Stretto di Messina

Concessionaria per la progettazione, realizzazione e gestione del collegamento stabile tra la Sicilia e il Continente Organismo di Diritto Pubblico
(Legge n° 1158 del 17 dicembre 1971, modificata dal D.Lgs. n°114 del 24 aprile 2003)

EurolinK

PONTE SULLO STRETTO DI MESSINA

PROGETTO DEFINITIVO

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Unità Funzionale	OPERA DI ATTRAVERSAMENTO	PS0211_F0
Tipo di sistema	SISTEMI SECONDARI	
Raggruppamento di opere/attività	STRUTTURE SECONDARIE	
Opera - tratto d'opera - parte d'opera	Generale	
Titolo del documento	Performance Specification - General access facilities	

CODICE: C G 1 0 0 0 P S P D P S S R 4 0 0 0 0 0 0 0 0 0 1 0

REV	DATA	DESCRIZIONE	REDATTO	VERIFICATO	APPROVATO
F0	20-06-2011	EMISSIONE FINALE	JEJE/JAPK/TOGG	LFJ	JEJE/SOLA

NOME DEL FILE: PS0211_F0.docx

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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 requirements for the general access facilities. The general access facilities consist of:

- Walkways in suspended deck
- Wagon for suspended deck
- Lifts, stairs, ladders and doors in tower
- Access facilities to the main cable for inspection and maintenance
- Inspection of terminal structure and drop-in span

The following access facilities are not included in this performance specification:

- Inspection gantry for girders

- Inspection gantry for main cables and hangers
- Inspection and maintenance gantries for towers

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 rev.0. 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 rev.0. Specific Techniques for Construction of the Crossing, Stretto di Messina, 2004, July 15.

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 CG.10.00-P-RG-D-P-GE-00-00-00-00-00-02-A - “Design Basis, Structural, Annex,” COWI 2010

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.

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 Pressure Equipment Directive 97/23/EC

11 Machinery Directive 2006/42/EF

12 Low Voltage Equipment Directive 2006/95/EC

13 Electromagnetic Compability 89/336/EEC

1.3.3 Drawings

14 CG10.00-P-DX-D-P-SS-R4-00-00-00-00-01. Access facilities, overview

15 CG10.00-P-DX-D-P-SS-R4-00-00-00-00-02. Access to suspended deck, Overview

16 CG10.00-P-AX-D-P-SS-R4-00-00-00-00-17. Access to suspended deck, Main access

17 CG10.00-P-AX-D-P-SS-R4-00-00-00-00-07. Access to suspended deck, Typical

18 CG10.00-P-AX-D-P-SS-R4-00-00-00-00-08. Waggon for suspended deck

19 CG10.00-P-AX-D-P-SS-R4-00-00-00-00-09. Access to anchor block

20 CG10.00-P-AX-D-P-SS-R4-00-00-00-00-10. Access to bearings, expansion joints and buffers at towers

21 CG10.00-P-AX-D-P-SS-R4-00-00-00-00-11. Access to bearings and expansion joints at terminal structure

22 CG10.00-P-AX-D-P-SS-R4-00-00-00-00-12. Lift, stair and door facilities in tower

23 CG10.00-P-AX-D-P-SS-R4-00-00-00-00-15. Access to main cable in the midspan and at the saddle

24 CG10.00-P-AX-D-P-SS-R4-00-00-00-00-14. Access to tower base

2 Nomenclature

The following definitions shall apply:

- "Mobile aerial platform" - There are two devices for inspection and maintenance works. One mobile aerial platform for cables, hangers and clamps in the midspan. Other mobile aerial platform for terminal structures and side span.
- "Midspan access stairway" - access to cable walkway in the midspan
- "Access from saddle" - elements allowing access to cable walkway
- "Access from anchor block" - elements allowing access to cable walkway
- "Anti-vandal protection" - optional element mounted above the anchorage blocks restricting access to main cable (if mounted then it will affect usage of the other inspection equipment)
- "Basket" - element of the mobile aerial platform where the personnel can operate safely.
- "Access spot" - place where the vehicle with mobile aerial platform can be safely positioned for executing maintenance and inspection works.
- "Access road" - road which give an access to access spots
- "Articulation system" - longitudinal and transversal supporting system at the towers positioned below the suspended deck including beams, joints, bearings, expansion joints and hydraulic buffers.
- "Drop-in span" - part of the road suspended deck above the articulation system located between main span and side span.
- "Terminal structure" - part of the bridge at the level of the suspended deck located between side span and approach viaduct.

3 Walkways in Suspended Deck

3.1 Introduction

This performance specification contains the requirements for the inspection and maintenance walkways, which must be used in the suspended deck of the Messina Strait Bridge.

