



PONTE SULLO STRETTO DI MESSINA



PROGETTO DEFINITIVO

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1 Introduction

1.1 Scope

The scope of work for the gantries for the suspended deck can be summarized in the following:



- Inspection and maintenance gantries for suspended bridge
- Access platforms to gantry
- Loading cranes for gantry

The scope of work covers detail and workshop drawings and calculations of the design, supply, installation, testing - including both FAT and SAT, commissioning, training of operators, as-built documentation, operation and maintenance manuals and quality assurance activities in accordance with the general requirement of the contract and the present specification. Fabrication and assembly of the gantries shall be inspected.

The design of the gantries, platforms and cranes must include integration of the access facilities into the overall bridge design, considering interface requirements from other parts of the bridge project.

The interfaces to be considered include, but are not limited to, the following:

- Increased height of the bridge cross girder at the towers
- Reduced clearance at main access walkways (every 360 m) at road bridge girder
- Wind screens
- Water supply systems
- Electrical systems and installations
- Corrosion protection system
- Control and monitoring systems
- Safety and operation control/SCADA
- Communication systems

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The interfaces are described further in this specification.

1.2 References

1.2.1 Design Specifications

- 1 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.
- 2 GCG.G.03.04. Various works, Section 2, Stretto di Messina, 2004, July 15.
- 3 GCG.F.04.01. Engineering – Definitive and detailed design: Basis of design and expected performance levels, Stretto di Messina, 2004 October 27.
- 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.
- 6 CG1000-P-RG-D-P-GE-00-00-00-00-02_A_Basis of Design_ANX, Stretto di Messina, 2010, October 11.
- 7 CG1000-P-2S-D-P-IT-M4-C3-00-00-00-06-A Design Specifications - Mechanical and Electrical

1.2.2 Codes and Standards

- 8 EN 1990-2:2007 Basis of structural design
- 9 EN 1991 Eurocode 1: Actions on structures
- 10 EN 1993 Eurocode 3: Design of steel structures
- 11 Machinery Directive 2006/42/EF
- 12 Low Voltage Equipment Directive 2006/95/EC

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13 Electromagnetic Compatibility Directive 2004/10/EC

14 Reference standards: Standards in the document: CG1000-P-2S-D-P-IT-M4-C3-00-00-00-06-A Design Specifications - Mechanical and Electrical; Appendix 2; Standards

1.2.3 Drawings

- GC10.00-P-AX-D-P-SS-R4-PA-00-00-00-02-A Gantry for suspended deck
- GC10.00-P-AX-D-P-SS-R4-00-00-00-00-01-A Service lane
- GC10.00-P-AX-D-P-SS-R4-00-00-00-00-02-A Wind screen
- GC10.00-P-AX-D-P-SS-R4-00-00-00-00-13-A Access to gantry for suspended deck

2 Nomenclature



The following definitions shall apply:

- "Gantry" - in this document refers to the inspection and maintenance gantry for the suspended deck of the Messina Bridge.
- "Suspended deck" - comprises the structure suspended from the main cables by hangers, i.e. the two roadway girders, the railway girder and the cross girders.
- "FAT" - Fabrication Acceptance Test
- "SAT" - Site Acceptance Test

3 Gantries for suspended deck

3.1 Introduction

This document defines the requirements for the inspection and maintenance gantries, access platforms and cranes to be used for the suspended deck.

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3.2 General Requirements

3.2.1 General

The specification for the inspection gantries summarises the following:

- Functional requirements
- Operational requirements
- Structural requirements
- Mechanical and Electrical installations and systems requirements
- Material requirements
- Documentation
- Codes and standard



The suspended bridge must be equipped with four identical (with only minor exceptions) mobile self-propelled gantries. Two in the main span and two in the side span of the suspended deck for inspection and maintenance work.

The facilities shall be designed so that the following main objectives are fulfilled:

- The gantries shall give access to all external parts for inspection and maintenance
- The gantries shall be easy to erect on the suspended deck and easy to operate
- All relevant safety aspects are provided for
- The gantries do not damage adjacent bridge structures and equipment
- The gantries shall be able to pass under the main access walkways between bridge girders
- The gantries are robust and have a long service lifetime

3.2.2 Gantries for suspended bridge

For the suspended deck four gantries shall be provided. The gantries shall be minimum 5 m wide and be self-propelled. All external surfaces of the suspended deck shall be accessible from the gantries, and each gantry shall be equipped with two telescopic platforms in order to give access to

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the entire height of the cross girders and to the surfaces of the road and rail girder above direct reach from the working area on the gantry.

