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Concessionaria per la progettazione, realizzazione e gestione del collegamento stabile tra la Sicilia e il Continente Organismo di Diritto Pubblico
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EurolinK

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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 Calabria 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

This performance specification specifies the cable carriage and hanger basket for inspection of the main cable and hangers.

In the reference drawings the arrangement of expansion joints has been shown only in principle. The tender drawings show a specific make of joint, however other makes may be proposed. In such cases the tender drawings may be subject to modifications.

1.3 References

1.3.1 Design Specifications

1 GCG.G.02.01 rev.0. Construction of the street and railway connections: Norms for the execution of the civil works - street and railway infrastructures. Stretto di Messina, 2004 July 6.

2 GCG.G.03.02. Technical specifications for the construction of the suspension bridge - Structural steel works and protective treatments, Stretto di Messina, 2004 July 30.

3 GCG.G.03.04. GCG.G.03.04. Specific Techniques for Construction of the Crossing, Stretto di Messina, 2010, July 15.

4 GCG.F.04.01. Engineering – Definitive and detailed design: Basis of design and expected performance levels, Stretto di Messina, 2004 October 27.

5 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.

6 CG1000-P-RG-D-P-CG-00-00-00-00-00-13_A_Basis of Design_ANX. Basis of Design and Expected Performance Levels, Stretto di Messina, 2010, July 26. CG1000-P-2S-D-P-IT-M4-C3-00-00-00-06-A Design Specifications - Mechanical and Electrical

1.3.2 Codes and standards

7 EN 1990-2:2007 Basis of structural design

8 EN 1991 Eurocode 1: Actions on structures

9 EN 1993 Eurocode 3: Design of steel structures

10 Machinery Directive 2006/42/EF

11 Low Voltage Equipment Directive 2006/95/EC

12 Electromagnetic Compatibility 2004/10/EC

13 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

1.3.3 Drawings

14 CG1000-P-AX-D-P-SS-R4-PA-00-00-00-03. Main cables carriage and hanger basket

15 CG1000-P-AX-D-P-SV-S7-SS-00-00-00-01. General arrangement

16 CG1000-P-DX-D-P-SS-R4-00-00-00-00-01. Access facilities, overview

17 CG1000-P-AX-D-P-SS-R4-00-00-00-00-02. Wind screen

18 CG1000-P-AX-D-P-SS-R4-00-00-00-00-09. Access to anchor block

19 CG1000-P-AX-D-P-SS-R4-00-00-00-00-15. Access to main cable in the midspan and at the saddle

20 CG1000-P-AX-D-P-SS-R4-00-00-00-00-16. Portals for road signs

21 CG1000-P-BX-D-P-SV-S7-SL-00-00-00-03. Main cable. Hand strands - Details 2

22 CG1000-P-BX-D-P-SV-S7-CL-00-00-00-01 Cable clamps. Details 1

23 CG1000-P-BX-D-P-SV-S7-CL-00-00-00-02 Cable clamps. Details 1

24 CG1000-P-BX-D-P-SV-S7-SL-00-00-00-01 Tower saddle. Cover and cable sleeve

25 CG1000-P-AX-D-P-SV-S7-SL-00-00-00-01 Tower saddle. General arrangement

2 Nomenclature

The following definitions shall apply:

- "Cable walkway" - inspection walkway on the main cable
- "Cable carriage" - carriage for inspection and maintenance of the main cables
- "Handstrand"- two wires serving as a railing and barrier along cable walkway
- "Towing system" - system for moving cable carriage along the main cable
- "Main winch haul" - driving element of the towing system which is placed inside the tower
- "towing wire" - element of the main winch haul
- "guiding wheels" - element of the towing system guiding towing wire along main cable; guiding wheels are mounted on inner handstrand posts at every hanger clamp
- "Small winch haul" - driving element mounted directly on the cable carriage
- "Hanger basket" - self hoisting device for inspection and maintenance of the hangers

- "FAT" - Fabrication Acceptance Test
- "SAT" - Site Acceptance Test

3 Main cable carriage & hanger basket

3.1 Introduction

Normal inspection of the main cables of the suspended bridge can be executed from cable walkways. Main cable carriage and hanger basket shall facilitate detailed inspection of the main cables and hangers according to Operation and Maintenance plan.