3.2 Scope of Work

The complete access facilities for the suspended deck covered by this specification are as follows:

- Access to interior walkways in bridge girders
- Cross access between bridge girders
- Access walkways in suspended bridge

The scope of work covers detail and workshop design, supply, installation, testing, commissioning, as-built documentation, operation and maintenance manuals and quality assurance activities, in accordance with general requirement for the contract and this technical specification.

The design of the walkways shall include integration of the access facilities into the overall bridge deck design, considering interface requirements from other parts of the bridge project.

The interfaces to be considered include but are not limited to:

- Free space profile requirements
- Safety barriers
- Service lane structure
- Drainage pipeline system
- Utility water and fire fighting systems
- Power supply and electrical systems
- Corrosion protection system
- Control and monitoring systems

- Safety and operation control/SCADA
- Communication systems

The interfaces are described further in this report.

3.3 General Requirements

The technical specification for the tender design of the walkways in the suspended bridge deck summarises the:

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

The bridge deck girders and cross girders must be equipped with hatches, manholes, stairs and carriage beams etc. as shown on drawings.

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

- Walkways shall give access to all inner parts for inspection and maintenance
- Hatches and manholes provide free space to access and exit the bridge girders
- All relevant safety aspects are provided for
- The facilities are robust and have a minimum service lifetime of 25 years

3.3.1 Access to interior walkways in bridge girders

Main access between the service lane and the inside of the roadway box girder shall be provided at intervals of 360 m. An access opening in the service lane along with stairs shall provide access to an external platform below the road girder at the location of a cross girder. From the external

platform a ladder and an opening shall provide access to the inside of the road girder. An access opening in the road girder along with a ladder shall provide access to the bottom level of the cross girder in which access along the whole length of the cross girder shall be provided, and thus provide access between the three bridge girders. From the cross girder a ladder leading to an access hatch in the railway girder shall be provided.

The access openings at the main access shall be at least 0.6 x 1.3 m. in both service lane and the girders. The external platform shall have a minimum width of 2.0 m and a minimum clear height of 1.9 m. The main access shall not obstruct passage of the gantries for the suspended deck.

Supplementary access openings shall be provided adjacent to the service lane, either at each cross beam or midway between two cross beams i.e. cc 30 m. The supplementary access openings shall have minimum dimensions W x H = min. 0.8 x 0.5 m. These openings shall allow for emergency transportation of a person on a stretcher.

Special access openings (min. opening W x H = 1.5 x 1.0 m) in the side of the bridge cross girders shall be provided at intervals of 120 m to give access for installation of electrical panels etc.

Special openings of 1.5x1.0 m are normal locked and provide possibility of placing electrical and mechanical equipment in the cross beam only. All external openings shall have air- and watertight doors/hatches which can be opened from the inside without a key in emergencies.

All external openings shall be equipped with a surveillance system with alarms for intrusion and lacking closure.

3.3.2 Cross access between bridge girders

Transverse walkways between the three bridge girders and through the cross beams must be arranged at 30 m intervals, i.e. at each cross girder. Access is through openings and via platforms, stairs and ladders. The bottom edge of all internal openings shall not be more than 400 mm over the walking surface.

At main access:

All interior pathways shall have minimum clear openings of W x H = 0.6 x 1.3 m.

At supplementary access:

All interior pathways shall have minimum clear openings of W x H = 0.8 x 0.8 m.

3.3.3 Access walkways in suspended bridge

Longitudinal walkways are arranged inside the three bridge girders.

All interior longitudinal walkways shall have minimum clear openings of W x H = 0.8 x 1.3 m.

The bottom edge of all internal doors/hatches shall not be more than 400 mm over the walking surface.

3.3.4 Access from service lane to cross overs

Access from the service lane to the cross over area shall be provided in order to provide an evacuation route in case of an emergency. Furthermore this provides an access route for service and maintenance personnel.

An access opening in the service lane along with stairs shall provide access to an external platform below the road girder. At the other end of the platform stairs shall provide access to a platform in the same level as the top of the cross girder, and thus access to the cross over area.

The access opening in the service lane shall be at least 0.6 x 1.3 m. The external platform shall have a minimum width of 1.5 m and a minimum clear height of 1.9 m. The external platform shall not obstruct passage of the gantries for the suspended deck.

The top of the cross girder shall be provided with a railing on the side away from the cross over area for safety. The railing shall have a minimum height of 1.5 m.

3.4 Functional Requirements

3.4.1 General

The walkways shall provide inspection access to the entire internal surface of the suspended bridge deck.

