



PONTE SULLO STRETTO DI MESSINA



PROGETTO DEFINITIVO

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1 Introduction

1.1 The Project

The Messina Strait Bridge will span the Messina Strait between Calabria on the Italian mainland and the island of Sicily. The suspension bridge crossing comprises a 3,300 m main span, which will be longest in the world when constructed.

The bridge carries four marked vehicle lanes, two emergency lanes and two rail lines. The bridge superstructure comprises three separate orthotropic deck steel box girders, one for each of the Sicily and Italy bound roadways and one for the railway. The three box girders are connected by transverse steel box cross girders spaced at 30 m. The superstructure is supported by pairs of hanger cables connected to each cross beam end. The hangers are connected to pairs of main cables on each side of the bridge (four main cables), with each main cable having a diameter of 1.24 m. The main cables are anchored at each bridge end in massive reinforced concrete anchor blocks. The main cables are supported by two steel main towers, each with a height of 399 m above mean sea level. The main towers are founded on reinforced and post-tensioned concrete footings, which are supported on underlying rock formations.

1.2 Scope

The work comprises detailed design, manufacturing, delivery and participation in erection of the bearings including backing plates in accordance with the drawings and the specifications. Further the works include delivery of spare parts for the first 5 years use in accordance with the maintenance manual.

1.3 References

1.3.1 Design Specifications



- 1 GCG.G.03.04. Various works, Section 2. Stretto di Messina, 2010, July 15
- 2 GCG.G.02.01 rev.0. Construction of the street and railway connections: Norm for the execution of the civil work - street and railway infrastructures. Stretto di Messina, 2004 July 6.

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- 3 CG.10.00-P-RG-D-P-GE-00-00-00-00-02-A - "Design Basis, Structural, Annex," COWI 2010
- 4 GCG.F.05.03 rev. 1. Technical specifications for the definitive and the executive project of the bridge - Design development requirements & guidelines. Stretto di Messina, 2004 October 22.
- 5 GCG.G.03.02. Technical specifications for the construction of the suspension bridge - Structural steel works and protective coatings, Stretto di Messina, 2004 July 30.

1.3.2 Material specifications

- 6 EN 1337 Structural Bearings - Part 1: General design rules
- 7 EN 1337 Structural Bearings - Part 2: Sliding elements
- 8 EN 1337 Structural Bearings - Part 5: Pot bearings
- 9 EN 1337 Structural Bearings - Part 7: Spherical and cylindrical PTFE bearings
- 10 EN ISO 12944:2000. Paints and varnishes - Corrosion protection of steel structures by protective paint systems
- 11 EN 10025-1:2004 Hot-rolled products of structural steels
- 12 EN 10025-2:2004 Hot rolled products of structural steels - Part 2: Technical delivery conditions for non-alloy structural steels
- 13 EN 10164:2005 Steel products with improved deformation properties perpendicular to the surface of the product – Technical delivery conditions.
- 14 EN ISO 898-1:2009 Mechanical properties of fasteners made of carbon steel and alloy steel – Part 1: Bolts, screws and studs.
- 15 EN 20898-2:1994 Mechanical properties of fasteners – Part 2: Nuts with special proof load values – coarse thread (prEN ISO 898-2:2010).
- 16 EN 14399-3:2005 High-strength structural bolting assemblies for preloading - Part 3: System HR - Hexagon bolt and nut assemblies

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17 EN ISO 14555:2006 Welding-Arc stud welding of metallic materials.

18 ANSI/IEC 60529-2004 Degrees of protection provided by enclosures

1.3.3 Drawings

The basic requirements and principle for the hydraulic systems are shown on the following drawings:

19 CG.10.00-P-DX-D-P-SS-A0-AP-00-00-00-01-A Articulation system - Bridge bearings, Overview

2 Design by contractor

2.1 Type of bearings

The vertical load bearings shall be spherical bearings. However, pot type bearings may be proposed by the manufacturer if it can be documented by LCC analysis (Life Cycle Cost), that it is more suitable for the works than the spherical type. All bearings shall be of the same type.

