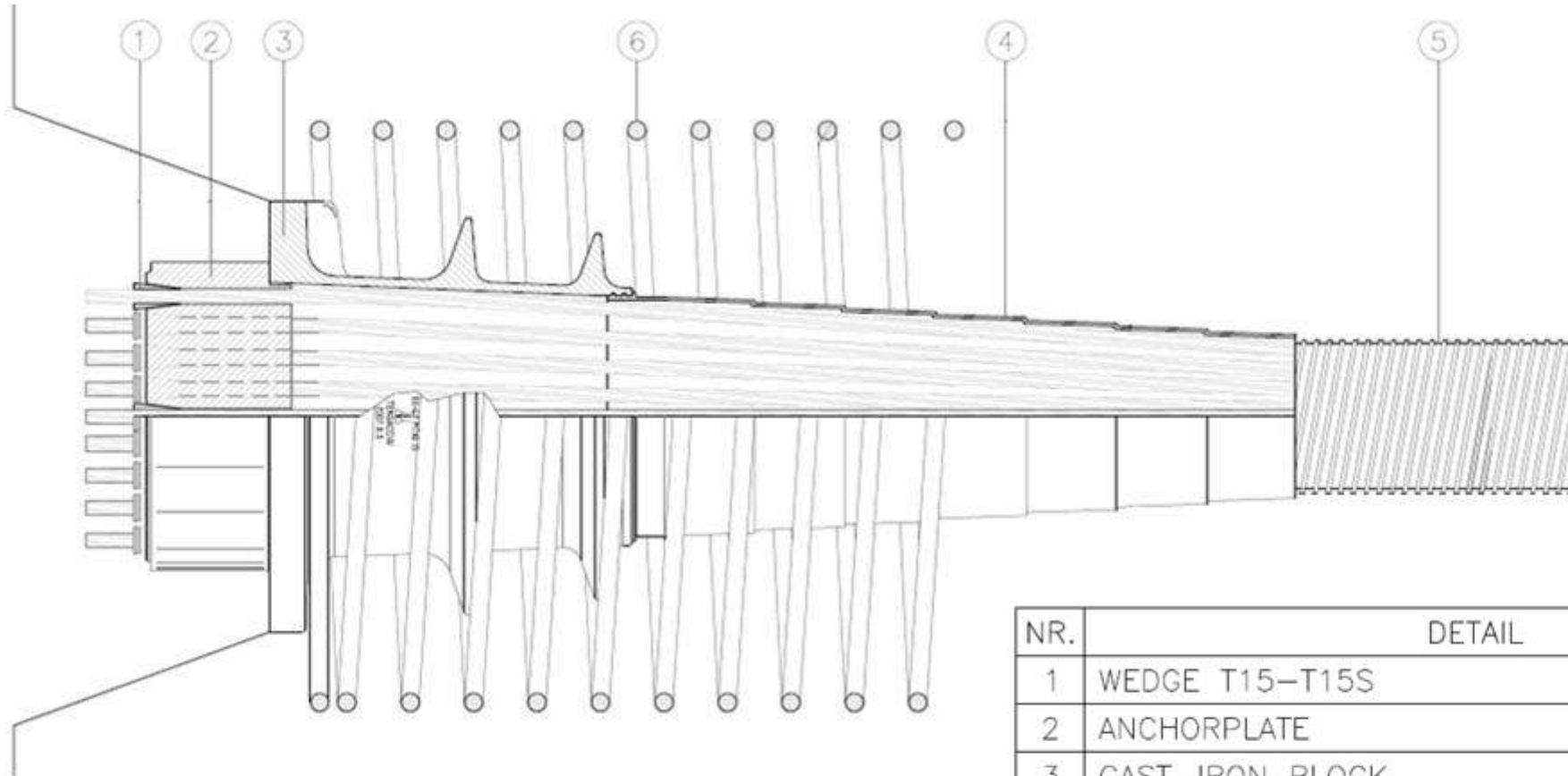
POST-TENSIONING – ANCHORAGES TYPE



MTAI SYSTEM IN CRYOGENIC APPLICATIONS

This system has been successfully tested at cryogenic conditions (-196°C) as per ETAG013 and SR 88/2. Compliance for use in LNG tanks and special structures has been completely assessed by Third Party Laboratories.

POST-TENSIONING – ANCHORAGE DESCRIPTION



NR.	DETAIL
1	WEDGE T15-T15S
2	ANCHORPLATE
3	CAST-IRON BLOCK
4	TRUMPET
5	CORRUGATED METAL SHEATH DUCT
6	STANDARD SPIRAL

POST-TENSIONING – EQUIPMENT



Stressing jacks



POST-TENSIONING – EQUIPMENT



Hydraulic Pumps



Strand pushing machines



POST-TENSIONING – EQUIPMENT



Grouting machines



POST-TENSIONING - CERTIFICATIONS

ETA 08/0012
for multi-strand PT system

ETA 15/0023
for PTSE slab, 1MT single strand, CU single
strand coupler PT systems

ETA 11/0017
for 1C15 monostrand PT system



Cerema **ETA**

European Technical Assessment **ETA 08/0012**
of 23/01/2017

Technical Assessment Body leading the ETA: Cerema
Via Salaria 300
00198 Roma (RM) Italy
Tel: +39 06 4981 1111
www.cerema.it

Trade name of the construction product: TENSACCIAI post-tensioning system

Product family to which the construction product belongs: Reinforcing and anchoring steel for concrete (and ancillary). Post-tensioning kits.

Manufacturer: TENSACCIAI S.p.A.
Via Postronale, 9
20132 Milano (Italy)
www.tensacciai.it

Manufacturing plant(s): Via Galilei, 35
33050 Ponzacco del Friuli, Udine (Italy)

This European Technical Assessment contains: 22 pages including 17 Annexes which form an integral part of this assessment.

This European Technical Assessment is issued in accordance with regulation (EU) No 305/2011, on the basis of: ETA-08/0012

This ETA replaces: ETA 08/0012 version 2 issued on 25/02/2015



ASQPE **CERTIFICATE OF CONSTANCY OF PERFORMANCES** **CE**
No. 1885 - CPR - 0037

POST-TENSIONING MULTI-STRAND SYSTEMS

ASQPE
Via Salaria 300
00198 Roma (RM) Italy
Tel: +39 06 4981 1111
www.asqpe.it

Manufacturer: TENSACCIAI S.p.A.
Via Postronale, 9
20132 Milano (Italy)
www.tensacciai.it

Product family: TENSACCIAI systems



Cerema **ETA**

Evaluation report **ETA 15/0023**
of 18/01/2015

Trade name of the construction product: TENSACCIAI PTSE slab post-tensioning system, TENSACCIAI 1MT single strand post-tensioning system, TENSACCIAI CU single-strand coupler post-tensioning system

Product family to which the construction product belongs: Reinforcing and anchoring steel for concrete (and ancillary). Post-tensioning kits.

Manufacturer: TENSACCIAI S.p.A.
Via Postronale, 9
20132 Milano (Italy)
www.tensacciai.it

Manufacturing plant(s): Via Galilei, 35
33050 Ponzacco del Friuli, Udine (Italy)

This evaluation report: 23 pages including 22 Annexes



ASQPE **CERTIFICATE OF CONSTANCY OF PERFORMANCES** **CE**
No. 1683 - CPR - 0027

POST-TENSIONING MULTI-STRAND SYSTEMS

ASQPE
Via Salaria 300
00198 Roma (RM) Italy
Tel: +39 06 4981 1111
www.asqpe.it

Manufacturer: TENSACCIAI S.p.A.
Via Postronale, 9
20132 Milano (Italy)
www.tensacciai.it

Product family: TENSACCIAI systems (PTSE, 1MT & CU)



Cerema **ETA**

European Technical Assessment **ETA 11/0017**
of 14/01/2016

Technical Assessment Body leading the ETA: Cerema
Via Salaria 300
00198 Roma (RM) Italy
Tel: +39 06 4981 1111
www.cerema.it

Trade name of the construction product: TEST 1C15 monostrand post-tensioning system

Product family to which the construction product belongs: Reinforcing and anchoring steel for concrete (and ancillary). Post-tensioning kits

Manufacturer: TENSACCIAI S.p.A.
Via Postronale, 9
20132 Milano (Italy)
www.tensacciai.it

Manufacturing plant(s): Via Galilei, 35
33050 Ponzacco del Friuli, Udine (Italy)

This European Technical Assessment contains: 22 pages including 19 Annexes which form an integral part of this assessment.

This European Technical Assessment is issued in accordance with regulation (EU) No 305/2011, on the basis of: ETA 11/0017

This ETA replaces: ETA 11/0017, issued on 22/11/2014



ASQPE **CERTIFICATE OF CONSTANCY OF PERFORMANCES** **CE**
No. 1825 - CPR - 0032

POST-TENSIONING MULTI-STRAND SYSTEMS

ASQPE
Via Salaria 300
00198 Roma (RM) Italy
Tel: +39 06 4981 1111
www.asqpe.it

Manufacturer: TENSACCIAI S.p.A.
Via Postronale, 9
20132 Milano (Italy)
www.tensacciai.it

Product family: TEST 1C15 monostrand system

POST-TENSIONING - TESTING

As per EN13391 and ETAG 013, post-tensioning tendons must guarantee:

1. Efficiency performance (ultimate breaking load);
2. Load transfer performance (capability of transferring loads to concrete).
3. Fatigue performance (behavior under cyclic loading)

All tests carried out on TENSA PT systems were performed in accordance to EN13391 and ETAG013 in third party international worldwide known laboratories.

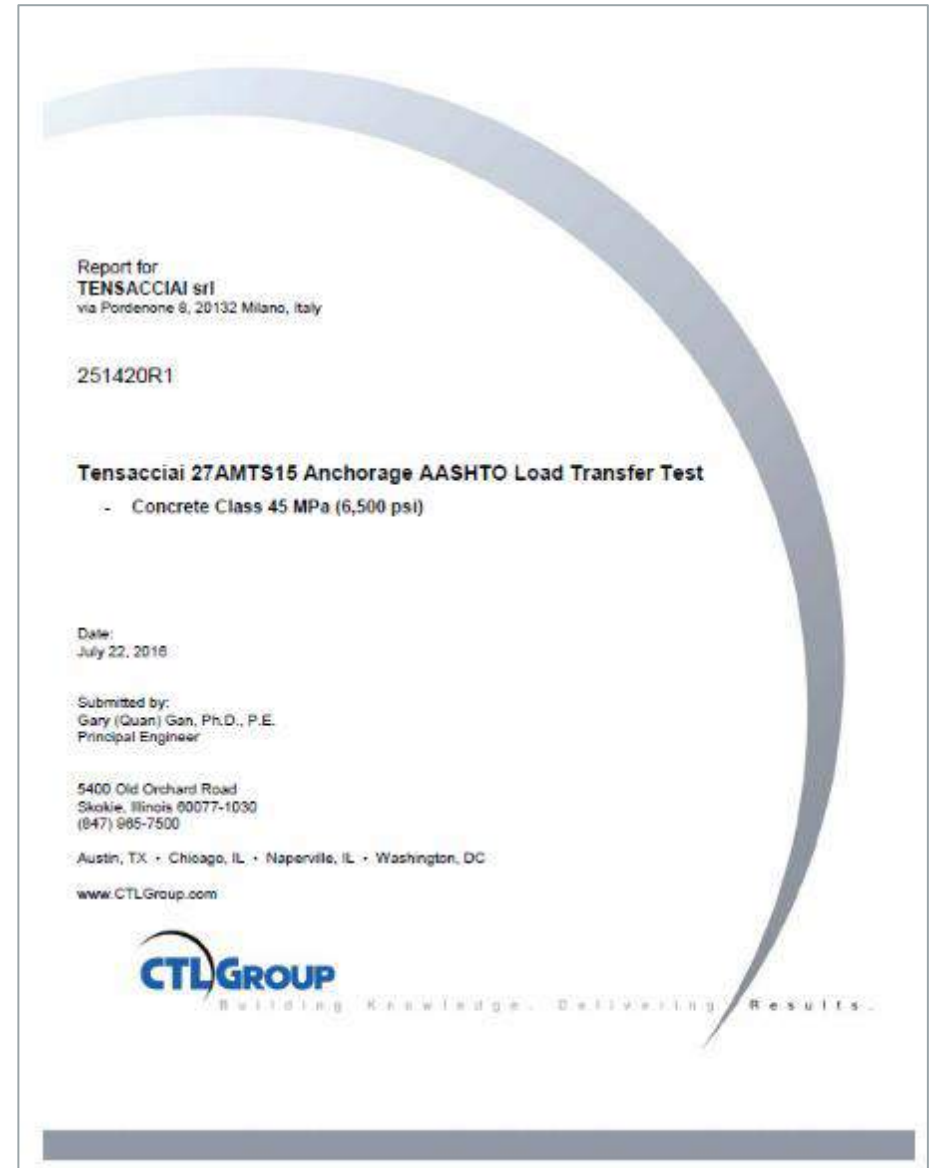


POST-TENSIONING - TESTING

TENSA PT systems have been tested under the requirements of AASHTO LRFD Specifications, PTI/ASBI M50 “Guide specification for grouted post-tensioning” and State DoTs Specifications.