These specifications contain the requirements for the inspection and maintenance access facilities, which is to be used on the main cables and hangers of the suspension Messina Strait Bridge.

3.2 Scope of Work

The scope of work for the main cable carriage and hanger basket includes following elements:

- Cable walkway
- Cable carriage
- Towing system
- Hanger basket

The scope of work covers:

- Design: Detailed and workshop design of the cable carriage, hanger basket and appurtenant parts, including the submission of as-built documentation, design calculations, shop and installation drawings and details to the supervision.
- Manufacture and testing: manufacture, assembly, works inspection, quality assurance activities. and as a minimum following FAT shall be included: prototype trials under simulated running conditions; dismantling, inspection and re-inspection of the prototype.
- Supply, installation on the Messina Bridge, adjustments, testing and commissioning

  As a minimum the stated SAT shall be included:

- Mounting / dismantling cable carriage
- Running cable carriage with a full /no load on the full length of the cable under simulated wind conditions
- Parking cable carriage with full / no load at three different positions
- Using braking systems
- Using control system
- Clearance check under simulated wind conditions
- Running fully loaded cable carriage on three handstrands
- Using small winch haul
- Using generators in cable carriage
- Using hanger basket with full / no load under simulated wind conditions
- Mounting / dismantling hanger basket from the cable carriage
- Landing hanger basket on the deck with no power supply for hanger basket
- Using generators in hanger basket

• Post-installation: Provision of spare parts, operation and maintenance manuals, as built records and training of personnel.

All those shall be in accordance with the general requirements of the contract and this technical specification including enclosed drawings.

Design of the cable carriage, hanger basket shall 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:

• Service lane and roadway clearance profile.

• Safety barrier and wind screens.

• Access to and escape from the cable carriage and hanger basket.

- Increased width of main cable shroud at the saddles.
- Increased width of main cable covering at anchor blocks.
- Hanger clamps and other fasteners (hanger forks).
- Handstrands, handstrand posts and handstrand post clamps.
- Electrical systems and installations.
- Dehumidification system.
- Corrosion protection systems.
- Control and monitoring systems.
- Safety and operation control/SCADA.
- Communication systems.

3.3 General Requirements

3.3.1 General

The technical specification for the tender design of the main cable carriage and hanger basket summarises the:

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

The suspended bridge main cables and hangers must be equipped with mobile cable carriages and baskets located in side- and main-spans on both sides of the bridge. The inspection equipment and related facilities shall be designed in such a way that the following main objectives are fulfilled:

- Cable carriages shall give safe and stable access to all external parts for inspection and maintenance works.
- The cable carriage and the hanger basket shall be easy to erect on the main cable and easy to operate.
- All relevant safety aspects are provided. Cable carriage and hanger basket must not damage the cable, hanger or adjacent structures and equipment. In particular the surface treatment shall be protected.
- The cable carriage and hanger basket are robust and have a long service lifetime.
- Cable carriage and hanger basket shall be capable of being parked at a cable clamp for extended periods and capable of sustaining severe weather conditions as specified in section 3 of document: CG1000-P-2S-D-P-IT-M4-C3-00-00-00-06-A Design Specifications - Mechanical and Electrical, without deteriorating its features.

3.3.2 Cable walkway

Cable walkway consists of the main cable upper surface and two handstrands along the main cable.

Two handstrands shall be provided for each cable, one on each side and with a maximum horizontal distance of 1 m. The height shall be approx. 1 m above the cable surface.

Handstrands shall allow attaching safety harnesses with two hooks.

The handstrands shall be without splices, unless this is necessary for erection purposes in the main span. In this case (main span only) suitable splices shall be provided as explained elsewhere.

Walkway is not accessible for unauthorised personnel.

3.3.3 Cable carriage

The carriages (4 pieces) for the main cables shall be provided. Two for each bridge side.