Some bearings shall be able to take also uplift loads. The elements of the bearing that transfers the uplift loads shall be separated from the other parts of the bearing so that the uplift parts are easily access able and can be inspected and maintained from the outside of the bearing. The uplift shall not cause the bearing to separate totally or endanger the function of the bearing. The movement in upwards direction shall for bearings A10 and A11 be less than 2 mm when the bearing is subjected to SLS2 uplift loads.

For all other bearings the movement in upwards direction shall be less than 10 mm when the bearing is subjected to the SLS2 lift force. The bearing shall be able to function after the uplift.

The proposed bearing design shall have been used for similar sizes and under similar conditions with satisfactory results for a period of at least 5 years. The manufacturer shall submit reference list for the proposed bearings.

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2.2 Standards and norms

The bearings shall be in accordance with material specifications [6], [7], [8] and [9] and the design specifications [1], [2], [3] and [4].

2.3 Loads and movements

Loads and movements for the completed bridge are stated in [19]. These movements include the additional 10% as required in [4] section 10.5

In addition to the movements stated on the drawings the bearings shall be designed to allow loads and movements during the construction period. (to be specified later)

In addition to the movements stated on the drawings the bearings shall allow for additional ± 50 mm for adjustment of the bridge in longitudinal direction.

Special attention shall be paid to the durability of the bearings. The bridge type and the size of the bridge lead to large maximum movements and large accumulated movement. The maximum movements will occur only few times. However, the bridge girder will move longitudinally due to traffic loads and wind loads even if the bridge is held by hydraulic buffers in the longitudinal direction. These movements will be relatively small but will happen many times a day and with a fluctuating nature. There will be a large number of stop and starts in alternating directions. The estimated velocity and acceleration of the longitudinal movements are stated in **Errore. L'origine riferimento non è stata trovata.** It means that the wear of the moveable parts will be considerably.

	Bearing location		
	Terminal Structure/ Suspension bridge	Side Span/ Deck element at Tower	Deck element at Tower/ Main span
Accumulated movement pr. year	1- 10 km	NA	0.1-1 km
Expected max. velocity of frequent movement	~20 mm/sec	NA	~20 mm/sec

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Expected acceleration of frequent movement	~ 20 mm/sec ²	NA	~20 mm/sec ²
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Table 1 Estimate of accumulated movements per year, velocity and acceleration of bearing movements

The sliding elements shall last at least 20 years before they have to be replaced.

2.4 Bearing arrangement

The bearings shall be arranged and fastened in such a way that inspection and maintenance can be performed easily and unhindered and possible replacement of the bearings can take place by utilising the provisional supports indicated in the project without further interference with the bridge structure. To allow for bearing replacement and vertical adjustment, the bearings shall be supported by separate steel plates fastened to the superstructure and the substructure. The bearings shall not be welded to the superstructure or substructure.

It shall be possible to replace a bearing within 4 hours during night time.

Bearings shall be fitted with pointer/scale arrangement for distant reading of the bearing position.

3 Materials

3.1 General

Materials shall comply with the requirement of [5], [6], [7], [8] and [9].

High performance sliding materials shall be considered in the design to reduce the size of the bearing and to increase the expected life time of the sliding surfaces.

The manufacturer shall prepare a quality plan for manufacturing and installation.

The bearings shall function in ambient air temperatures in the interval +45⁰C and -5 ⁰C.

3.2 Corrosion protection

The surface treatment shall meet the requirements of corrosive category C5-M, durability "High" in accordance with [6].

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The primer of the surface treatment shall be 80 μ thermally metal sprayed and sealed with a sealer that is compatible with the intermediate and top coat.

The colour of the top coat shall be same as on the girders.

3.3 Mortar for grouting under backing plates (terminal structure)

The mortar shall be of a type that does not shrink or creep.