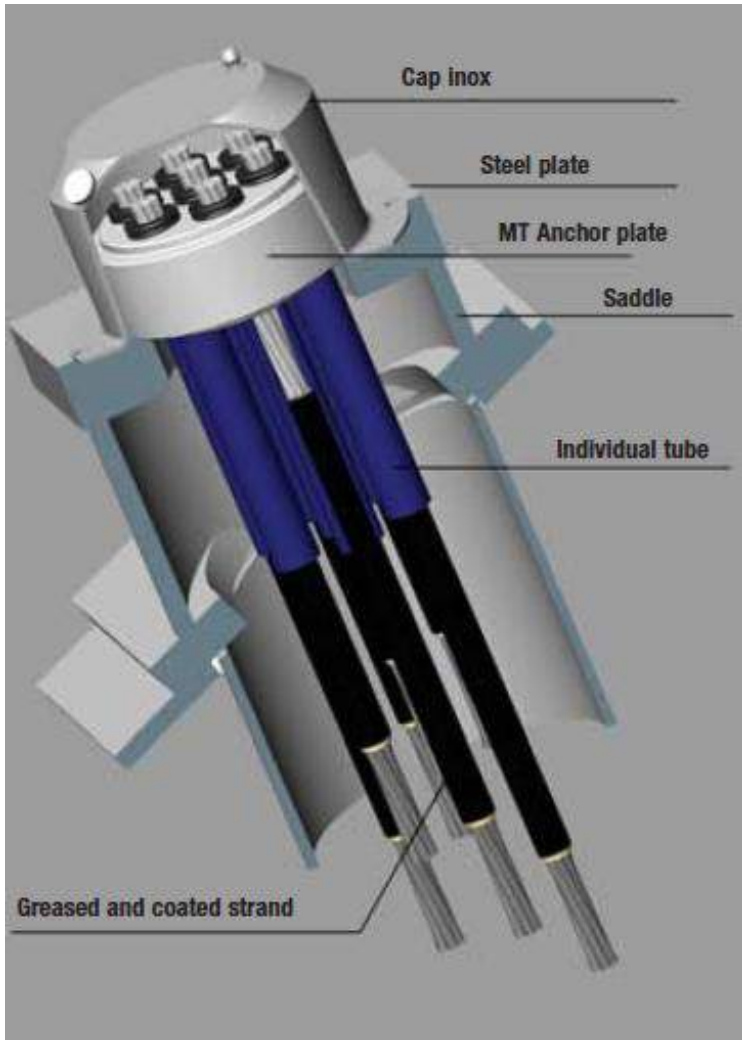
Tests have been performed in AASHTO qualified laboratories in full compliance with Technical Specifications.

TENSA PT systems have been approved by FDOT

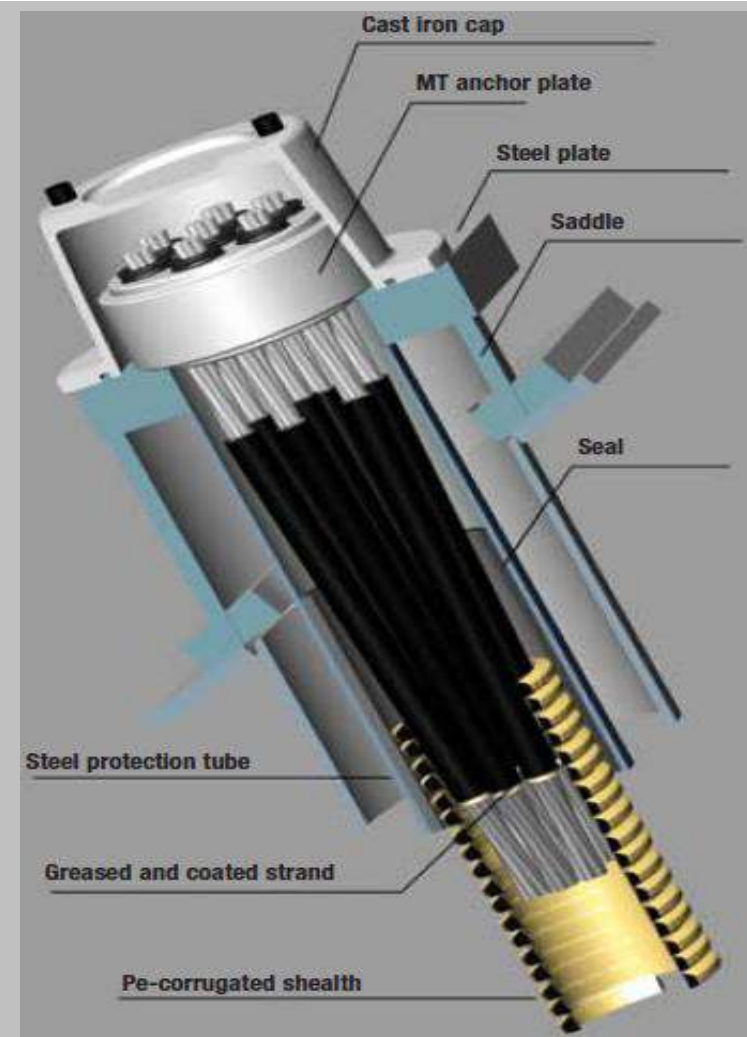


GROUND ANCHORS

GROUND ANCHORS



Temporary ground anchor



Permanent ground anchor

BEARINGS, EXPANSION JOINTS AND SEISMIC ISOLATORS

Division for antiseismic device, bearings and expansion joints

It's more than 35 years that TENSA works in the specific fields of design, construction and setting of connecting devices and structural bearings. TENSA has been developed a great experience getting numerous specific solutions both for new constructions and for the retrofitting of existing ones.

TENSA is appreciated in Italy and abroad as a high-qualified company. It takes part in the writing out of both Italian and European Standards (CEN-TC340), public associations and many Universities for the drawing up of documents specifically referred to bearings, seismic devices, and expansion joints. Such activity guarantees TENSA a constant updating on the most advanced requirements and provides a precious source for technical and professional incentive.

During its developing process TENSA has also matured great expertise in fields like restoration and production of special devices for cultural heritage. This has enabled a great know-how concerning the employment of a vast range of materials, from rubber to steel, titanium, up to shape memory alloys (SMA) and composite materials (FRP).



Active member of:



TENSA Products

BEARINGS

RUBBER

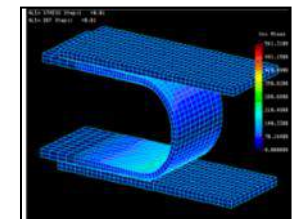
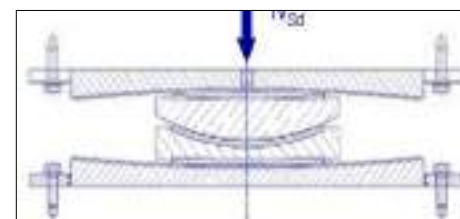
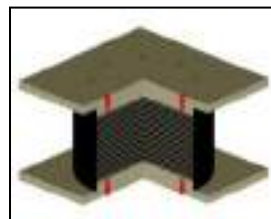
TR - Tens Rubber Bearing

STEEL

TP - Tens Pot Bearing

TS - Tens Spherical Bearing

TK - Tens Cylindrical



SEISMIC DEVICES

RUBBER ISOLATORS

TDRI - Tens Damping Rubber Isolator

TLRI - Tens Lead Rubber Isolator

CURVED SURFACE SLIDERS

TFPI - Tens Friction Pendulum Isolator

RIGID CONNECTION

TSTD - Tens Shock Transmitter Device

VISCOUS DAMPERS

TFVD - Tens Fluid Viscous Damper

TPSD - Tens Preloaded Spring Damper

HYSTERETIC DEVICES

TEPD - Tens Elasto-Plastic Device

DISSIPATIVE BRACINGS

TFB - Tens Frame Bending

EXPANSION JOINTS

ROAD

UBJ - Uni Block Joint

MBJ - Multi Block joint

SFJ - Steel Finger Joint

RAILWAY

RRJ - Rubber Railway Joint



BEARINGS

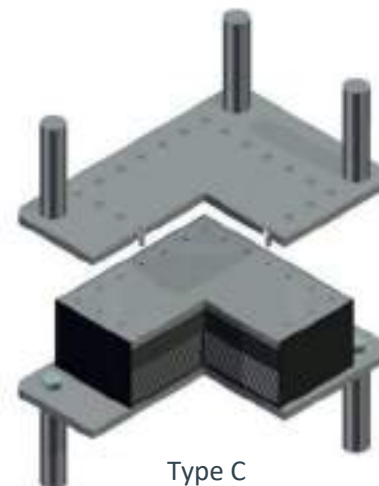
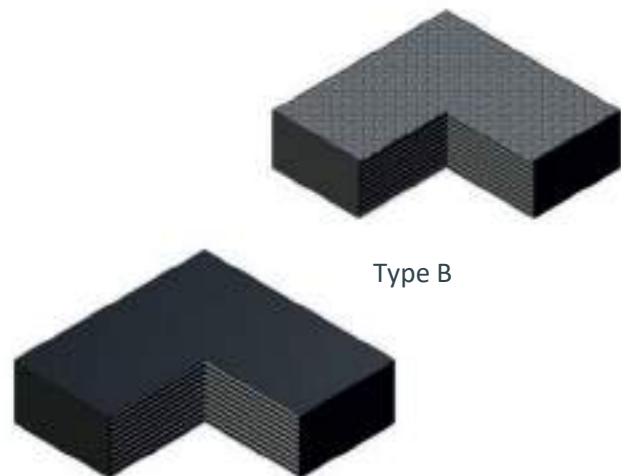
Tens Rubber Bearing



TENS RUBBER bearings are able to transfer vertical and lateral loads between the superstructure and the substructure; they allow displacements in all directions and rotations about any axis thanks to the rubber's elastic deformation. TR bearings are usually made of alternating rubber layers and steel sheets or, alternatively, of rubber only. The bearing is realized through vulcanization. The steel sheets are completely incorporated in the elastomer and are thus protected from external agents and corrosion. The allowable displacements at ULS correspond to a tangential deformation of the rubber equal to $\tan \gamma = 1$ (this means that the maximum lateral displacement at ULS is equal to the rubber's total height, without considering upper and lower rubber covers if thinner than 2.5 mm). The bearing is able to deform in all directions of the horizontal plane.