The facilities must provide access to the following areas for inspection:

- The inside of the roadway girders

- The inside of the railway girder
- The inside of the cross girders
- Bearings, transverse bracing and hydraulic buffers
- Bridge deck expansion joints and bearings

3.4.2 Size of access facilities

The size of the access facilities must be (approx.):

Roadway girder length	L = 3666 m
Railway girder length	L = 3666 m
Cross girder	L X W x H = 52 x 3.75 x 4.68 m
Main access opening	W x H = 0.6 x 1.3 m
Main access platform	W x H = 2.0 x 1.9 m
Supplementary hatch	W x H = 0.8 x 0.5 m
Main access internal openings	W x H = 0.8 x 1.3 m
Supplementary internal access opening	W x H = 0.8 x 0.8 m
Stair/ladder	W = 0.8 m

3.5 Operational Requirements

3.5.1 General

All walkways in bridge girders shall be equipped with access doors/hatches, manholes, stairs and ladders though the entire length of the bridge.

The walkways shall be equipped with necessary installations to provide safe transport and working conditions, e.g. normal and emergency lighting, emergency telephones, alarms etc.

The influence on the free space required in openings from the rails for the wagon in the road girder shall be kept to a minimum.

The location of the walkways shall be chosen in a way that influence on the free space from other installations such as drainage pipelines, cable trays etc. is kept to a minimum.

3.5.2 Clearances

The minimum clearances between access facilities and structures must be:

Stair c = 0.1 m

Ladder c = 0.1 m

Bulkheads c = 0.1 m

3.5.3 Safety

Stairs

All stairway runs must be provided with intermediate deck, handrails and rail for safety wire to the extent required by the Italian Regulations.

Ladders

All ladders must be provided with intermediate deck, safety cage and rail for safety wire to the extent required by Italian Regulations.

Doors

All doors must be constructed with a minimum fire resistance in accordance with Italian Regulation requirements.

All external openings shall be equipped with a surveillance system with intrusion alarms and lacking closure. Particular attention shall be paid to areas at deck to prevent intrusion.

All external openings shall have air- and watertight doors which can be opened from the inside without a key in emergencies.

3.6 Structural Requirements

3.6.1 Local design of access facilities

Live loadings (approx.):

Facility	**p_v [kN/m^2] Distributed**	**P_v[kN] concentrated**
Stair & deck	3.0	5.0
Platform	2.0	3.0
Ladder	NA	3.0

All handrails must be designed for a variable horizontal load along the upper rail of:

p =1.0 kN/m

3.7 Mechanical & Electrical Requirements

3.7.1 General

The mechanical and electrical work covered in the access facilities scope of work can be stated as follows:

- **Access to interior walkways in bridge girders**
  - Main access hatch and ladder cc 360 m
  - Main access walkway cc 360 m
  - Main access door in cross girder cc 360 m
  - Supplementary access hatch cc 30 m
  - Access opening in cross girder cc 120 m
  - Control and monitoring system
- **Cross access between bridge girders**
  - Main access internal openings cc 360 m
  - Supplementary access internal openings cc 30 m

- Ladders
- Hand and safety rails
- Power supply and distribution systems
- Safety
- Communication

• **Access walkways in suspended bridge**

- Stairs/ladders
- Hand and safety rails
- Power supply and distribution systems
- Safety
- Communication

3.8 Material Requirements

3.8.1 General

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

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.

3.8.2 Corrosion protection

The facilities 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 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.

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

Attention must be paid to the corrosive environment 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.

3.9 Codes and standards

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

4 Waggon for suspended deck

4.1 Introduction

The inspection and maintenance of the suspended bridge decks can be executed from internal walkways and waggons running in the entire length of the suspension Messina Strait Bridge. A detailed inspection of the bridge deck interior will probably be carried out continuously.

These technical specifications contain the requirements for the inspection and maintenance waggon for the suspended deck, which is to be used inside the suspended decks of Messina Strait Bridge.

4.2 Scope of Work

The scope of work for the waggon for suspended deck includes the following elements:

- Driving waggons for roadway girder
- Material waggons (trailer) for roadway girder
- Rails for waggons
- Battery charger stations

The scope of work covers:

- Design: Detailed and workshop design of the waggons for the suspended decks 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 and prototype trials under simulated running conditions; dismantling, inspection and re-inspection of the prototype, quality assurance activities.
- Installation and trial running: Supply, installation on the Messina Strait Bridge, connection to running rails, site trials and adjustments, testing and commissioning.
- Post-installation: Provision of spare parts, operation and maintenance manuals, as built records and training of personnel.

All the above shall be in accordance with the general requirements of the contract and this performance specification.

Design of the waggon for the suspended deck 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:

- Clearance profile in openings in bridge deck diaphragms.
- Access and escape routes in cross girders in bridge deck.
- Drainage pipelines.
- Power supply and electrical systems.
- Dehumidification system.
- Corrosion protection systems.
- Control and monitoring systems.
- Safety and operation control/SCADA.
- Communication systems.