The bedding of the bearings shall be designed according to EN 1992-1-1, section 10.9.5.2. Here the maximum stress in the concrete underlying or overlaying bridge bearings under the design load in ULS is limited to minimum value of the strength of the mortar and 85% of the cube strength of the concrete.

4 Execution

4.1 General

In the factory the bearings shall be sufficiently assembled and packed in such a way that they will not be damaged during transport and installation. The consignment shall be accompanied by a detailed instruction regarding installation of the bearing. A specialist fitter from the bearing manufacturer shall be present at the installation.


The sliding surfaces of the bearings shall be supplied with dustproof cover for protection against contamination in order to ensure the nominal sliding qualities to be present.

The bearings at the expansion joints shall have the same longitudinal slope as the bridge deck, whereas the other bearings shall be installed horizontally.

The bearings shall not be loaded before the grout has developed sufficient strength and stiffness.

4.2 Factory test

One finished bearing shall be presented in the workshop before the mass production of the bearings commence. The arrangement shall represent the actual access- and inspection conditions of the finished bridge and shall include the function of the sliding bearing, adjustment, pointer scale and coverings. Erection and replacement procedure shall be demonstrated.

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The manufacturer shall document the friction values of the sliding bearings at the actual stress level for temperatures ranging from + 45 °C to -5 °C.

4.3 Site Tests

The procedure for grouting of backing plates shall be verified by test grouting in an arrangement where the dimensions and positions are the same as on the pier top for the actual conditions. The test shall demonstrate an undisturbed grouting operation and a complete filling of the total bearing area.

The backing plates shall after grouting is completed be supported on not less that 90% of the surface. No un-supported area of the backing plate must be larger than 2 times the thickness of the backing plate in any direction.

5 Tolerances

Bearings shall be placed with a tolerance of ± 5 mm relative to the longitudinal and transverse web plates of the girders of the steel superstructure.



In the longitudinal direction the position of the bearings may not deviate more than 20 mm from the theoretical position.

The bearing shall be designed and installed in such a way that no torsion forces are introduced into the superstructure due to the dead load. The absence of torsion forces shall be secured in a verifiable way e. g. by hydraulic balancing of the superstructure during placing the bearings. For this purpose all bearings shall be arranged for a possible shimming between the bearings and superstructure between 0 - 20 mm.

A set of vertical bearings shall be shimmed so that the variation in levels from the torsion free position is less than 0.5 ‰ of the distance between the bearings.

The sliding surface may in the sliding direction of a set of bearings deviate 1 ‰ from the theoretical value.

The slope of the sliding surface in the sliding direction of a set of bearings may have a difference of slope of 1 ‰ for bearing supporting the roadway, for bearings supporting the railway the difference of slope shall be less than 0.5 ‰.

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For bearings constrained against lateral movements, the direction of the free movements may not deviate more than 1.0 ‰ from the direction of the theoretical longitudinal axis of the bridge.

The possible movement in lateral direction for bearings constrained against lateral movement shall be less than ± 0.5 mm.

Bearings with vertical anti lift device shall not move upwards more than 2.0 mm when subjected to the SLS2 lift load.

The contact areas between the bearing and the backing plates shall be machined to a flatness to be less than 0.1 mm. The contact area between backing plates and the superstructure or substructure shall be machined to a flatness to be less than 0.3 mm from a plane.

6 Submissions

6.1 Documentation

The manufacturer shall prepare and submit for acceptance by the Works Supervision calculations and detailed drawings of the bearings inclusive anchoring.

The manufacturer shall prepare a quality plan for manufacturing and installation of the bearings.

Plan for and test results from full scale workshop presentation of a typical bearing.

Plan for and test report from friction test on a full scale bearing.

The manufacturer shall submit a declaration of compatibility, stating that the bearings are suitable for functioning under the actual conditions regarding support and general arrangement of the adjacent structure.

The manufacturer shall supply a maintenance manual in Italian and English language.

The manufacturer shall supply as built records.