TENS RUBBER bearings, according to EN 1337-3, can be divided into 3 types:

- Type B bearings
- Type C bearings
- Type E bearings.

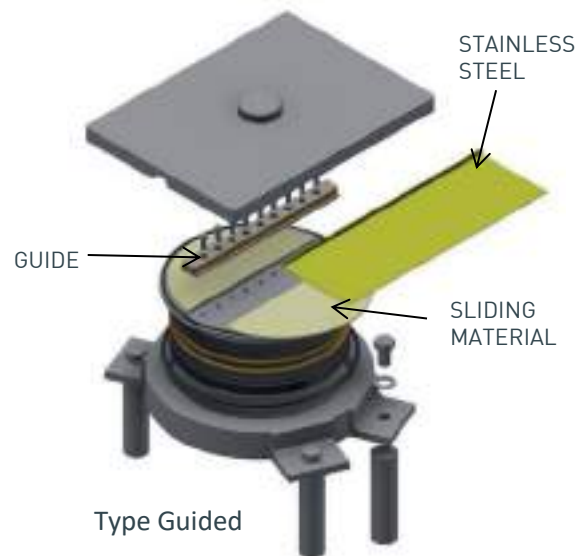
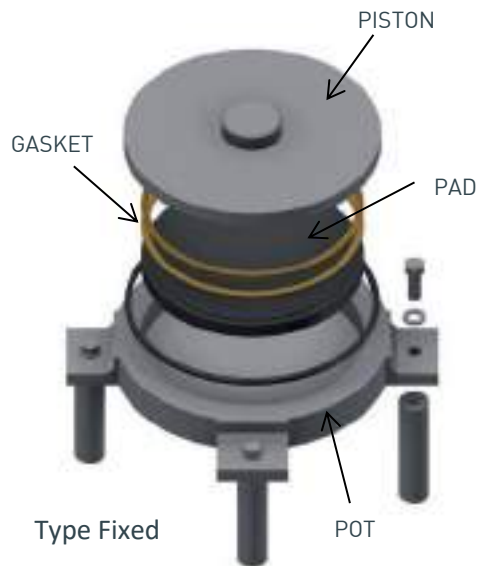


Tens Pot Bearings



TENS POT bearings are able to transfer vertical and lateral loads between the structure and the substructure. The TENS POT bearing (TP) is mainly made of a steel basement known as "pot", within which an unreinforced elastomeric pad is inserted. A cylindrical steel piston is positioned in contact with the rubber's upper surface and laterally with the basement. The vertical load thus moves from the piston to the basement through the rubber. In order to avoid the possible extrusion of the rubber, caused by the pressure induced by the piston, it is necessary to insert an adequate gasket and position it in the contact perimeter between piston and basement.

In the case of free and guided bearings, the sliding (in one or both directions) occurs through contact between an austenitic steel mirror polished surface and a dimpled PTFE that can host silicon grease.



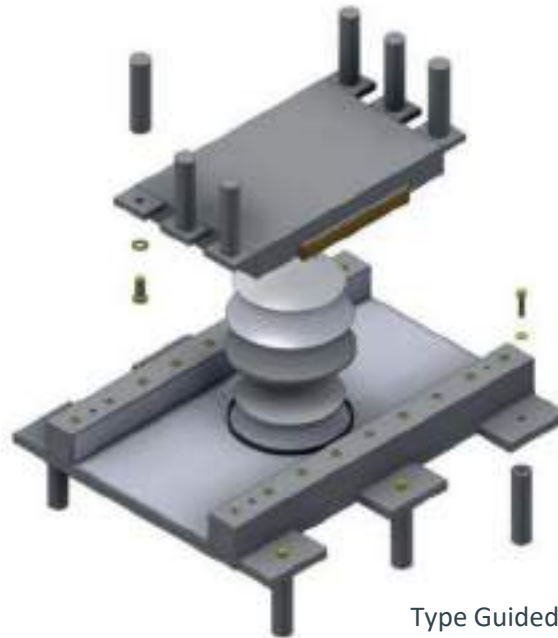
Tens Spherical Bearings



TENS SPHERICAL bearing in its basic configuration is a device composed by three main steel elements: a basement, a spherical hinge positioned within a recess specifically obtained by machining the basement and a close fitting piston provided by a concave surface in contact with the convex hinge upper surface. Vertical loads are transferred from the superstructure (piston) to the substructure (basement) through the spherical hinge while horizontal loads by direct contact between the piston and the basement. At both interfaces, between basement and hinge and between the latter and the piston, a lubricated and dimpled PTFE sheet (or alternative special material) is in contact with an austenitic steel or a chrome plated surface. The low friction developed among them allows the structure rotation (up to 0.05 rad) around any horizontal axis.



Type Fixed



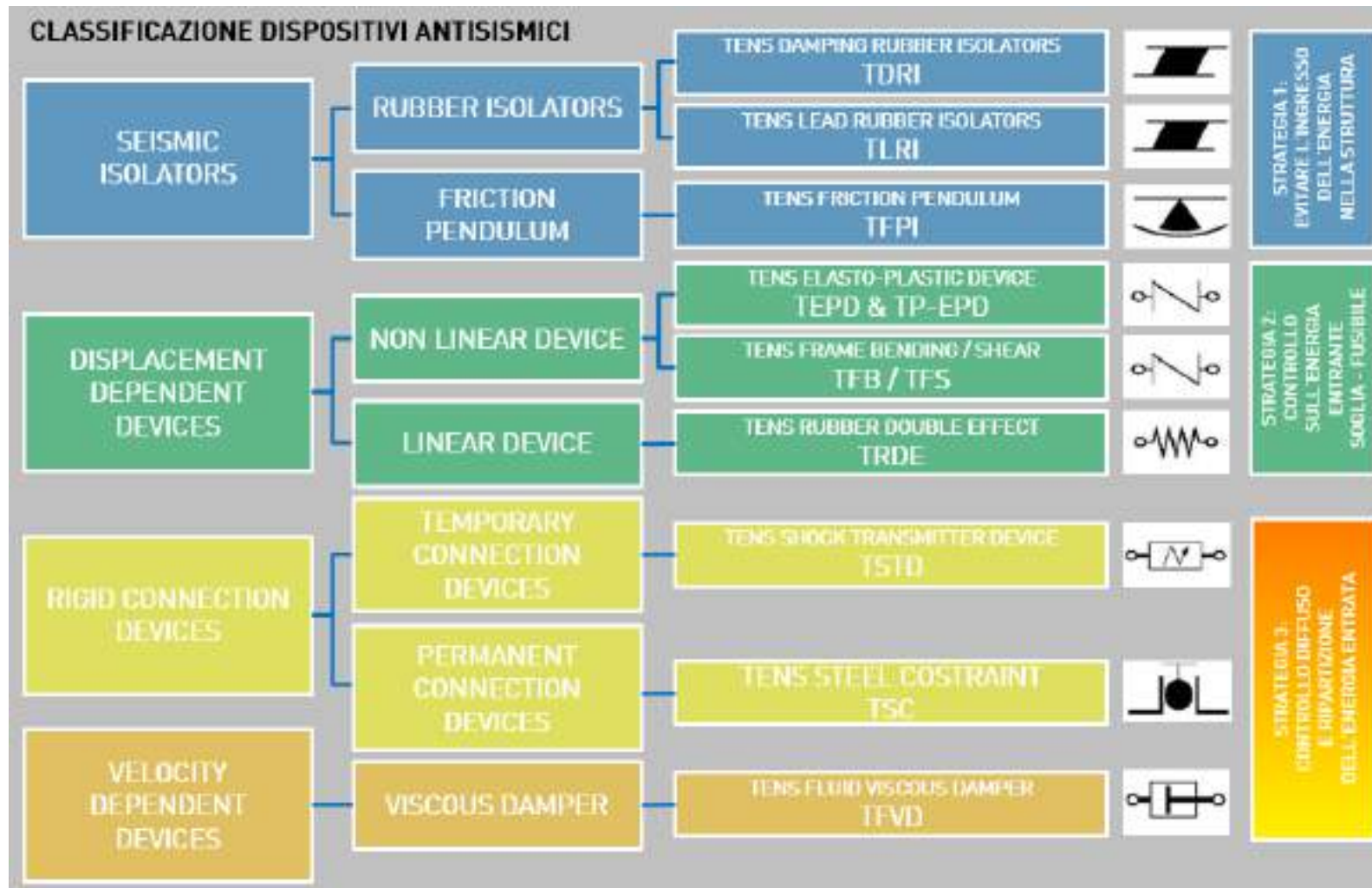
Type Guided



Type Free

ANTISEISMIC DEVICES

Antiseismic Device according to EN15129

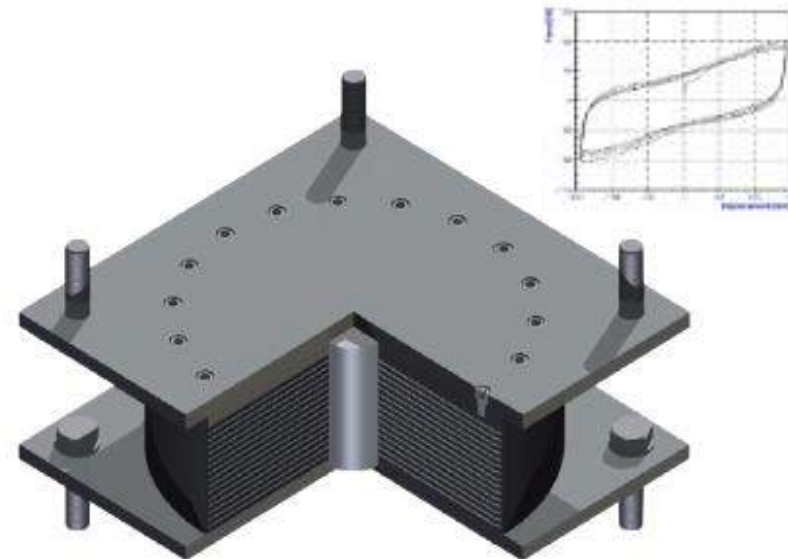
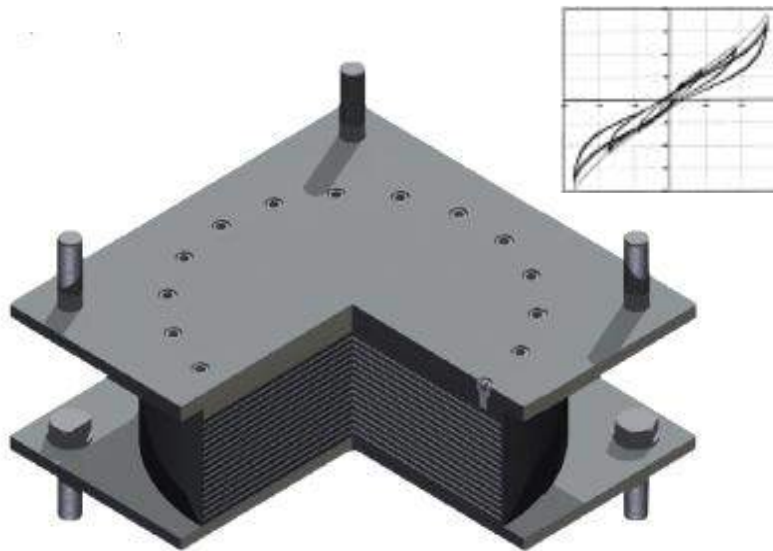