The base frame with wheels shall be supported on handstrands. The carriage is a pendulum suspended on the base frame.

The carriage must be towed by a powered towing system between the top of the bridge tower and the anchor block or centre of the bridge, in total 8 towing systems. Main winch hauls are mounted inside the the towers. Towing system can only lift the cable carriage upwards. The downward movement is due to the gravity force.

The towing wire shall be guided by ski-lift type guides to follow the main cables at every clamp location.

Close to the midspan due to the geometry of the main cable the horizontal component of the gravity force is too small to lower the cable carriage. Cable carriage is equipped with small winch haul which allows moving the cable carriage downward in this area.

The working area for the carriage is outside approximately 350 m of the midspan area where cable carriage collides with road clearance profile. Under special conditions (restricted traffic) the cable carriage shall be able to work in "extended working area" including midspan.

3.3.4 Hanger basket

The hanger basket (4 pieces) shall be a self-hoisting unit capable of giving access for one man to the whole length (max. 350 m) of the hangers in the whole length of the bridge except from approx. 350 metres at centre of the bridge.

The hanger basket must be operational from the service lane or from the cable carriage, whichever suits the inspection and maintenance program best.

The hoist wire rope for the basket must be installable from the cable carriage to fixtures at hanger clamps in order to transfer basket loading directly to the main cables during operation.

The hanger basket climbing system must be equipped with a separate safety wire rope.

3.4 Functional Requirements

3.4.1 Cable walkway

Cable walkway shall enable safe inspection of the main cable and give access to the cable carriage.

Upper surface of the main cable should be covered with anti-slide material. Anti-slide surfacing must not damage cable wrapping.

Handstrands shall enable hooking safety harness and provide support for cable carriage.

3.4.2 Cable carriage

The carriage shall provide access to the main cables for inspection and maintenance. The cable carriage shall be able to access the following areas for inspection and maintenance:

- The entire circumference of the main cables over the entire length
- All parts of the cable clamps including the tensioning rods
- Tensioning control of rods in cable clamps
- Hanger cable forks, pins and sockets
- Surface treatment on cables and clamps
- Hand ropes and supporting posts
- Carriage support cables and supporting posts

The following areas will not be available for inspection from cable carriages:

- midspan of the bridge (approximately 350 m)
- main cables inside anchor blocks
- main cable at the whole length of the saddle including shrouds
- below anti-vandal protection in the side span (if anti-vandal protection is applied)

3.4.3 Hanger basket

The hanger baskets shall provide access for operation and maintenance to the entire length of the hanger cables.

Hanger basket shall enable mounting special devices on the hanger (such as dampers, spacers, helical ropes, lighting, etc).

3.4.4 Size of access facilities

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

Handstrand	**L = 8 x length of the main cable**
Height above main cable	H = 1 m (approx.)
Cable carriage	L x W x H = 3.5 x 5.4 x 7.2 m
Hand rail	H = 1.5 m
Wind screen	Mesh 50% closed
Towing wire (1 item)	D x L = 0.018 x 1800 m
Small winch haul wire	D x L = 0.010 x 80m
Hanger basket	L x W x H = 0.9 x 0.9 x 1.5 m
Hoisting wire	D x L = 10.0 mm x 350 m

3.5 Operational Requirements

3.5.1 Cable walkway

The handstrands shall be connected to each cable in such a way that allows relative longitudinal movement between the cables and the handstrands, but limits the lateral movement.

Tensioning of the handstrands shall limit the vertical sagging of the handstrand in the half distance between handstrand posts caused by fully loaded cable carriage to 250mm.

Tensioning of the handstrands shall limit the lateral deflection caused by wind load on the cable carriage to 200mm.

The design of the handstrands shall consider variations in stress caused by the bridge and cable deformations under variable loads.

Possible vibrations of the handstrands shall be considered as well as measures for dampening.

The handstrands supporting cable carriage shall be locked coil or another type that can be documented as suitable. The clamps between the handstrands and handstrand posts shall provide smooth passage of the cable carriage wheels.

3.5.2 Cable carriage

The minimum travel speed of the carriage must be:

v = 25 m/min.