The suspended bridge deck must be provided with rails at the sides of the service lane for support and transportation of the gantries. The rail arrangements are shown in drawing GC1000-P-AX-D-P-SS-R4-00-00-00-00-01-A Service lane.

The lifting platform shall be movable in the entire length of the gantries and arrangements for fixing/parking shall be included.

3.2.3 Access platform to gantry

Access platforms to gantries shall be extended from the first and enlarged cross girder from the tower. The gantry shall be parked next to the access platform when not in use.

The platforms shall facilitate lifting of equipment, parking of the gantries and give access to the parked gantry.

3.2.4 Loading crane for gantry

The access platform shall include a loading crane for lifting service equipment from ground level on to the access platform and gantry for the suspended deck. The crane shall have a safe working load of 22 kN at a reach allowing the crane to place the lifted item at the centerline of the working area on the gantry.

3.3 Functional Requirements

3.3.1 General

Gantries will provide inspection access to the entire external surface of the bottom of the suspended bridge deck, including vertical and inclined surfaces.

The access will include the possibility to clean the elements with pressurised water, or other light maintenance operations which can be undertaken from the work areas indicated on the drawings.

Gantries and lifting platforms must provide access to the following areas for inspection:

- The underside of the road bridge deck
- The underside of the railway bridge deck

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- Outside faces of the cross girders in the bridge deck
- The underside of the cantilevered service lane deck

The following areas will not be available for inspection from gantries:

- The bridge deck between the tower and the first and enlarged cross girder on both sides of the tower
- The approach bridge deck
- The piers for the approach bridge

3.3.2 Size of gantries



The size of the gantries must be (approx.):

Gantry	L x W x H = 66.0 x 6.0 x 5.2 m
Boogie distance	D = 9 m (centreline-centreline)
Boogie length	L = 3 m
Telescopic platform	L x W x H = 3.0 x 1.2 x 1.5 - 7.5 m
Hand rail	H = 1.5 m
Wind screen	H = 2.0 m
Gantry rail length	L = 3240 m (pr. side of bridge)
Rail centre distance	e = 59.8 m
Access platform	L x W x H = 6 x 2.63 x 2 m
Loading crane	L x W x H = NA

3.3.3 Suspension bridge dimensions

The main dimensions of the suspension bridge are (approx.):

- Bridge deck width (incl. service lane) W = 60.4 m
- Bridge length, mid span L = 3300 m

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- Bridge level, at tower z = +57.63/+65.05 m
- Bridge level, mid span z = +79.0 m

3.4 Operational Requirements

3.4.1 General

The minimum travel speed of the gantry must be (to be agreed with Client):

$$v \geq 0.5 \text{ m/s}$$

The travel speed will be valid for the vertical alignment of the bridge which is equivalent to an inclination of the rail of maximum 1.5 % relative to horizontal.

The gantries must be designed to perform all operations in gust wind speeds 75 m above sea level, equivalent to a basic wind speed of:

$$v_b = 10 \text{ m/s (10 min. average at 10 m above sea level)}$$

The gantries shall be designed to withstand operating wind speed conditions (15-20 m/s, to be agreed with Client) when fully loaded and travelling along the bridge deck.

Raining conditions are considered to be included in normal working conditions.

The gantries must be designed to survive a 50-year storm when fully loaded and locked in parked position under the superstructure. The wind speed in this condition will be equivalent to a basic wind speed of:

$$29 \text{ m/s (10 min. average at 10 m above mean sea level)}$$



The design wind speed at gantry levels shall be calculated in accordance with the document no. CG1000-P-RG-D-P-GE-00-00-00-00-02_A Design Basis, Structural, Annex.

3.4.2 Gantries for suspended deck

A fully loaded gantry for the suspended deck must be able to travel the entire length between the access platforms and back without requiring additional fuel supply.

Parking/blocking points shall be provided at regular and frequent intervals.

The gantries shall be self-aligning.

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The gantry is envisaged supported on boogies that distribute the vertical loads equally to all boogies. Gantry will be horizontally stabilized with guide rollers against bridge deck edge, and the boogie wheels shall have capability to move transverse to the moving direction of the gantry without transferring transverse forces to the bridge deck.

Sensors shall be provided to prevent collision with structures and other gantries.

The structure supporting the gantry, i.e. the gantry rail on the service lane, shall be designed for 1.5 times the maximum reaction of the gantry. The rails shall have additional thickness to compensate for corrosion and wear.

The gantry rail shall be continuous or if joints, these shall provide smooth passage of the gantry.

The gantry rail shall be replaceable.

The gantries shall be able to park against the access platform.