Rubber Isolator – TDRI & TLRI

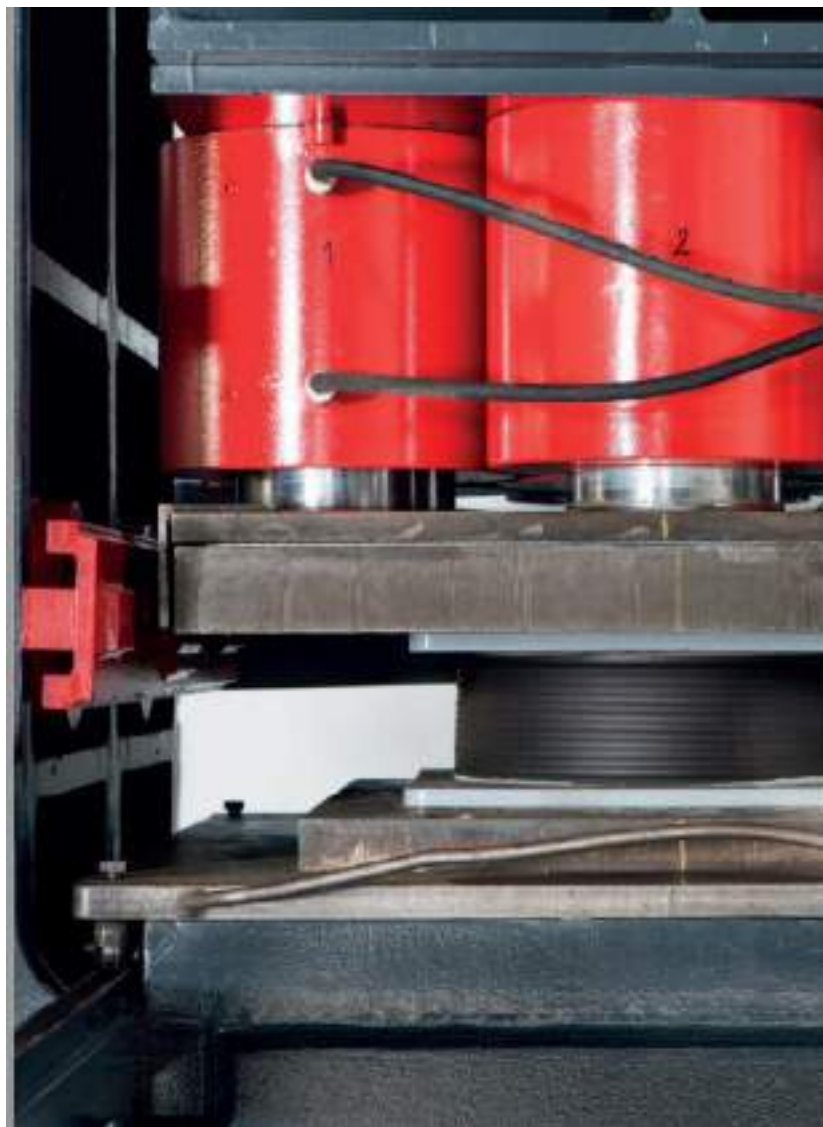


The TDRI consists of alternating layers of elastomer and steel vulcanised together. The inner reinforcing steel plates are fully embedded into rubber so they are protected against corrosion. The elastomers have high damping characteristics (ξ (100%)>6%) even if we can propose in alternative low damping compounds (ξ (100%) \leq 6%). One or two thick end plates are vulcanised to the rest of isolator. Those are safely connected mechanically to the external steel mounting plates, which allows the Isolators to be fixed to the structure (through dowel anchoring bars, screws, and pins). Isolators are able to resist gravity load of a structure and resist seismic and non-seismic actions (wind, thermal, creep, shrinkage). These devices, characterised by a limited horizontal stiffness, are able to absorb the large displacements produced by the seismic action and to limit the horizontal force entering in the structure thanking to their energy dissipation capacity. In fact, the special rubber compounds (different G modulus between 0.4 – 1.4 N/mm² at 100% shear deformation) allow a nominal dissipation ξ in the range of 10-15% at 100% rubber shear deformation.

The TLRI's are similar to the TDRI's devices in concept and production. In addition, they are provided by one central or more properly distributed lead plugs that changes the device behaviour from "linear" to "bi-linear" (pure lead 99.9%).



Experimental Tests on Rubber Isolators



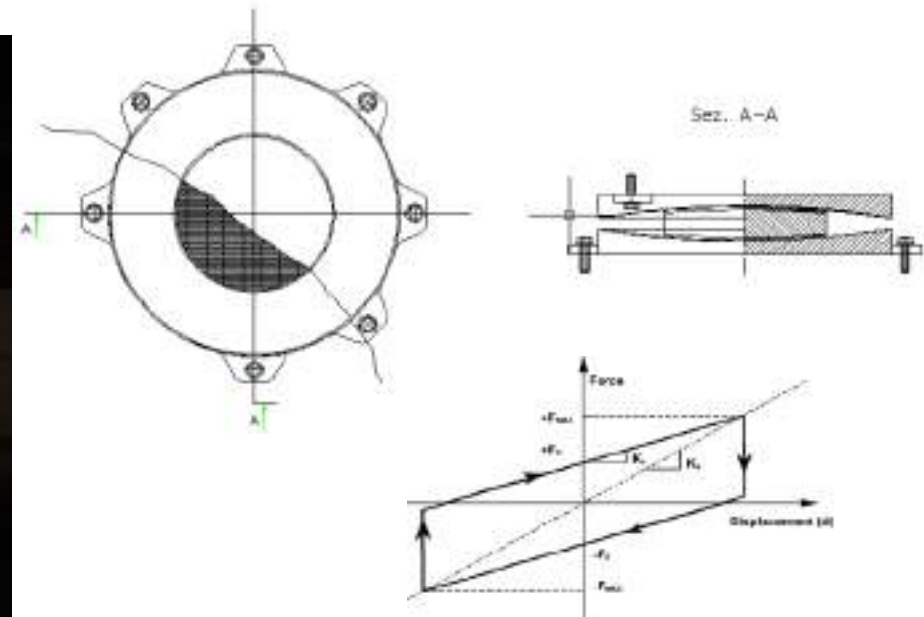
Friction Pendulum Isolators - TFPI



Tens Friction Pendulum Isolator TFPI are devices with double surface pendulum and standard rotation capacity of ± 0.01 [rad] around any horizontal axis and unlimited rotation around the vertical axis. The device consists of the following components:

- Two concave external plates, usually circular shaped, provided with welded lateral anchor plates to allow, through the anchor bolts, the fastening to the external supports; upper and lower plates together configure a container element for the spherical slider. On the concave surfaces is made the stainless-steel recess, which creates the twin spherical surfaces.
- Spherical slider: central convex element placed between the two concave plates, which allows to realize the reverse pendulum motion; on the two lower and upper convex surfaces, are realized the seats for the anti-friction discs material.

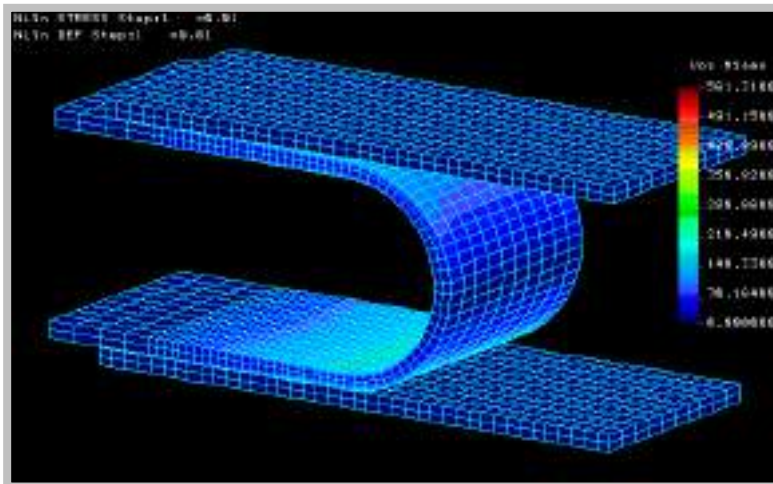
A special sliding material (TensaSlide) is used to obtain the design dynamic coefficient of friction. TensaSlide material is covered by an European Technical Assessment (ETA17/0403) with operative temperature range from -35° C to $+90^{\circ}$ C



Displacement Dependent Device - TEPD



The TEPDs are steel restraints able to transmit only horizontal forces without carrying any vertical load. For this reason these devices are generally used in parallel with bearings. TEPDs have an elasto-plastic constitutive law with high dissipation and a stable hysteretic behaviour (high number of dissipative cycles without degradation). TEPD guarantees a perfect control of maximum loads activated between the connected elements, independently of the seismic intensity and frequency. For this reason, those are normally referred as “displacement dependent devices”. This technology foresees steel hysteretic elements (‘C’ shaped), usually in stainless steel to guarantee a better mechanical feature and reliability in time considering the inalterability of the material. In function of the hysteretic elements distribution it is therefore possible to obtain a response both axisymmetric type and conditioning in two orthogonal directions. After an earthquake, it is possible to replace, without having to disassemble the whole device, the only deformed elements.



Experimental Tests on TEPD

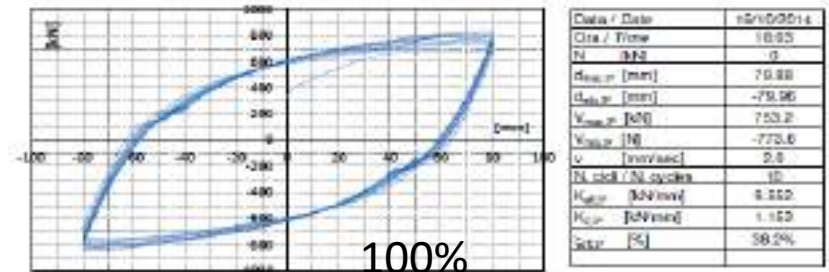
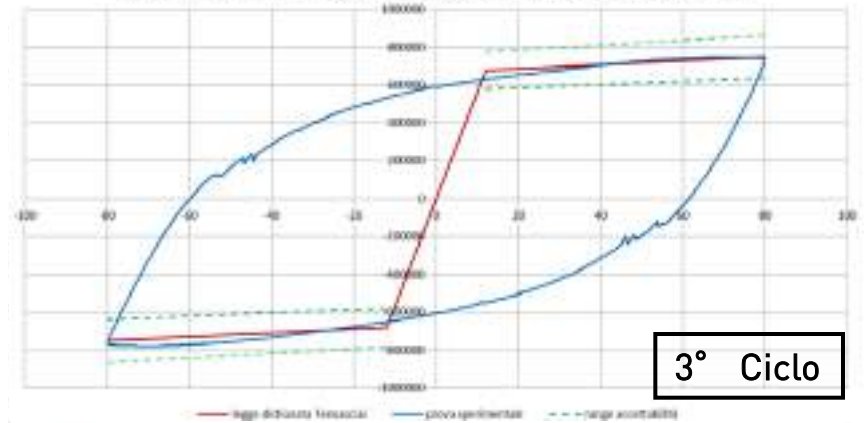


diagramma forza - spostamento [N - mm]
 appoggio di pia 7 - n.10 elementi dissipativi spessore 15mm larghezza 150mm diametro medio 102mm



ciclo	d _{max}	d _{min}	V _{max}	V _{min}	K _{avg}	ΔK _{avg}	Wt	ΔWt	ζ _{avg}	Δζ _{avg}
[M°]	[mm]	[mm]	[kN]	[kN]	[kN/mm]	[%]	[kN/mm]	[%]	[%]	[%]
2	80.1	-79.7	729.7	-751.8	9.271	2.0%	0.968	17.7%	38.0%	1.8%
3	79.9	-80.0	753.2	-773.6	9.552	0.0%	1.178	0.0%	38.2%	0.0%
4	80.0	-80.0	753.0	-745.8	9.358	2.0%	1.180	0.2%	38.6%	1.1%
5	80.1	-79.8	775.7	-791.9	9.602	2.6%	1.189	1.0%	37.1%	3.0%
6	79.9	-80.0	797.1	-815.2	10.072	5.4%	1.193	1.3%	36.4%	4.7%
7	80.0	-79.8	803.5	-816.6	10.132	6.0%	1.221	2.7%	36.3%	5.0%
8	80.0	-79.9	802.4	-816.7	10.127	6.0%	1.246	5.8%	36.3%	4.9%
9	80.0	-79.9	818.1	-833.0	10.325	8.1%	1.264	7.3%	35.8%	6.2%
10	80.0	-79.7	831.0	-845.9	10.460	9.8%	1.277	8.4%	35.2%	7.8%