The travel speed must be valid for the carriage considering an inclination of the main cables at the steepest point.

The cable carriage must be designed to perform all operations in wind speed:

v_b = 20 m/s (10-minute average at the present cable carriage height)

The cable carriage should be equipped with an anemometer. When the wind speed at the present cable carriage height exceeds 20m/s the cable carriage should be parked at the hanger clamp.

The cable carriage must be designed to survive a 50-year storm, when fully loaded or not and locked in parking position at the hanger clamp. The wind speed in this condition will be equivalent to a basic wind speed of:

29 m/s (10-minute average, 10 m above mean sea level)

The design wind speed at cable carriage and hanger basket levels shall be calculated in accordance with the document no. GCG.F.04.01 "Basis of design and expected performance levels for the bridge".

The cable carriage shall be able to travel the entire length of the main cable between the midspan and the saddle and return with a full load, without requiring any additional power supply.

The cable carriage shall be able to travel the entire length of the main cable between the anchor block and the tower top and return with a full load, without requiring any additional power supply.

Power supply in the cable carriage shall be provided from its own power generator. Extra power supply can be provided by electrical cable along the hangers from the service lane.

The design shall provide an optimal and safe operation without damage to any elements or the corrosion protection and without excessive deformation of the handstrands or supports.

Special attention shall be made to the design of the guiding wheels for the towing wire mounted on handstrand posts at every clamp along the cables and guiding wheels within saddle and tower area.

The design of the handstrands and handstrand posts shall take into account the requirements of the cable carriage and ensure easy and safe passage and parking.

Main winch haul at the tower consists of 2 towing wire drums, 2 engines and 1 gear box. One towing wire drum serves for main span, one for side span. Each wire drum is equipped with brake, and latch or ratchet. One engine is a core engine, one is a spare engine. Both towing wire drums and engines are connected to one gearbox. The gearbox drives one of the towing wire drum at a time. From one tower inspection can be executed in main span and side span parallel but the cable carriages cannot be moved simultaneously.

Towing wire drums, engines and gear box can be replaceable and transportable separately by tower elevator.

Steering of the towing system on the tower takes place from the cable carriage by remote radio control.

Small winch mounted on the cable carriage shall be used close to the midspan for lowering the cable carriage and in the midspan when operating in "extended working area". In this case main winch haul helps to control the downward movement of the cable carriage. Using small winch haul requires that the personnel attach the small winch haul towing wire to the clamps ahead.

Small winch haul shall be used for positioning cable carriage in the parking position at the clamp in case of power cut on the main winch haul.

The movement and run quality of the cable carriage along the cable shall be smooth, particularly when passing over the handstrand clamps and shall not cause any uncomfortable impact.

It must be ensured that the cable carriage does not disturb the roadway traffic by colliding with traffic clearance profile.

Cable carriage shall be easy to erect on the handstrands in the anchor block area and in the midspan. Erection in anchor block area shall be performed from the access road and from service lane in the midspan. If the anti-vandal protection is applied in the side spans then cable carriage shall be mounted above the anti-vandal protection.

Cable carriage can be installed in pieces if necessary (but the structure of the cable carriage shall allow quick dismantling procedure in case of significant weather deterioration forecast.

Threaded holes shall be provided on the side surface of the cable clamps for fixation of the lugs/ eye bolts. Lugs shall be used for parking the cable carriage and for attaching hanger basket.

Cable carriage shall be attached to the cable clamp in parked position. Parking in other position is not allowed since it can cause damage of main cable corrosion protection.

The upper level of intermediate deck of the cable carriage shall be below the upper tip of the lowest rod of the most inclined clamp (for easy access to clamp rods).

The lower deck shall facilitate inspection of the cable clamps and hanger forks mounting the hanger basket on the hanger clamp and launching the hanger basket. Launching hanger basket shall be smooth and safe.

All components which are critical to the movement of the cable carriage shall be replaceable in-situ in order that the cable carriage can always be recovered from all locations on the main cable.