4.3 General Requirements

4.3.1 General

The performance specification for the design of the waggon for the suspended deck summarises the:

- Functional requirements
- Operational requirements
- Structural requirements
- Mechanical & Electrical requirements
- Material requirements

- Documentation
- Codes and standards

The suspended bridge decks will be equipped with mobile inspection waggons located inside roadway girder in the full length. The inspection equipment and related facilities shall be designed in such a way that the following main objectives are fulfilled:

- Waggons shall give safe and stable access to all internal parts for inspection and maintenance works.
- Waggons shall be easy to erect on the rails and easy to operate.
- All relevant safety aspects shall be provided. Waggons must not damage the openings or adjacent structures and equipment.
- The waggons are robust and have a long service lifetime.
- Waggons shall be capable of being parked at electrical loading stations for extended periods.

4.3.2 Waggon for suspended deck

The waggon (2 pieces) for the roadway girder shall be provided for each girder.

Each waggon consists of a driving waggon and a material waggon which are linked to one another.

The waggon base frames with wheels shall be running and supported on two rails (UNP180 profiles) which are installed in the entire length inside the roadway girder.

The driving waggon will be powered by a battery driven electric motor placed in the bottom of the base frame. The driving waggon will be equipped with a cabin in order to facilitate safe transport of two persons, one driver and one passenger.

Waggons shall be equipped with all necessary equipment to secure safe and comfortable operation (buffers, interconnections, lightning, alarm, control system, communication system etc.).

The waggons will be guided against the rails to ensure safe passage of all openings in the diaphragms in the roadway girder.

The working area for the waggons is the entire main span length of the suspended deck between drop-in span on Calabria and Sicilia side.

Waggons shall be parked and chargeable at battery charger stations located at both ends of the main span of the suspended bridge deck.

Waggons shall be movable by operator as well as by remote control system to any desired position in the main span between the drop-in spans.

4.4 Functional Requirements

4.4.1 Waggon for suspended deck

The waggons shall provide access to the bridge girder interior for inspection and maintenance. The waggons shall be able to access the following areas for inspection and maintenance:

- The entire interior of the roadway girder
- Electrical systems
- Drainage pipelines, branches and gullies

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

- Terminal structures
- Side span bridge girder
- Drop-in span girder
- Railway girder

Waggon control system shall comprise:

- Joy-stick speed and stop control.
- Emergency stop on control panel.
- Manual brake on cabin ceiling.
- Cabin locking control for safe operation of driving waggon.

4.4.2 Rails for waggons

Two rails in each roadway girder shall support and facilitate the running of waggons in the full length of the main span of the suspended bridge deck.

4.4.3 Battery charger stations

Battery charger station at both ends of main span and at midspan of the bridge girder shall serve the charging of the two driving waggons.

4.4.4 Size of access facilities

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

Driving waggon	L x W x H = 2.5 x 0.7 x 1.2 m
Rail distance	W = 515 mm
Wind screen	Mesh 50% closed
Material waggon	L x W x H = 2.5 x 0.7 x 0.5 m

4.5 Operational Requirements

4.5.1 Waggon for suspended deck

The variabel travel speed of the waggon must be:

v = 0 - 5 km/h

The travel speed must be valid for the waggon considering an inclination (1.5 %) of the suspended bridge deck at the steepest point.

The driving waggon shall be chargeable for minimum 2 hours variable operation and maximum loading.

The waggon shall be able to travel the entire length of the bridge deck between the drop-in spans and return with a full load, without requiring any additional power supply.

Power supply in the waggon shall be provided from its own batteries. Extra power supply can be provided by electrical battery charger at stations located in both ends of the main span.

Service batteries for minimum 2 hours operation of lighting, signals, switches and safety brakes shall be installed in the driving waggon.

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

Special attention shall be made to the design of the guiding wheels for the waggon in order to ensure safe and stable running.

The waggon wheels will be provided with a surface that facilitates high friction drive and vibration damping.

It must be ensured that the waggon does not disturb the diaphragm structure by colliding with the clearance profile for the openings.

The waggon shall be easy to erect on the rails in the roadway girder corridor. Erection in roadway girder area shall be performed from the service lane and though cross girder openings.

The waggon can be installed in pieces if necessary (but the structure of the waggon shall allow quick dismantling procedure in case of significant maintenance work.

The waggon shall be attached to the rails in parked position.

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

- From walkways inside roadway girder.
- From the cross girder.

It is recommended that the waggon for suspended deck shall be stored in garage at battery charger stations at ends of roadway girder when not in use.

The waggons shall be installed with front and back lights comparable to car lights.

The waggons shall be installed with electrical signalling/horn.

The waggons shall be installed with front and back buffers and flexible couplings with safety splits.

4.5.2 Rails for waggon

The design of the rails shall take into account the requirements of the waggon and ensure easy and safe passage and parking.

4.5.3 Battery charger stations

Battery charger station will be installed at both ends of the roadway girder.