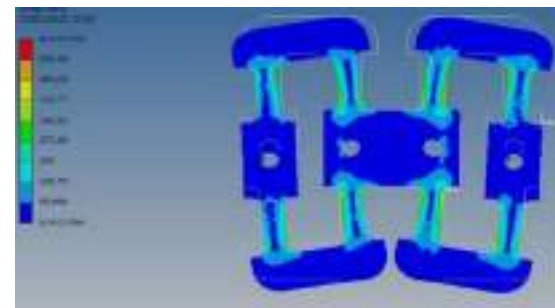
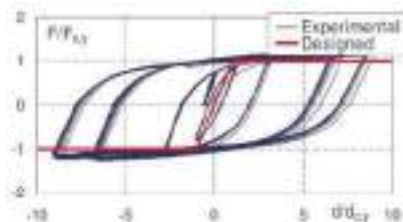
Dissipative Bracing - TFB



The seismic protection strategy that involves the use of dissipative braces is a passive protection method, mostly used on existing buildings for seismic improvement interventions. This method produces a distributed increase in strength and stiffness of the structure. The dissipative braces generate a reduction of the own period, by positioning the seismic response of the structure in the area of maximum actions. But, by virtue of the high losses of energy of which they are capable, they can strongly reduce the seismic effect in terms of displacements. It follows a sharp reduction in the expected structural damage.

TFB device consists of a pair of joint plates, which make the connection of the rod elements with the structural nodes. These plates are suitably shaped in order to concentrate the inelastic deformations in appropriate sections, such as to dissipate the energy with predominantly bending deformations. The devices are designed with a ductility value in terms of displacement at least equal to 20, maintained for a number of load cycles of not less than 10.

The stiffness in the inelastic field is to be considered not greater than 5% of the stiffness in the elastic range, with reference to the change of theoretical behavior.



Velocity Dependent Device - TFVD

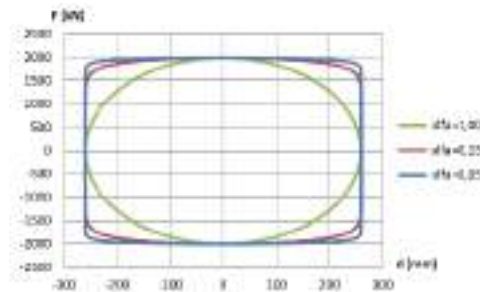


The TFVD are designed to reduce the seismic structural response by adding an important energy dissipation to the system. They are used in parallel with bearings and isolators, as they are not designed to resist vertical loads. Devices activation is provided by the ground speed. In case of earthquake, they react with an output force that depends on the velocity but they do not impede the structure motion. TFVD are therefore designed to cover slow displacements (f.i. creep, shrinkage, post tensioning, thermal) but also the important ones induced by the earthquake.

This device consists of a steel cylinder divided into two chambers by the presence of a piston. Those chambers are filled by silicone-based oil. The device connects two elements of a structure (typically superstructure with the abutment/pier/foundation). In case of an earthquake a relative motion between superstructure and foundation (therefore between piston and cylinder) is generated and the oil flows from one chamber to the other through the hydraulic circuit obtaining an energy thermal dissipation based on the fluid viscosity. The selected fluid is actually characterised by a viscosity, which is independent from the temperature changes. This makes the device behaviour to have a consistent and stable response. The following constitutive law characterizes Tens Fluid Viscous Device: $F = C \cdot v^\alpha$

Where:

- F is the axial load at ULS (kN);
- C is the constant kN/(mm/sec);
- v is the ground speed (mm/sec);
- $\alpha < 1$ is the exponent



Preloaded Spring Dampers - TPSD

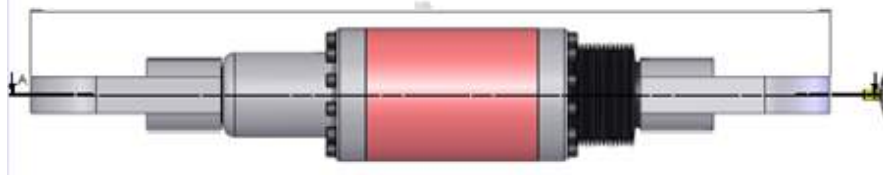


The TPSD are designed to reduce the seismic structural response by adding an important energy dissipation to the system and, being preloaded, they allow to have a constraint for the service horizontal forces. They are used in parallel with bearings and isolators, as they are not designed to resist vertical loads. These device are commonly used when it's necessary to have a preload for the service conditions and to have also an elastic behavior depending on the displacement. In case of preloading F_0 , the service movements are not allowed and the device is a fixed device up the force F_0 . After this value, the device work according to the velocity as a normal one. In case of earthquake, after the service limit, they react with an output force that depends on the velocity but they do not impede the structure motion. This device consists of a steel cylinder divided into two chambers. Those chambers are filled by solid silicone based oil. The device connects two elements of a structure (typically superstructure with the abutment/pier/foundation). In case of an earthquake a relative motion between superstructure and foundation (therefore between piston and cylinder) is generated and the oil flows from one chamber to the other through the hydraulic circuit obtaining an energy thermal dissipation based on the fluid viscosity. The selected fluid is actually characterised by a viscosity, which is independent from the temperature changes. This makes the device behaviour to have a consistent and stable response. The TENS PRELOADED SPRING DAMPER (TPSD) are generally characterized by a constitutive law expressed by the following relationship:

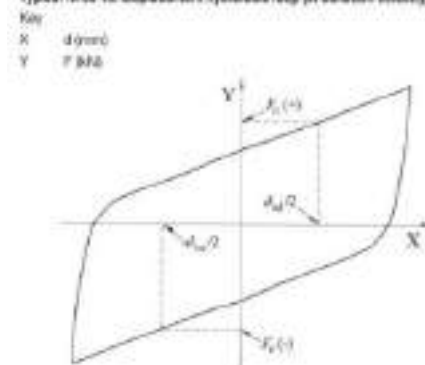
$$F = F_0 + kx + cv^\alpha$$

Where:

- F is the axial load at ULS (kN);
- C is a constant (kN/mm/sec);
- v is the velocity (mm/sec);
- α is an exponent which describes the damping properties
- F_0 is the axial preload at ULS (kN);
- k is a elastic costant
- x is the elastic displacement (mm)

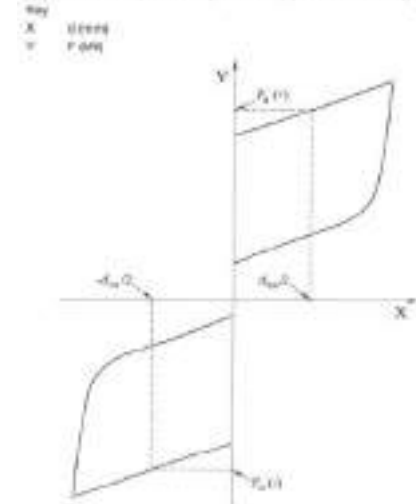


Typical force vs. displacement hysteresis loop (at constant velocity, $F_0=0$)



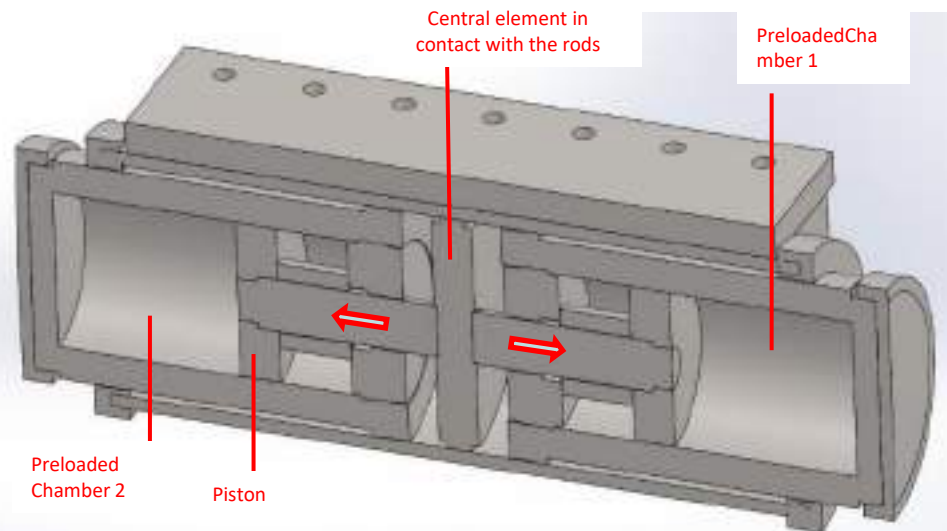
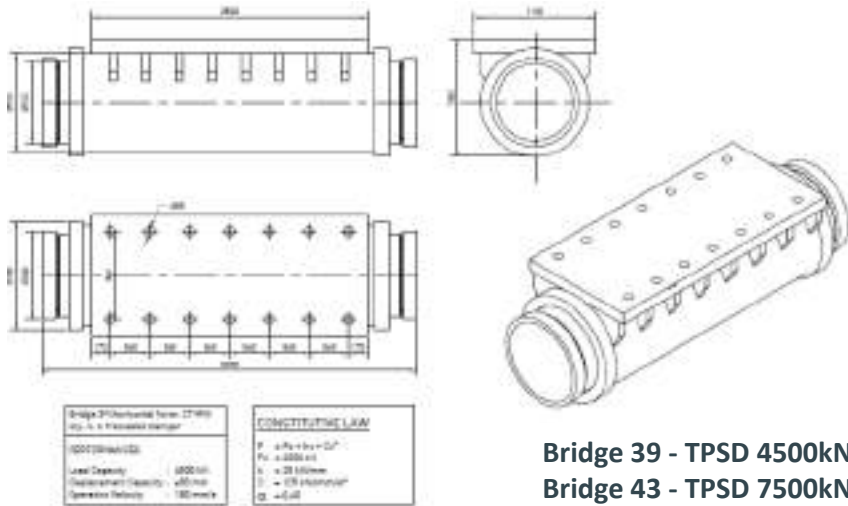
No Preloaded $F_0=0$

Typical force vs. displacement hysteresis loop (at constant velocity, $F_0>0$)



Preloaded $F_0>0$

Preloaded Spring Dampers - TPSD



Tests required for type and FPC testing

	Pressure Test	Low Velocity Test	Constitutive Law Test	Damping Efficiency Test	Wind Load Test	Seal Wear Test	Stroke Verification Test
Type Tests	x*	x	x	x	x*	x*	x*
Factory Production Control	x*	x*	x*	x*			

(*) Test performed at ambient temperature

3 cicli a velocità crescente 1%, 25%, 50%, 75%, 100%

5 cicli

Shock Transmitter Unit - TSTD



The TSTD is a temporary dynamic connection device activated only by fast movements as the ones induced by seismic actions. The device provides for an output force in tension or in compression. They are generally used in parallel with bearings, as they are not designed to resist vertical loads.

Their external shape is very similar to the one of TFVD but the behaviour is completely different. For TSTD when the velocity exceeds the activation value, the device becomes temporarily a "pseudo-rigid" connection linking two elements of the structure (typically superstructure with the abutment/pier/foundation). Under impulsive loads, the device shows a small activation displacement due to the fluid deformability always within 10% of device nominal displacement capacity.