3.4.3 Access platform to gantry

The gantries shall be accessible from platforms extended from the first enlarged cross beam from the tower in the main span and in the side span.

The access platform shall extend 2-3 m out from the cross girders, corresponding to the first diaphragm in the girder in order to support the platform from this. The gantry shall be parked immediately next to the access platform.

The platforms shall be supported by the suspended deck and the cross girder.

Access platforms shall support a lifting crane.

3.4.4 Loading crane for gantry

The access platform shall include a loading crane for lifting equipment to the access platform for the gantry or to the gantry itself.

The crane shall be secured against interferences with any part of other structures (road girder, rail girder, tower, gantry, platform, etc.).

The loading crane shall be operational from the platform as well as from the ground to accommodate what suits the maintenance personnel best.

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Electronic locks shall be installed to prevent the gantry from moving when the loading crane is in operation and also prevent the loading crane from moving when the gantry is in motion.

3.4.5 Clearances

The minimum clearances between gantries and structures must be:

Structure	Minimum clearance between structure and gantry
Suspended deck	2.0 m
Access platform	0.1 m
Lifting crane	1.0 m

3.4.6 Safety

Access

All ladders and walkways must be provided with rail for safety wire to the extent required by Italian regulations.

Travel control

In order to limit the displacements of the gantry during travelling, guide wheels shall be provided.



Provisions to prevent the gantry from running into any part of the suspended deck during operation, must be included in the design. This includes sensors signalling to stop the gantry and controls for stopping the gantry with signal when gantry is stopped and interlocked.

Gantry will be horizontally stabilized with guide rollers against bridge deck edge and thereby secured to rest on the rail in case of wheel derailment.

Provisions shall be taken to prevent the gantry from movement when the telescopic platforms are raised.

Operators shall be trained on safe working conditions according to Operation and Maintenance instruction for suspended deck gantry.

Parking

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Special support fixtures for stabilizing the gantry to the bridge structure in wind conditions above maximum operation wind speed must be provided. The maximum operation wind speed must be specified in the design and in the I & M Manual.

Gantries must be designed for parking under the bridge with full load and 50-year wind load.

Escape

In case of failure in the electrical installations, or the internal combustion motor drive, escape to the service lane shall be possible from both sides of the bridge. This could be accomplished via an extractable ladder located at the top of the gantry, that when extended, provides access to the top of the wind screen on the service lane, and from here the service lane can be reached by use of a safety rope.

Manual operation of the telescopic platforms and the aerial work platforms shall also be provided to the extent required for safe escape of personnel.

3.4.7 Acceptance tests

Acceptance tests in factory and on site shall as minimum include the following:

- Hydraulic power unit testing
- Safety control system testing
- Complete gantry testing on temporary tracks under all load conditions
- Full live load testing
- Start and stop testing at full speed during simulated design wind load
- Misalignment detection testing
- Automatic and manual misalignment correction testing
- Wet condition testing
- Normal and emergency stop testing.

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3.5 Structural Requirements

3.5.1 Global design of gantries

The structural frame of the gantries must be designed to travel on rails as shown on drawing CG1000-P-AX-D-P-SS-PA-00-00-00-02 Gantry for suspended deck.

The centreline distance between the gantry rails are 59.8 m.

The gantry shall be cambered to account for deflection from dead load.

The maximum weight of a gantry with equipment and personnel must not exceed 55.5 tons. The supplier shall provide documentation of the weight during design.

The tender design of the rails has been based on the following load limitations for the gantries:

Item	Dead load [kN]	Live load [kN]	Wind load [kN]
Bridge gantry	4x110	4x29	4x±110
Access platform	NA	25	NA
Loading crane	NA	15	NA



For establishment of reactions on the rails, the variable and live load for global design will be assumed uniformly distributed on the entire workspace of the gantry.

The forces transferred to the rail from misalignment of the gantry must be determined in corporation with the supplier. Provisions must be made to absorb these lateral misalignment forces.

The nominal reactions will include any dynamic effects from generation of gantry or wind.

The reactions on the rails must be based on the following load combinations, see table 24 in document CG1000-P-RG-D-P-GE-00-00-00-00-02_A Design Basis, Structural, Annex:

- 2) 1.5 x Permanent load + 1.0 x Wind load
- 5) 1.5 x Permanent load + 1.5 x Live load
- 6) 1.5 x Permanent load + 1.1 x Live load + 1.0 x Wind load + 1.1 x Misalignment forces

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The gantry rail must be designed for 1.5 times the maximum reaction of the gantry.