The battery charger located in one of the bridge girder ends shall be able to serve two waggons through electrical connections in the cross girder.

The battery charger shall be automatically controlled.

4.5.4 Clearances

The minimum clearances between a fully loaded waggon for suspended deck and structures must be:

Openings	c = 0.05 m
Walkways	c = 0.1 m
Drainage pipelines	c = 0.2 m

Above mentioned clearances must be fulfilled considering any protruding elements.

4.5.5 Safety

4.5.5.1 General

The waggon will be provided with the following safety equipment:

- Electrical switches for closed cabin doors.
- Electrical switches for active handbrakes.
- Automatic switch-on of back and front lighting.
- Automatic emergency rail end stop of waggon.
- Cabin door locking.
- Joy-stick control.
- Handbrake with self locking.
- Electrical switch for emergency stop.
- Fire extinguishing system.
- Rails and all elements of waggons shall be earthed during any operation and maintenance works.

The waggon will be provided with the following safety control system:

- Waggon in operation shall be stopped if any hatch in the bridge deck is opened.
- Waggon will be stopped in positions outside cross passages in the bridge girder at main access to interior walkways cc360m..
- Waggon in operation shall give warning by light flashing and/or bell.

4.5.5.2 Safety notices

Appropriate safety notices shall be provided on the waggon for suspended deck. These shall include, for example, notices clearly stating the safe working loads on the various parts of the waggons and operating instructions.

4.5.5.3 Travel control

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

The waggon shall be provided with automatic and manual safety brake system acting on the rails.

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 waggon from running into any part of the bridge deck structure during operation must be included in the design (sensors, signalling to stop the waggon or similar). The waggon shall not start before the movable cabin doors are closed (to prevent personnel damage/collision).

4.5.5.4 Failure mode effects analysis

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

Failure of a critical mechanical or structural component of the waggon 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.

4.5.5.5 Powercut pieces

All waggon cabin doors shall be provided with powercut pieces, in order to ensure stop of the waggon in case of door opening.

4.5.5.6 Emergency stops

Controls for emergency stop of waggon shall be provided. The emergency stop shall override the normal controls.

4.5.5.7 Escape

In case of failure in the electrical installations, or the motor drive, escape must be possible to the walkway in the bridge girders.

4.5.5.8 Service lifetime

The waggon must be robust and have a service lifetime of minimum 25 years.

The wagons shall be dismantable in parts which can be brought in and out through main access openings (0.6x1.3m) to interior walkways in bridge girders cc 360m.

4.6 Structural Requirements

4.6.1 Global design of waggons and rails

The structural base frame of the waggons must be designed to travel on the rails along the whole length of the roadway girder as shown on drawings.

The tender design of the rails must be based on the following waggon loadings:

Loads [kN]	**Dead load**	**Live load**
Driving waggon, operation	15	5 (2 persons + equipment)
Material waggon, operation	5	10

The nominal forces in the rails due to the waggon loadings shall include dynamic effects generated by waggons and/or bridge deck movements.

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

4.6.2 Design loads

4.6.2.1 Rail design load:

Dead load:

Driving waggon wheel load (max.)	5.6 kN
Material waggon wheel load (max.)	1.9 kN

Live load:

Driving waggon personnel	2 kN
Driving waggon equipment	5 kN
Material waggon equipment	10 kN

4.6.2.2 Waggon design load

Permanent load (approx.)

Driving waggon	15 kN
Material waggon	10 kN

Variable live loads (approx.)

Personnel	2 kN
Equipment	3 kN
Concentrated load on 0.1x0.1 m	1 kN
Waggon speed	5 Km/h

Variable environmental loads (approx.)

Seismic load	≤ 6.3 m/s2
Thermal load	-2/43 ºC

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

4.7 Mechanical & Electrical Requirements

4.7.1 General

The mechanical and electrical work covered in the waggon for suspended deck scope of work can be stated in headlines as follows:

Waggons (2 pieces):

- Driving supporting base frame including cabin
- Driving waggon cabin frame structure
- Material waggon
- Power and service supply batteries
- Electrical motor drive
- Electrical and manual brake systems
- Fire extinguishing system
- Power supply/generator
- Earthing and equipotential bonding.
- Electrical & instrumentation systems
- Control & monitoring
- Safety & operation controls
- Communication

4.7.2 Power supply

4.7.2.1 Power supply

General

- 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 to waggon

Waggon shall have the following two methods of working

- Waggon parked (not moving).
- Waggon in service. The following equipment shall be power supplied from batteries set on the waggon base frame. Waggon drive, lights, signals, brakes, control systems a.o. All the above-mentioned equipment shall work at any location of the waggon operation area. If necessary to achieve this a doubling of the battery power supply shall be provided.

4.8 Materials

4.8.1 General

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

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 the dehumidified environment inside the bridge deck 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 rails must be given high priority in the choice of materials in order to optimise the rails and support arrangement.