Similarly as TFVD, at the presence of thermally induced or other slowly imposed movements the device develops a small and negligible reaction.

Those devices, generally known as shock transmission units (STU) or lock up devices (LUD), are used to modify the links response from the static to the dynamic condition. In particular thanks to TSTD designer can f.i. provide its structure by a fixed point for service purposes and select a few movable constraints which will become fix only in case of dynamically applied load (f.i. seismic event, wind, braking in railway lines etc.). This way the large force developed will not be transferred through one bearing only but it will be distributed in more selected positions while for service the links can cover the slow motion. This technology is applied in new structures and in existing ones as a retrofit.

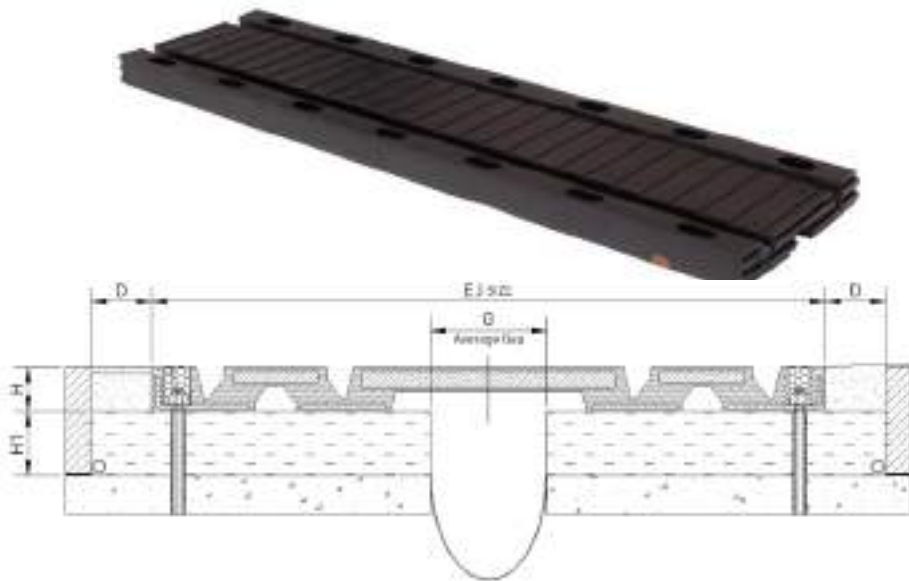


EXPANSION JOINTS

UBJ – Uni Block Joint (Road)

The reinforced rubber joints allow longitudinal movements, and, where necessary, also transversal and vertical movements, by elastic deformation of the internal rubber parts, in relation to the particular geometry.

The rubber joints have steel sheets inside that guarantee the proper rigidity of the overlapping system to allow traffic to travel over them safely and with adequate comfort. These plates do not require any kind of corrosion protection as they are vulcanized within the rubber, which by its very nature has excellent resistance properties to wear, ageing due to exposure to U.V. and contact with oils, greases and petroleum. UBJ reinforced rubber panels come in standard lengths of 1015 or 2015 mm, depending on the type. The panels are equipped with male-female joints that ensure structural continuity and impermeability between the panel joining line. In particular, the more and more frequent use of seismic isolation in the design of structure has caused an increase of the demand for joints that cover always larger displacements and gaps, in order to avoid the hammering phenomenon occurring during the seismic phase. Therefore the UBJ series has been designed to diversify joint performance in terms of service and seismic conditions.

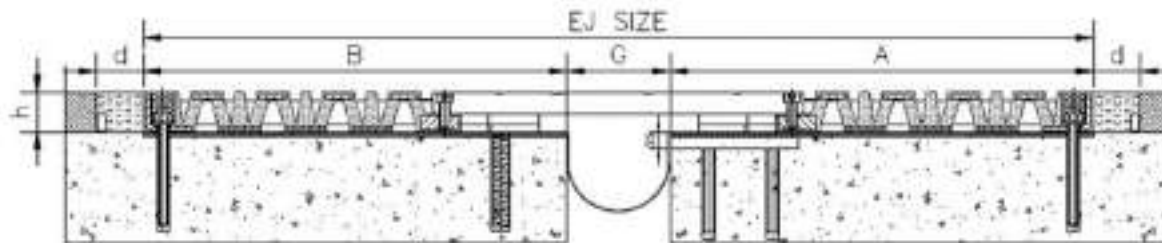
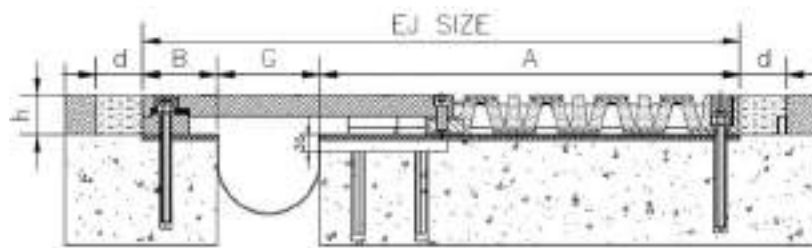


MBJ – Multi Block Joint (Road)

The MBJ series is an expansion joint that allows overall displacements of up to 1300 mm in SLS/SLU conditions and up to 1600 mm seismic (+ 650 mm and + 800 mm seismic). The MBJ joint consists of three elements: a bridge plate, a rubber tile and an anti-lifting device. For movements greater than 800 mm, the bridge plate is centred at the gap with respect to two rubber tiles on the sides. When only one rubber tile is present, the anchorage of the bridge plate to the concrete is realized by an elastic hinge. The joint movement is obtained by deformation of modular rubber elements arranged in series, whose total number varies according to the displacement capacity. The rubber tile, directly sliding on the structural extrados, is able to absorb displacements while ensuring continuity of the carriageway. The anti-lifting devices made of stainless steel guarantee the vertical stability of the joint with respect to the support surface, as well as a high level of travel comfort.

If a transversal movement is required, the anchorage of the anti-lifting device is made by a transversal guide recessed into the concrete at the opening side; a suitable sliding plate integral with the anti-lifting device, runs into the guide, allowing the transversal movement.

The surface of the bridge plate subjected to transiting is machined in such a way as to improve grip with the tyre and ensure a rapid outflow of rainwater.



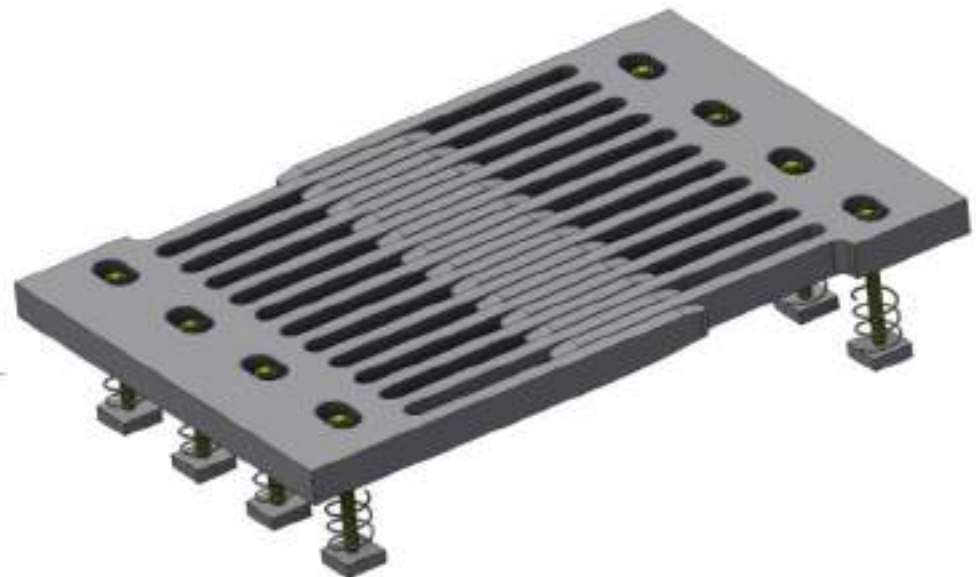
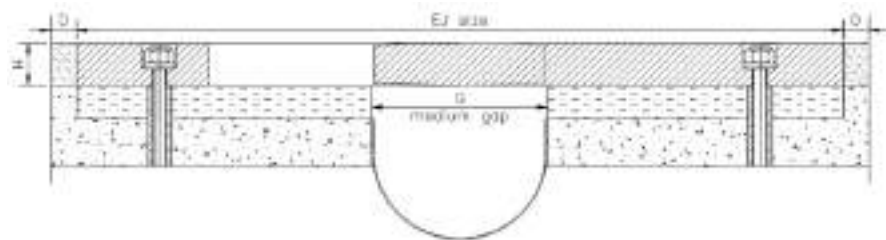
SFJ – Steel Finger Joint (Road)

The joints of the SFJ series are mainly made up of two metal elements with a finger configuration so that they are complementary to each other. Thanks to their interconnection they ensure a structural continuity of the carriageway when there is an expansion/contraction of the connected structural elements (deck - deck, abutment - deck). The steel elements are secured to the deck by means of specific anchor bars. The top surface of the joints is produced with an anti-skid process that increases the friction between the wheels of the vehicles and the joint. The SFJ devices cover mainly longitudinal displacements from 300 mm up to 800 mm. A flashing system is adopted, as with the other types of joints, to allow a correct flow of rainwater.

The standard SFJ range covers nominal movements from 300mm (± 150 mm) up to 800mm (± 400 mm), maintaining a residual load capacity after the event as well as covering the gap during the seismic deviation.

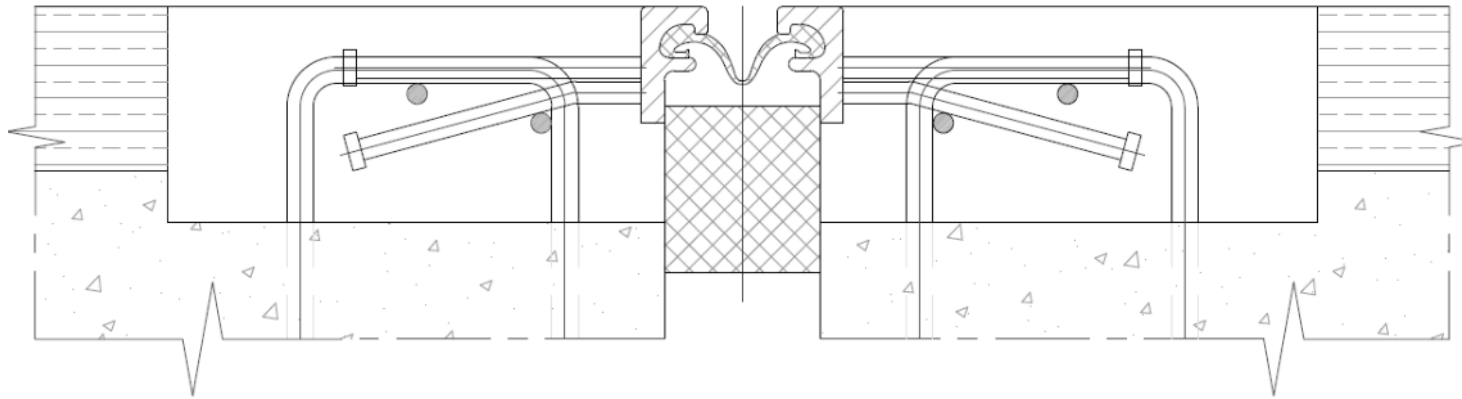
The transversal displacement of the joint is almost nil since the configuration does not allow displacements in an orthogonal direction to that of travel.

The gap may be less or wider than that indicated in the table, compatibly with a decreased movement capacity to be checked with the TENSACCAI technical office.