During the operation live loads inside the cable carriage (apart from personnel) shall be applied so that the cable carriage is in equilibrium - those requirements must be mentioned in the cable carriage instruction.

Optional toilet facilities of capacity appropriate for one day's use before requiring emptying shall be installed.

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

All access shall be easy and safe and the following accesses are required:

- From walkways to the main cables to the upper platform from both sides of the carriage at all locations along the main cable.
- From the upper platform to the lower service platform.
- Overall in each platform and between the lower platforms.
- Hinged floor sections in lower and intermediate floors shall be arranged to cover the gap between the two lower platforms.
- The hinged floor sections shall be arranged as a complete floor when operating in between hangers and open when operating at the hangers.

It is recommended that the cable carriage and hanger basket shall be stored in garage when not in use.

3.5.3 Hanger baskets

The hanger basket shall be easy to operate on the hanger.

Each hanger basket shall be lifted by its own hoist unit and equipped with safety hoist unit. Both hoists are controlled from the hanger basket.

The hoisting wire and safety hoisting wire shall be attached to the hanger clamp to transfer basket load directly to the main cable.

The hanger basket may be incorporated in the cable carriage.

The shape and equipment of the hanger basket shall allow passing dampers, spacers, architectural lighting and other devices which can be mounted on the hanger cables.

Hanger basket shall be attached to the hanger in such a way that swinging, spinning, twisting around the hanger and vertical swinging along the hanger due to the elastic elongation of the hoisting wire is restricted.

Free swinging of the hoisting wire and safety hoisting wire shall be restricted to prevent hanger lining damage.

Hanger basket shall be provided with wheels, rolls or other equipment which helps to manoeuvre it inside cable carriage.

Extra anchorage eyes for the hanger basket shall be provided at the upper hanger clamp and at the lower hanger fork (at cable and deck level). These extra supports shall have clearance from dampers, spacers and other devices on the hanger cables.

3.5.4 Clearances

The minimum clearances between fully loaded cable carriage or hanger basket and structures must be:

Tower	c = 1.0 m
Main cable	c = 0.2 m

Hangers	c = 0.2 m
Access stairway	c = 0.2 m
Shrouds at the saddle	c = 1.0 m
Shrouds at the anchor block	c = 1.0 m
Anchor block	c = 1.0 m
Suspended bridge deck	c = 4.5 m (vertically)
Wind screens	c = 1.0 m
Road clearance profile	c = 1.0m

Above mentioned clearances must be fulfilled considering any protruding elements.

Due to the final tolerances of the main cables and moving live load the cable carriage can tilt. In the tilted position the cable carriage should keep the above mentioned tolerances.

In case of one handstrand rupture at least half of the clearances values shall be preserved so that it is still possible to move the cable carriage to the midspan area and demount it without additional measures.

During installation of the cable carriage from the service lane close to the midspan there is a limited area for crane operation. During installation of the cable carriage at least 1.0m clearance should be preserved from all bridge elements.

3.5.5 Safety

Safety notices

Appropriate safety notices, warning signs and instructions shall be provided on the cable carriage and hanger basket. These shall include, for example, notices clearly stating the safe working loads on the various parts of the cable carriage and operating instructions.

Travel control

The carriage shall have adequate stability to prevent rotation/derailing.

The driving unit will be equipped with three separate braking systems:

- Electrodynamic motor brake for normal braking.
- Brake on towing wire in case of drive rupture.
- Safety brake system acting on the handstrands in emergency situations - deadman's lock and mechanical hand brake.

In case of main winch haul failure the small winch haul mounted on the cable carriage can serve as a secondary towing system. Using small winch haul and safety brake system it shall be possible to lower the cable carriage close to the midspan where it can be dismantled by crane.

Design of the steering system shall include considerations of its reliability in actual operation and also considerations of operator understanding and operator misuse of a deliberate or accidental nature.

Provisions to prevent the carriage from running into any part of the towers, the main cable, clamps or the superstructure during operation must be included in the design (sensors, signalling to stop the carriage or similar). The cable carriage shall not start before the movable decks are retracted (to prevent hanger collision). There shall be a brake switch on the winch drum to prevent running into tower. Towing wire shall not unroll when not tensioned (cable carriage in the midspan).