4.8.2 Corrosion protection

The waggons must be painted or otherwise protected with the aim to sustain the environmental conditions present, 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 surfaces.

Measures must be taken to prevent long-term water ingress into any structural hollow box section forming any part of the waggons.

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

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

Attention must be paid to the corrosive environment 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 waggons.

4.9 Codes and Standards

The design of the waggons and rails in the bridge deck with regard to safety, materials, and loads will follow relevant Italian and European Norms (EN) and regulations.

5 Lifts, stairs, ladders and doors in tower

5.1 Introduction

These performance specifications contain the requirements for the lifts, stairs and ladders to be used for inspection and maintenance in the towers of the Messina Strait Bridge.

5.2 Scope of work

The complete access facilities for the towers covered by this specification are as follows:

- Access lifts, stairs and doors in tower.
- Inspection walkways in tower.
- Inspection and escape ladders in tower.
- Access stairs and inspection lifting platform in tower cross beams.
- Access to main cable saddle and main cable walkway.

The scope of work covers detail and workshop design, supply, installation, testing, commissioning, training of operators, as-built documentation, operation & maintenance manuals and quality assurance activities in accordance with general requirement for the contract and this technical specification including enclosed drawings.

The design of the lifts, stairs, ladders and doors shall include integration of the access facilities into the overall bridge tower design, considering interface requirements from other parts of the bridge project.

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

- Free space, escape route size and inclination of tower
- Water supply systems
- Power supply and electrical systems
- Control and monitoring systems
- Safety and operation control/SCADA

- Communication systems.

5.3 General requirements

5.3.1 General

The performance specification for the lifts, stairs, ladders and doors in the towers summarises the:

- Functional requirements
- Operational requirements
- Structural requirements
- M & E requirements
- Material requirements
- Codes and standards.

The bridge tower legs and cross beam must be equipped with lifts, staircases, walkways, ladders, lift platform and doors as shown on drawings.

The access facilities shall be designed in such a way that the following main objectives are fulfilled:

- Lifts, stairways, walkways, ladders, platforms etc. must give access to all interior parts for inspection and maintenance.
- Doors are located at tower base, at bottom (internal only) and top of cross beams, at bridge deck levels and at cable saddle giving access to the whole interior of the tower legs and cross beams.
- All relevant safety aspects are provided for.
- The facilities do not damage the tower structure, in particular the adjacent structures and equipment.
- The facilities are robust and have a minimum 25 years service lifetime.
- All stairs and ladders will be installed with horisontal treads and landings and with vertical railing in order to assure safe access.

The access facilities have the following main features.

5.3.2 Access lifts, stairs and doors in tower

The towers must be equipped with lifts, stairs and ladders to give access for inspection of the tower base, entire inside surfaces of the towers, tower cross beams, main cable saddle and other mechanical and electrical systems, as shown on drawings.

The lift inside the tower will have windows for inspections at intermediate stops at tower assemblies and stairs.

Doors and hatches in the tower shall be provided as follows:

- Entrance to each tower leg through doors located at the service lanes and the tower base.
- Access openings between stairway and lift/ladder shaft.
- Escape openings between lift shaft and stairway shaft.
- Access to all cross beams via openings in each tower leg.
- Access to the top of cross beams through doors in each tower legs.
- Access to top of the upper cross beam via stairs and hatch.
- Access doors to top of the tower saddles via enclosed stairways.
- Access doors to the outer surfaces of the towers to climbing gantries.

All electrical and mechanical equipment shall be capable of being transported in parts though all openings and erected at specified locations in the tower.

5.3.3 Walkways

The tower legs shall be equipped with inspection walkways at the circumference of the central part of the tower legs. The walkways may be connected to the longitudinal/transverse stiffeners for the tower leg and shall be accessible from the stairway. The walkways shall be minimum 1m wide and provided with railings. The walkways on the inclined diaphragms at the circumference of the tower leg will be secured by vertical railing and kick plates.

5.3.4 Inspection and escape ladders in tower

The tower legs shall be equipped with inspection ladders in the entire height of the tower. Ladders shall be installed in each corner of the tower leg which is not accessible from the staircase or lift.

The lift shaft shall be equipped with escape ladders with intermediate deck and exit doors to the stairway.

5.3.5 Access stairs and inspection platform in tower cross beam

The tower cross beams at top of the tower shall be equipped with access stairways from bottom to top of the cross beam.

The cross beams shall be provided with removable gratings at the floor to allow for a first visual inspection. Gratings should be removable in pieces for detailed inspection and maintenance.

All cross beams shall include a mobile telescopic platform for giving inspection access to the entire interior of the cross beam structures. The mobile platform in lowered position shall be able to pass under internal bracing of cross beam.