TSSJ – Expansion Joint (Road)

The TSSJ solution, proposed by TENSA only for small movements, has a simple rubber bellows element attached to steel elements which allows the gap to be crossed in a practical and economic way while ensuring waterproof.



RRJ – Rubber Railway Joint (Rail)

The RRJ series expansion joints are designed specifically for the high speed railway bridges.

They have been approved by the RFI (Italian Railway Network) as they meet the specifications contained in RFI Technical Instruction.

The joint is designed to offer maximum structural and functional simplicity, ease of installation and consequent cost savings.

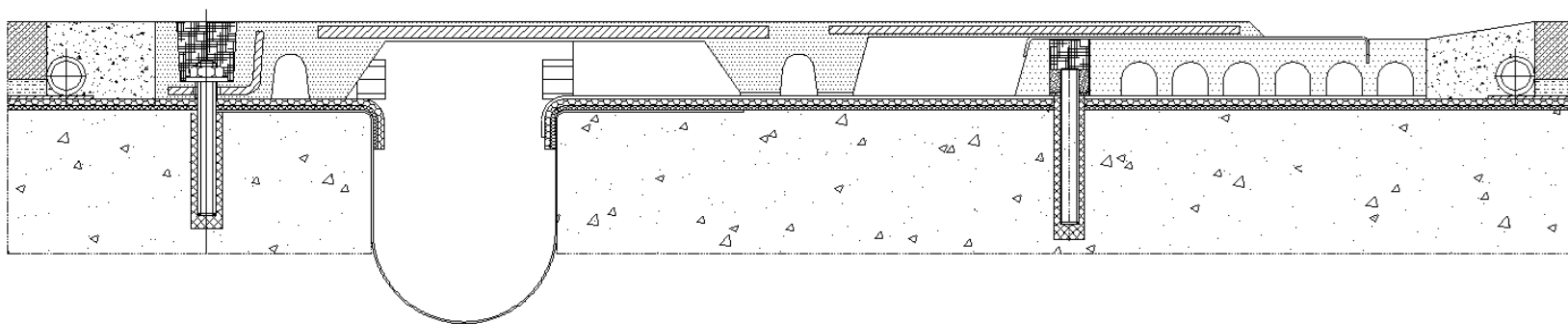
These joints are suitable for installation with ballast.

This type of joint consists of two parts installed separately. The relative movement is obtained by sliding between an elastomer and a stainless steel surface and not by deformation of the rubber elements of the joint.

The bridge plate is completely covered by 'dielectric' rubber with steel reinforcement vulcanized inside the rubber to limit the vertical deformation. These plates do not require any kind of corrosion protection as they are vulcanized within the rubber, which by its very nature has excellent resistance properties to wear, ageing due to exposure to U.V. and contact with oils, greases and petroleum.

The elastomeric components work as hinges during the rotations (in operation and in the lifting phases which determine vertical misalignment) and house the anchors to be grouted to the concrete structure.

The RRJ range covers nominal movements from 100mm (± 50 mm) up to 200mm (± 100 mm), maintaining a residual load-bearing capacity after the event and covering the gap during the seismic deviation. The RRJ joint allows a rotation of the connected decks of up to 2 degrees.



TENSALAB

TensaLab

Thanks to the experience matured along the years, and the facilities inherited from the group, Tensa is developing, in the recent years, its own testing laboratory.

With particular attention to structural bearings, expansion joints and anti-seismic devices, TensaLab offers today the necessary support for the testing of the most common devices produced by Tensa, within its premises or in collaboration with other laboratories. Within TensaLab, samples of pot bearings, spherical bearings, laminated rubber bearings, expansion joints and elasto-plastic antiseismic devices are regularly tested, for both Research & Development projects and for Factory Production Control procedures, in accordance to the main European and worldwide Standards.

TensaLab can count on experienced staff, who can manage the testing activity or give assistance according to the main worldwide standards:

- NTC DM2008
- EN 1337-2 Sliding elements
- EN 1337-3 Elastomeric bearings
- EN 1337-5 Pot bearings
- EN 1337-7 Spherical bearings
- EN 15129 Anti seismic devices
- AASHTO LRFD Bridge Construction Specifications
- AASHTO M251-06 Elastomeric Bridge Bearings
- BS 5400-4 Steel, concrete and composite bridges
- AS 5100-4 Bearings and deck joints
- RTA B282 Pot bearings – structural steel
- RFI DTC INC PO SP IFS 005 A (Italian Railways)

TensaLab can be performed with a third party supervision or simple witnessing, by accredited institutions or certified bodies, such as:

- Politecnico di Milano
- Roma Tre University (RM-3)
- Università della Basilicata
- Det Norske Veritas (DNV)
- Bureau Veritas
- ICECON Cert



TensaLab

30 MN STEEL FRAME

VERTICAL FORCE: 30.000 kN
TRANSVERSAL FORCE: 3.500 kN
LONGITUDINAL FORCE: 1.000 kN
LONGITUDINAL STROKE: 400 mm
SAMPLE SIZE LIMITS: 1200x1200x300 mm



EXPANSION JOINT TESTING BENCH

AXIAL FORCE: 200 kN
LONGITUDINAL STROKE: 500 mm

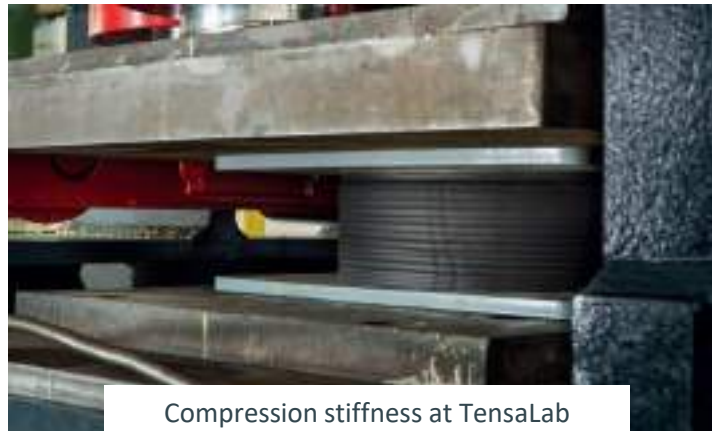


70 MN STEEL FRAME

VERTICAL FORCE: 70.000 kN
TRANSVERSAL FORCE: 2.000 kN
LONGITUDINAL FORCE: 2.000 kN
LONGITUDINAL STROKE: 800
mm
SAMPLE SIZE LIMITS:
2100x2100x1000 mm

TensaLab

Tests on rubber bearings



Compression stiffness at TensaLab



Shear stiffness at TensaLab

Table 5 — Routine test frequency for complete bearings

Type of test	Total Thickness			
	$T_b \leq 50$	$50 < T_b \leq 100$	$100 < T_b \leq 150$	$T_b > 150$
Compression stiffness ^a	150 dm ³	250 dm ³	300 dm ³	350 dm ³
Shear Stiffness	1 500 dm ³	2 500 dm ³	3 000 dm ³	3 500 dm ³
Shear Bond	3 000 dm ³ on sample type I (see 8.2.3.)			

NOTE 1: The volumes indicated above refer to the volume of rubber in the bearings.
 NOTE 2: For compression stiffness and shear stiffness the test should be performed on the first manufactured production bearing of each category.
^a Quick compressive test as described in 4.3.3.2.

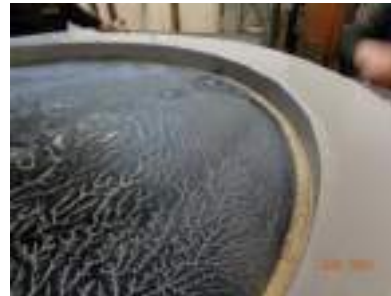


POLITECNICO DI MILANO
 REPRESENTATIVES WILL WITNESS ALL
 THE TESTS PERFORMED
 AT TENSALAB LABORATORY

TESTS ON BEARINGS
 WITH FREQUENCY
 DEPENDING OF VOLUME
 PRODUCED

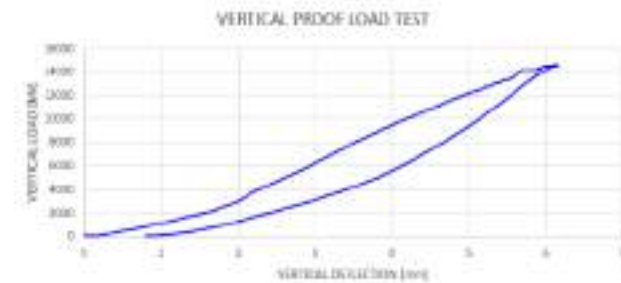
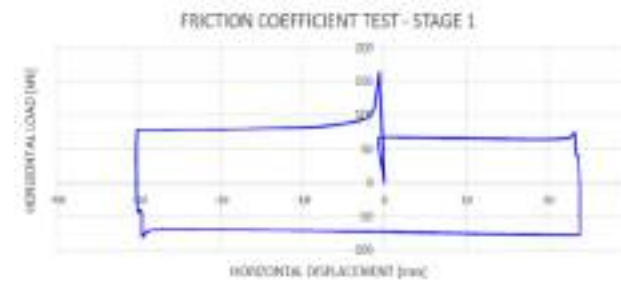
TensaLab

Tests on pot bearings



EN1337-5 DOESN'T PRESCRIBE ANY BEARING TEST.

UPON REQUEST
VERTICAL PROOF LOAD TESTS,
HORIZONTAL BEARINGS CAPACITY
AND COEFFICIENT FRICTION TEST
CAN BE CARRIED OUT.



HISTORY

WHERE WE ARE

WHO WE ARE

PRODUCT LINE

POST-TENSIONING

STAY CABLES

GROUND ANCHORS

BEARINGS

EXPANSION JOINTS

ANTI-SEISMIC DEVICES

PROJECTS

REFERENCES

ROSE FITZGERALD KENNEDY EXTRADOSED BRIDGE – NEW ROSS IRELAND

Extradosed Bridge with Multistrand Saddle up to 127 strands



STORSTRØM BRIDGE – DENMARK (UNDER CONSTRUCTION)

Around 3,500 tons of Post Tensioning

Total length : 4 km

Main span length: 160 m



**VIGEVANO ARCH BRIDGE,
MILANO, ITALY**





**SIGNATURE CABLE STAYED BRIDGE, NEW
DELHI, INDIA**
Max cables length > 300m
Pylon Height > 150m

**EXTRADOSED PEARL
HARBOR MEMORIAL
BRIDGE, USA**



SAN GIULIANO ARCH BRIDGE
SICILY, ITALY
Adjustable and Fixed forks with 31 strands