The distance between centrelines of two bogies on the same side of the gantry is assumed to be minimum 9 m and the bogie length is assumed to be 3 m.

Thermal induced forces and seismic loading due to earthquake shall be considered in accordance with document CG1000-P-RG-D-P-GE-00-00-00-00-02_A Design Basis, Structural, Annex.

3.5.2 Local design of gantries

Live loadings:

Item	Distributed load, p_v [kN/m²]	Concentrated load, P_v [kN]
<i>Gantry</i>		
-Personnel	2.5(A=7m ²)	2x1.0 (cc=1m)
-Telescopic platform (2 pieces)		15.0
-Generator/hydraulic unit		12.0
-Diesel tank		10.0
-Water tank		15.0
-Service container (2 pieces)		15.0
<i>Access platform</i>	2.5	3.0
<i>Loading crane</i>		15.0

The gantry shall be designed to withstand specified concentrated loads due to personnel and telescopic platforms at any location on the gantry deck. Generator/hydraulic unit, diesel and water tanks shall be located at centre of gantry in transverse direction whereas service containers shall be located at both ends of the gantry in the longitudinal direction.

All handrails must be designed for a variable horizontal load along the upper rail of:
 $p = 1.0$ kN/m



The height of the handrail must be a minimum of 1.5 m.

3.6 Mechanical & Electrical Requirements

3.6.1 General

The mechanical and electrical works covered in the inspection gantry scope of work can in headlines be stated as follows:

The gantries must consist of the following main components:

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- Gantries for suspended bridge (4 pieces)
 - Base gantry
 - Trolley equipment
 - Hydraulic drive, air cooled
 - Telescopic platforms
 - Flushing/Cleaning equipment
 - Wind screen panels
 - Fire extinguishing system
 - Service container(s) for tools and staff
 - Hydraulic unit and piping
 - Diesel tank
 - Water tank
 - Compressor unit (air and water)

The driving unit shall be specified with three separate braking systems:

- Electrodynamic motor brake for normal braking
- Electromagnetic disc brake for parking and emergency situations, equipped with deadman's lock
- Mechanical hand brake.

Electrical installations and systems:



- Redundant electric power supply system: Two diesel generator sets.
- Telecommunication system
- Control and Monitoring systems.
- Instrumentation

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- Lighting installation
- Safety systems and operation controls
- Equipotential bonding
- Access platform to gantry (4 pieces)
 - Power supply and distribution at the platform
 - Telecommunication system
 - Lighting installation
 - Equipotential bonding
- Loading crane for gantry (4 pieces)
 - Crane, winch haul and power unit
 - Power supply for the crane
 - Control and monitoring
 - Safety systems and operation controls
 - Telecommunication

3.6.2 Power supply for gantries

- **General**
 - Equipment and cables, which can be exposed to UV radiation, shall be resistant against this radiation
 - The equipment shall be of vandal class 2
 - Anti condensation heaters shall be installed inside switchboards
 - Circuit breakers, not fuses shall be used in the switchboards
 - IP code: 67
 - The Subcontractors installations shall include earthing and equipotential bonding



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- **Power supply for gantries**

- The gantries shall have the two following methods of work
 - Gantry parked (not moving). The following shall be in service: Lighting along access ways. Minimum 150 m flexible cable with plug for connection to socket outlet along the bridge shall be delivered.
 - Gantry in service. The following equipment shall be supplied from a diesel generator set located on the gantry: Hydraulic pumps, compressed-air plant, lighting installations, socket outlets. All the above-mentioned equipment may not be unworkable at any location on the platform operation area. If necessary to fulfil this a doubling (redundant power supply by two diesel generator sets) of the power supply shall be provided.
- An emergency source of power shall be provided so that the platform can be parked if the normal supply, as well as the diesel generator, should fail. This source shall be provided via a socket outlet at the bridge.

Requirements to diesel generator sets

- The diesel generator set must not cause vibrations of the gantries or the bridge constructions. The diesel generator shall be able to withstand vibrations as specified in the Design Specifications - Mechanical and Electrical.
- Construction shall facilitate on-site maintenance and repairs, including a barring facility if appropriate, and access to and removal of pistons and connecting rods. The engine/AC generator unit shall be mounted on a common, rigid bedplate supported on spring-type anti-vibration mountings. Means for lifting and moving the set into position shall be provided.
- The generator shall be 20 % oversized (kVA value) in order to have necessary capacity that might be needed in the future.
 - The diesel tank shall have a capacity suitable for the maximum traveling distance using the winch mounted on the cable carriage, at full speed, plus allowance for one weeks inspection work, with a minimum safety factor of 1.5.