Operators shall be trained on safe working conditions according to Operation and Maintenance instruction.Power supply for hanger basket is provided from cable carriage by electrical cable. In case of electrical cable rupture or power cut hanger basket shall be lowered by the hoisting wire to the service lane deck.

Failure mode effects analysis

Failure of a critical mechanical or structural component of the cable carriage shall not compromise its structural stability or the safety.

Failure of a critical mechanical or structural component of the cable carriage shall not result in damage to the any part of the permanent bridge structure or compromise the capacity of any part of the bridge structure to support its applied load.

Failure of the bridge permanent handstrands or handstrand posts shall not compromise the stability of the cable carriage or result in damage to the bridge structure. In case of one permanent

handstrand failure the deflection limits need not to be fulfilled but it must be possible to reach midspan by cable carriage without any additional measures.

The cable carriage shall include an element of redundancy in the design of all the main load carrying members so that if a critical load carrying member fails an alternative load path exists and catastrophic failure will not occur.

Power cut-pieces

All floor levels including hinged floors shall be provided with power cut pieces, which are located at all positions where contact with hanger cables is possible.

Emergency stops

Controls for emergency stop shall be provided at strategic positions throughout the cable carriage. The emergency stop shall override the normal controls.

Prevention of falling

The design shall prevent persons and all types of equipment in the carriage from falling out. Among other necessary features, all outer sides shall be covered by robust mesh or the like.

All floor surfaces shall be slip-resistant and provide a firm foothold.

Fixation rods

Fixation rods for attaching safety harness hooks shall be provided in all areas, as the use of safety harnesses is required at all times.

Escape

In case of failure in the electrical installations, or the motor drive, escape must be possible to the walkway on main cable.

Service lifetime

3.6 The carriage must be robust and have a service lifetime of minimum 25 years.Structural Requirements

3.6.1 Global design of carriages and handstrands

The structural base frame of the carriages must be designed to travel on the handstrands along the whole length of the cable.

The tender design of the handstrands must be based on the following cable carriage loadings:

Loads [kN]	Dead load	Live load	Wind load
Carriage, operation	48	23.5	See GCG.F.04.01
Carriage, parked	48	17.5	See GCG.F.04.01

Any two handstrands (not from one main cable) shall resist full load of the cable carriage. The cable carriage might be supported on any two handstrands (not from one main cable) only.

The nominal forces in the handstrands due to the cable carriage load shall include dynamic effects generated by cable carriage, hanger basket or wind.

The handstrands must be designed for min. 7 times the maximum reaction of the carriage and basket (to be confirmed by Italian authorities and Client).

Thermal induced forces and seismic loading due to earthquake shall be considered in accordance with document number GCG.F.04.01.

3.6.2 Design loads

Hanger basket design load:

Dead load:

Basket	1 kN
Ropes (350m of Ø9+Ø10)	3 kN
Winch hauls (basic + safety)	1 kN

Live load:

Man (1 of cable carriage personnel)	1kN

Tools (1kN of cable carriage equipment)	1kN
Extra load (e.g. helical wire/ power generator)	1,5kN
Electrical cable from deck (not considered)	

Cable carriage design load

Permanent load (approx.)

Steel frame of the cable carriage	27 kN
Supporting system with wheels	10 kN
Winch haul with 80m rope	6 kN

Variable live loads (approx.)

Personnel	6 kN
Tension (painting) equipment	5 kN (2kN)
Power generator with diesel tank	3 kN
Hanger basket (fully loaded, no personnel inside)	7,5kN
Concentrated load on 0.1x0.1 m	1 kN
Carriage speed (using main winch haul)	25 m/min.
Basket speed	9 m/min.

Variable environmental loads (approx.)