SHATT AL BASRAH CABLES STAYED BRIDGE, BASRAH, IRAQ



**MUHAMMAD AL-BAQIR AL-SADR
CABLES-STAYED BRIDGE,
BASRA, IRAQ**



**HIGH-SPEED RAILWAY LINE (TAV)
MILANO - BOLOGNA,
OVER PO' RIVER, PIACENZA - ITALY**



**ERASMUS BRIDGE,
ROTTERDAM,
HOLLAND**



OKAVANGO RIVER BRIDGE,
BOTSWANA



NANAY BRIDGE – Iquitos, Peru

Stay cables equipped with TSR anchorages system



ARCH BRIDGE OVER ARGESSEL RIVER, MIOVENI, ROMANIA

Adjustable and Fixed forks with 7 strands





VOILA ARCH BRIDGE, ROMANIA

Adjustable and Fixed forks with 7 strands



BRAILA ARCH BRIDGE, ROMANIA

Adjustable and Fixed forks



MAHI EXTRADOSED BRIDGE, INDIA

With multi-tube saddles - under construction



CHANDMARI CABLES-STAYED BRIDGE, INDIA





**BRIDGE OVER CRATI RIVER,
ITALY**
(BACK STAYS WITH 169
STRANDS)
SANTIAGO CALATRAVA IS THE
DESIGNER



**BRIDGE OVER CRATI RIVER,
ITALY**
(BACK STAYS WITH 169
STRANDS)
SANTIAGO CALATRAVA IS THE
DESIGNER

**FAVAZZINA STAYED
BRIDGE, SCILLA - ITALY**



**FLAIANO CABLE
STAYED BRIDGE IN
PESCARA, ITALY**



ADIGE RIVER CABLE STAYED BRIDGE, ITALY

No. 169 strands

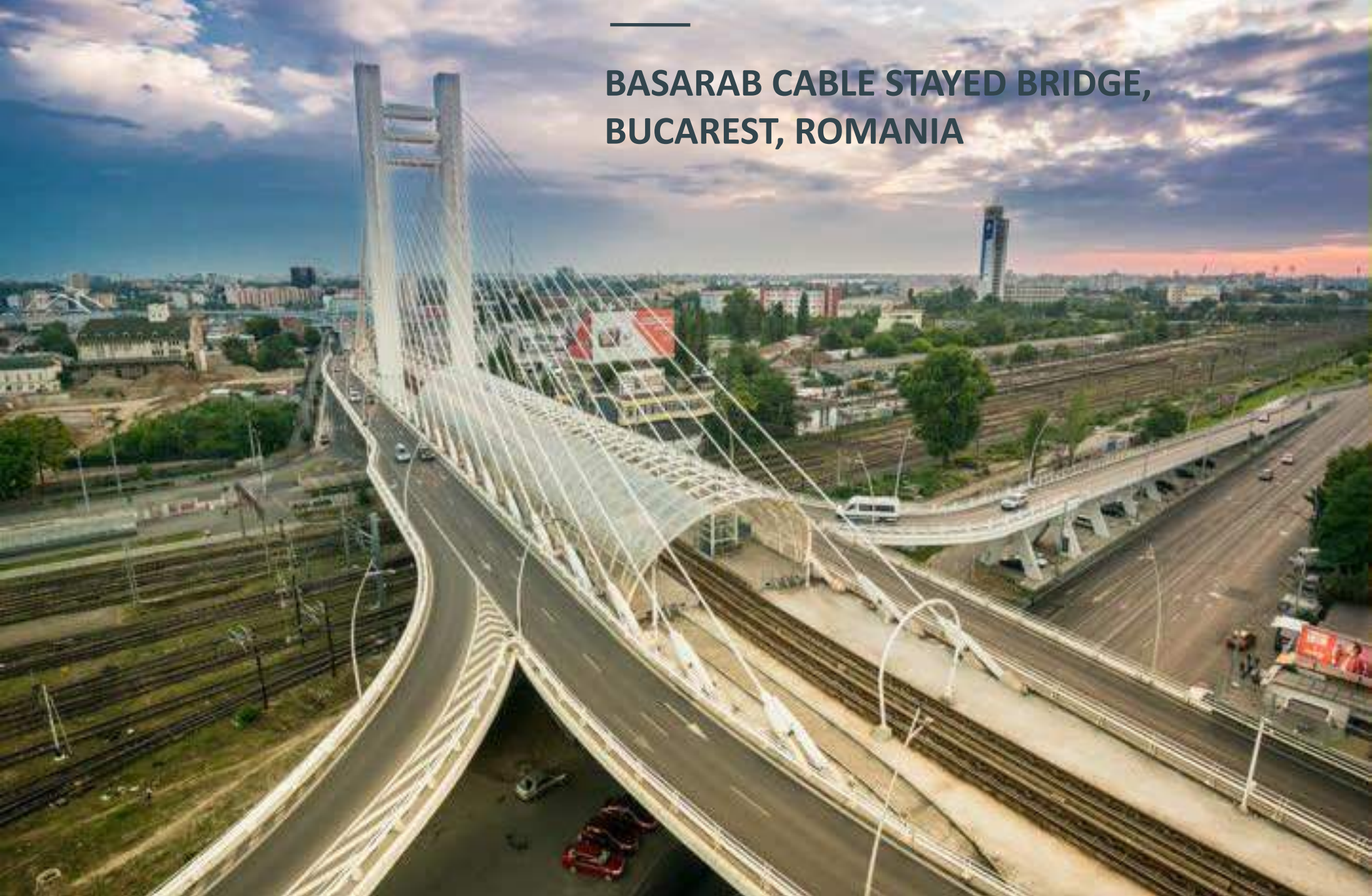
Main Span > 300m

CABLE STAYS - PROJECT IN INDIA

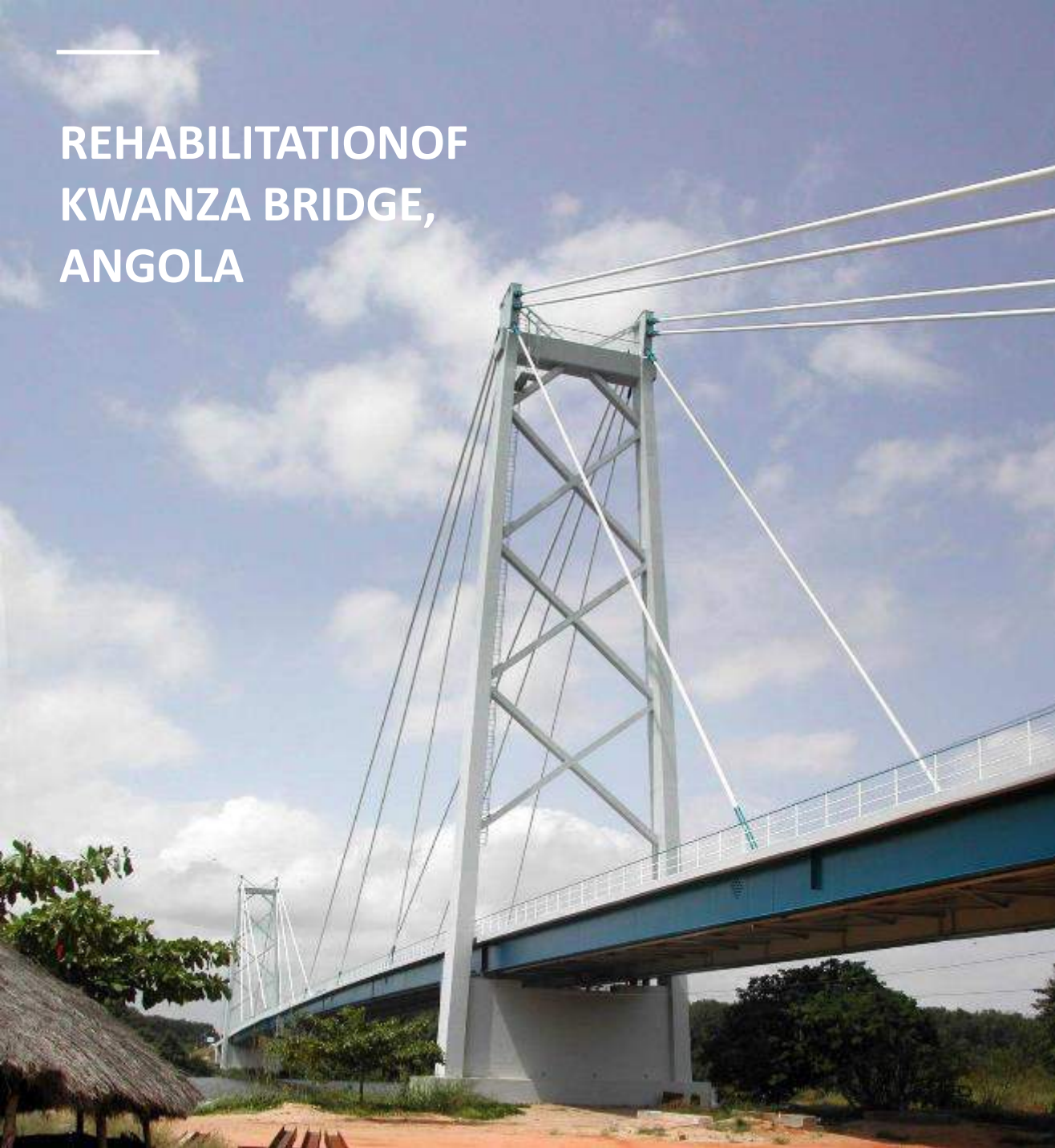
IRAI CABLE STAYED BRIDGE with TSRF system with fork anchorages at the pylon side and TSRA system at deck side



BASARAB CABLE STAYED BRIDGE, BUCAREST, ROMANIA



REHABILITATION OF KWANZA BRIDGE, ANGOLA



BARI STAYED BRIDGE, ITALY



BIG MOSQUE FOOTBRIDGES, ALGERI

TSRF Adjustable and Fixed fork system



PENSACOLA BAY BRIDGE, FLORIDA, USA

Arches equipped with TSRF fork anchorages system



**SANTA APOLONIA
RAILWAY BRIDGE,
PORTUGAL.**



REINFORCEMENT OF RAILWAY BRIDGE, POGGIO RENATICO (FE), ITALY



**BRIDGE OVER THE
SANGONE RIVER,
ITALY**



VAL GEROLA STAYED BRIDGE, ITALY



BRESSANONE STAYED BRIDGE – TRENTO ALTO ADIGE - ITALY

CALOLZIOCORTE – OLGINATE STAYED BRIDGE - ITALY



VAL D'ELSA STAYED BRIDGE – SIENA – ITALY



**SHAIKH KHALIFA BIN
SALMAN BRIDGE,
BAHREIN**



MARCHETTI ARCH BRIDGE,
HIGHWAY A5, ITALY



**TWENTE ARCH
BRIDGE,
NETHERLANDS**



LLOCLAMAYO ARCH BRIDGES, PERU'



MEMPHIS UNIVERSITY FOOTBRIDGE, USA

With TSRF fork anchorages system



NIZZA MONFERRATO BRIDGE, ITALY



CHIHANI SUSPENDED BRIDGE, ALGERIA



**SUSPENDED ROOF OF EXPO 2015, MILAN
ITALY**



KAMORO SUSPENDED BRIDGE, MADAGASCAR

Main Span > 200m



POST-TENSIONING REFERENCES

HIGH-SPEED RAILWAY LINE (TAV) MILANO - BOLOGNA PIACENZA VIADUCT, ITALY



ARTIC2 LNG PROJECT, RUSSIA (UNDER CONSTRUCTION)



Réseau Électrique Métropolitain – REM Montreal, CANADA) – 16 km viaduct



RA 245
Kuwait
Post Tensioning
+ Form Traveler



RA 245 Kuwait: 4 pairs of Form Traveller



Red and Purple Modernization (RPM) of Metro line in Chicago



MONORAIL CAIRO – From 6th October to New Administrative Capital of Cairo (L>100km)



**I-395 SIGNATURE BRIDGE,
MIAMI, FLORIDA, USA
Precast Arch with PT cables**



**ROUTE 2020,
DUBAI METRO PROJECT,
DUBAI, UAE**



RED LINE METRO, DOHA, QATAR



MANHATTAN WEST
DEVELOPMENT
PROJECT, NY, USA

VIADUCTO DO LOUREIRO, PORTUGAL





**ROSKILDE FJORD LINK,
DENMARK**

DAHHER LNG TANKS, INDIA





MALAMPAYA OFF SHORE CONCRETE GRAVITY STRUCTURE PLATFORM, SUBIC BAY, PHILIPPINES



MOORIN DOLPHINS, ITALY





ARZAW LNG PROJECT, 2 TANKS, ALGERIA



ISOZAKI TOWER, MILAN, ITALY



REGIONE PIEMONTE TOWER, TURIN, ITALY





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