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3.6.3 Telecommunication

Radio telecommunication shall be provided.

3.6.4 Control, monitoring and instrumentation

The gantry shall be provided with a control panel for the diesel generator set and a main control panel for electrical power supply and distribution.

The telescopic platforms and the lifting crane shall be equipped with operator control panel.

The control panel for diesel generator shall include at least: an hour counter, a voltmeter, a frequency meter, an ammeter and an alarm panel.

The main control panel shall comprise current and voltage measurements for each phase, alarm lamps and an alarm display panel.



A gantry operation and safety control panel shall be provided for operation and control of the gantry.

3.6.5 Lighting and socket outlets installations

- Lighting shall be installed to allow operation, inspection and maintenance activities. The installations shall include lighting in all parts of the carriage including lighting along access ways and the working area. The luminaires shall be provided with built in batteries which must have a capacity at minimum one hour back up time.
- The luminaires shall be manufactured in such a way that it will be easy to replace lamps with new ones, only by using hand tools.
- Lamps shall be of a type with a long life time and the ballasts in the luminaires shall be electronic. An average illumination level of minimum 200 lx shall be provided at the working area. The uniformity (E minimum/E average) shall be $\geq 30\%$.
- The luminaires must not dazzle the road-users or the ships.

Lighting and socket outlets installations shall comply with section 5 of doc. no.: G1000-P-2S-D-P-IT-M4-C3-00-00-00-06-A Design Specifications - Mechanical and Electrical,

Sockets Outlets

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The carriages shall be provided with power sockets for tools or auxiliary lamps connection.

All socket outlets shall have a screwed-on cover to the outlet, providing a degree of protection min. IP 66, and be impact proof to IK 10

- Socket outlets shall be placed in clusters (or built as a switchboard).
- A cluster shall as minimum contain:
 - one 400V (3 phase + neutral + earth), 32 A switched socket outlet- two 400V (3 phase + neutral + earth), 16 A switched socket outlet
 - two 230V (1 phase + neutral + earth), 10 A switched socket outlet
- The distance between these clusters shall be such as the maximum length of the flexible cord connected will be maximum 10 meter indifferently where on the working area the connected equipment is used.
- The socket outlets shall be protected against indirect contact by residual current circuit breakers.

Bonding and Earthing

All the elements of gantries and the electrical and mechanical and other equipment shall be earthed during any operation and maintenance works.



- All metallic parts shall be bonded.

3.7 Materials

3.7.1 General

Materials, components and equipment must be of recognised and well-known make and available in Italy as standard components.

Gantry structural components are fabricated from Grade S355J2+N structural steels, produced in accordance with EN 10025-4. All material shall be delivered with 3.1 inspection certificate according to EN 10204.

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Replacement of installations and equipment with short service life must be easy. Components to be regularly inspected and maintained must be easily accessible and removable. Spare parts of components subject to wear or failure (motor parts, bearings, wheels etc) must be available.

All materials must be selected with due regard to durability and service requirements in a sea-water environment for the specified service lifetime of 25 years. Selection of lightweight materials with minimum maintenance requirements during the service life shall be emphasised. Minimizing the reactions on gantry rails must be given high priority in the choice of materials in order to optimise the rail and support arrangement.

3.7.2 Corrosion Protection

The surface treatment of the gantry carbon steel structure, painting and stainless steel shall meet the requirements of atmospheric corrosivity category C5-M according to EN12944. Hot dip galvanising coating of 140 µm shall be applied to carbon steel structure according to EN1461.

The gantries must be painted to match the bridge deck girder.

All gantry parts must be made from galvanised carbon steel or stainless steel with the aim to sustain the environmental conditions present in the Strait of Messina (corrosivity category C5-M), without further maintenance for a period of minimum 25 years.

The gantry structure and all other parts (mechanical and electrical) must be easy to maintain and to replace if necessary after end of service lifetime.



Due attention must be paid to the effects of mechanical wear and grease or other liquids on surfaces inside as well as outside.

Due attention must be paid to the problem of galvanic corrosion by electric isolation, as required, between different materials.

Attention must be paid to the steel composition in relation to hot dip galvanising (silicium content).

Attention must be paid to the corrosive environment (corrosivity category C5-M according to EN12944) when selecting materials and components.

The specific requirements for pre-treatment and for corrosion protection systems must be specified in the detailed design of the gantries.

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3.8 Documentation

It is required to supply operation and maintenance manuals in both Italian and English.

3.9 Codes and Standards

The design of the gantries and the installations on the gantries with regard to safety, materials, and loads will follow relevant Italian and European Norms (EN) and regulations.