Operation wind speed	20 m/s
Parked carriage wind speed	55 m/s
Seismic load	≤ 6.3 m/s2
Thermal load	-2/43 ºC

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

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

All side panels, side mesh and other side restraints must be designed for a patch load of 0.5kN over an area of 0.3x0.3 m

3.7 Mechanical and electrical requirements

3.7.1 General requirements

The mechanical and electrical works covered in the main cable carriage and hanger basket scope of work can be stated in headlines as follows:

Cable walkway (all stretches):

- Handstrand wires (also supporting cable carriage)
- Handstrand posts

Cable Carriages (4 pieces):

- Carriage supporting base frame
- Trolley equipment (boogie with wheels)
- Carriage frame structure
- Access ladder between service platforms
- Access ladder to walkway on main cable
- Wind screen panels
- Cable towing and guide wheel system
- Electrically powered motorized winch haul equipment at the saddle
- Electrically powered motorized winch haul equipment at the cable carriage
- Fire extinguishing system

Electrical installations and systems:

- Redundant electric power supply system: Two diesel generator sets.
- Telecommunication system
- Control and Monitoring systems.
- Instrumentation
- Lighting installation
- Safety systems and operation controls
- Bonding

Hanger Baskets (4 pieces):

- Base basket
- Lifting wire system
- Electrically powered mobile hoist
- Power supply for hanger baskets
- Control & monitoring
- Safety & operation controls
- Communication

The general requirements to operational and personal safety, vibration resistance, electromagnetic compatibility, voltage levels, corrosion protection, degree of protection by enclosure and environmental pollution are specified in doc. no.: G1000-P-2S-D-P-IT-M4-C3-00-00-00-06-A Design Specifications - Mechanical and Electrical.

3.7.2 Power supply for carriages and baskets

General

- Equipments 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

Power supply for carriages

The cable carriage shall have the following two methods of working

- Carriage parked (not moving).
- Carriage in service. The following equipment shall be supplied from a diesel generator set located on the carriage: Compressed-air plant, lighting installations, socket outlets. All the above-mentioned equipment shall work at any location of the platform operation area. If necessary to achieve this a doubling of the power supply (redundant power supply by two diesel generator sets) shall be provided.

Power supplies for baskets

- Power supply for the hanger basket might be provided from cable carriage or from service lane or by diesel generator sets or batteries mounted in the baskets.

Requirements to diesel generator sets

- The diesel generator set must not cause vibrations of the carriage 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.

3.7.3 Telecommunication

Radio telecommunication shall be provided

3.7.4 Control, monitoring and instrumentation

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

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 cable carriage and hanger basket control panel shall be provided for operation and control.

3.7.5 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 ≥ 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

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

Handstrands and all elements of cable carriage and hanger basket shall be earthed during any operation and maintenance works.

All metallic parts shall be bonded.

3.8 Materials

3.8.1 General

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

The cable carriage structure shall be made of carbon steel (e.g. S355J2+N) and mechanical components of stainless steel.

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.

All materials must be selected with due regard to service in sea-water environment for the specified service lifetime of 25 years. Importance must be attached to selection of lightweight materials with a minimum of maintenance requirements during the service life.

Minimising the reactions on supporting cables and hangers must be given high priority in the choice of materials in order to optimise the cables and support arrangement.

3.8.2 Corrosion protection

The gantries must be painted or otherwise protected with the aim to sustain the environmental conditions present in the Strait of Messina, without further maintenance for a period of minimum 25 years. Due attention must be paid to the effects of mechanical wear, grease or other liquids, on inside as well as outside surfaces.

Attention must be paid to the corrosive environment when selecting materials and components.

The surface treatment of the gantry carbon steel structure, painting and stainless steel parts shall meet the requirements of atmospheric corrosivity category C5-M according to EN 12944. Hot dip galvanizing coating of 140µm shall be applied to carbon steel structure acc. to EN 1461.

Due attention must be paid regarding the steel composition in relation to hot dip galvanising (silicon content).

Measures must be taken to prevent long-term water ingress into any structural hollow box section forming any part of the cable carriage or hanger basket.

Due attention must be paid to prevent galvanic corrosion by electric isolation between different materials.The specific requirements for pre-treatment and for corrosion protection systems must be specified in the detailed design of the gantries.

3.8.3 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.