5.3.6 Access to saddle room

The saddle room will be accessible by caged ladders from the last lift and stairway level. Access shall be provided through holes to each cell in the saddle room.

5.3.7 Access to main cable saddle and main cable walkway

Cross beam 3 shall be provided with an enclosed access stairway to the tower saddle and main cable walkway.

5.3.8 Access to tower base

The difference in height between the access road in terrain level and the tower base is approximately 15m and furthermore a platform is installed at the tower base to stay clear of the anchors at the tower base. The level of the platform corresponds to the entry level in the tower. To facilitate access from terrain level to the platform on the tower base a lift shall be provided. The lift is mounted on the external surface of the tower foundation, and emergency stairs shall be

provided. Lifts in the parked position and emergency stairs must be protected from unauthorised access.

5.4 Functional requirements

5.4.1 General

The lifts, stairs, walkways, ladders and doors must provide inspection access to the entire internal surface of the bridge towers, including vertical and inclined surfaces.

The access is to include the possibility of cleaning elements with pressurised water and light maintenance operations which can be undertaken from the work areas indicated on the drawings.

The facilities on the typical drawings must be able to access the following areas for inspection:

- The inside of the bridge tower leg
- The inside of the tower cross beam
- The outside top of the tower cross beam
- The saddle rooms
- The main cable saddle at top of tower
- The dehumidification equipment in the cross beams
- The walkway for inspection of main cables
- The inside and outside of the tower base

The following areas will not be available for inspection from the facilities:

- The outside faces of the tower legs above tower base
- The outside faces of the sides and bottom of the tower cross beams
- The suspended bridge deck.

5.4.2 Size of access facilities

The size of the access facilities must be (approx.):

Lift cabin (outside)	L x W x H ≤ 2.8 x 1.8 x 2.5 m (approx.)
Lift shaft space	L x W x H = 3 x 2.2 x 362 m
Stair section height	H ≤ 3.5 m
Stair shaft	L x W x H= 6.0 x 2.2 x 362 m
Ladder section height	H ≤ 6.0 m
Telescopic platform	L x W x H = 1.2 x 1.0 x 18 m
Handrail for walkways	H = 1.5 m
Other handrail inside tower	H = 1.2 m
Handrail outside tower	H = 1.5 m
Doors, openings and hatches	
Tower base	W x H = 0.8 x 2.0 m
Stairway to ladder/lift	W x H = 0.8 x 2.0 m
Lift escape to stairway	W x H = 0.8 x 2.0 m
Bottom of cross beam	W x H = 0.8 x 2.0 m
On top of cross beam	W x H = 0.8 x 2.0 m
Service lane	W x H = 0.8 x 2.0 m
Climbing gantries	W x H = 0.8 x 2.0 m
In top of cross beam	W x H = 0.8 x 0.8 m
Enclosed stair to saddle	W x H = 0.8 x 2.0 m
Saddle room	W x H = 0.8 x 0.6 m
Sealed openings for demountable beams	ø 600 mm

5.5 Operational requirements

5.5.1 General

All tower legs shall be equipped with access lifts, stairs, walkways and ladders through the entire height of the towers between the levels shown on the tender drawings.

The lifts and stairs shall be equipped with necessary installations to provide safe transport and working conditions, e.g. normal and emergency lighting, emergency telephone, alarm etc. They shall be lockable, electrically and mechanically, while in working position in the tower.

LIFTS

The minimum operational requirements for the access lifts in the bridge tower legs shall be as follows:

Lift cabin floor area	A = 1.6 m^2 (min.)
Lift cabin size (inside)	L x W x H = 1.4 x 1.15 x 2.2 m
Hinged cabin door opening	W x H = 0.8 x 2.0 m
Emergency escape hatch	L x W = 0.8 x 0.8 m
Escape ladder	ø 800 mm
Escape openings in shaft	W x H = 0.8 x 2.0 m
Transparent panels in cabin	W x H = 1.2 x 0.6 m
Operational lift height (level 0 to 25)	H = 362 m
Number of working levels in hoist cage	L = 26
Number of intermediate inspection levels	Li = 26
Capacity live load	Q = 15 kN/20 persons
Equipment (Transformer)	Q = 20 kN
Lift type	Rack-and-pinion lift system
Maximum travelling speed	v = 3 m/s
Motor power (approx.)	60 kW

Cabin construction:

- Cabin structure made from stainless steel profiles
- Inner shell (roof, wall and floor) covered in stainless steel plates
- Transparent inspection windows made of safety glass
- Electrical panels and armatures in plane with inner plates
- Mechanical elements in plane with inner surfaces

Cabin doors:

- Hinged doors in plane
- Escape hatch in top of cabin

The minimum operational requirements for the access lifts to tower base shall be as follows:

Lift cabin size (inside)	L x W = 2.0 x 2.0 m
Hinged cabin door opening	W x H = 1.8 x 2.0 m
Escape caged ladder	ø 800 mm
Operational lift height (approx.)	H = 17 m
Capacity live load	Q = 15 kN/20 persons
Equipment (Transformer)	Q = 20 kN
Lift type	Rack-and-pinion lift system
Maximum travelling speed	v = 3 m/s

Cabin construction:

- Cabin structure made from stainless steel profiles
- Inner shell (walls and floor) covered in stainless steel plates
- Electrical panels and armatures in plane with inner plates
- Mechanical elements in plane with inner surfaces

Cabin doors:

- Hinged doors in plane

Access lifts to tower base in the parking position must be stored in a shelter at the terrain level. Shelter at the terrain level must protect lift from the weather conditions and unauthorised personnel access.

Escape ladder for the access lift must be accessible from terrain level for authorised personnel only.

The platform at tower base inside the tower is at the same level as outside. The platform inside tower gives direct access to lifts inside tower.

STAIRS

All stairway runs are to be provided with intermediate deck, handrails and rail for safety wire to the extent required by the Italian Regulations.

WALKWAYS

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

LADDERS

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

DOORS

All primary doors and openings in the tower shall be min. W x H = 0.8 x 2.0 m.

Hatches shall be W x H = 0.8 x 0.8

Other openings shall be W x H = min. 0.6 x 1.3 m.

Manholes min. D = 0.6 m unless other standards require more.

All external openings must have watertight doors/latches, which in emergencies can be opened from the inside without a key.

All external openings shall be equipped with a surveillance system with intrusion alarms and lacking closure. Particular attention shall be paid to areas at deck and base to prevent intrusion.

All doors in towers must be constructed in carbon or stainless steel in dimensions and with a safety fire resistance in accordance with Italian Regulations.

MOBILE TELESCOPIC PLATFORM

The cross beams shall be provided with mobile telescopic platforms in order to give access to the entire height of the cross beams.

The mobile aerial platform shall be movable on gratings in the whole length and width of the cross beams and arrangements for fixing/parking shall be included.

A demountable basket is acceptable to allow for passage of the cross bracing in the cross beams.

ACCESS TO SADDLE

The stairway from the tower top cross beam to the tower saddle shall be installed with intermediate deck, handrails and safety rails.

The whole staircase shall be covered by a light weight shielding with doors at entrance and at top to saddle room.

5.5.2 Clearances

The minimum clearances between access facilities and structures must be:

Lift cabin c = 0.1 m

Stair c = 0.1 m

Ladder c = 0.1 m

Lifting platform c = 0.1 m

5.5.3 Safety

LIFTS

In case of failure in the electrical installations, or the internal motor drive, manual operation must be possible to the nearest escape route.

The lift cabin must be equipped with escape ladder for escape through a hatch in the cabin roof to ladders and escape doors in the lift shaft. The cage hoops of the escape ladders in the lift shaft shall have hinged openings with handles on both the inside and outside. The cabin roof shall have fences with hinged openings at the escape ladders.

Access to tower base shall be provided with escape ladder. Escape ladder must be provided with intermediate platforms.

The upper platform of the tower foundation in the area of the tower anchorage (around tower) shall be fenced with railing.

STAIRS

All stairway runs must be provided with intermediate deck, handrails and rail for safety wire to the extent required by the Italian Regulations.

WALKWAYS

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

LADDERS

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

DOORS

All doors must be constructed with a minimum fire resistance in accordance with Italian Regulation requirements.

All external openings must be equipped with surveillance system with alarms for intrusion and lacking closure. Particular attention shall be paid to areas at deck and base to prevent intrusion.

All external openings must have watertight doors which in emergencies can be opened from the inside without a key.

MOBILE TELESCOPIC PLATFORMS

Manual operation of the mobile telescopic platforms will also be provided to the extent required for safe escape of personnel.

5.6 Structural requirements

5.6.1 Global design of lift

The structural frame of the lifts must be designed to travel on rails.

The rails must be placed at distances to optimize the structural frames and minimize the load on the rails.

The design of the rails shall be based on the following load limitations for the lifts:

Loads	**Live load**
Lift	15 kN (20 persons)
Equipment	or 20 kN (transformer)

5.6.2 Local design of access facilities

Live loadings (approx.):

Facility	**p_v [kN/m^2]** **Distributed**	**P_v[kN]** **Concentrated**
Stairs & walkways	2.0	3.0
Lifting platform	2.0	3.0
Ladder	NA	3.0

All handrails must be designed for a horizontal load along the upper rail of:

p = 1.0 kN/m

5.7 Mechanical & electrical requirements

5.7.1 General

The mechanical and electrical work covered in the access facilities scope of work can be stated in headlines as follows:

- **Access lifts in tower (8 pieces)**

  Lift cabin

  – Base lift cabin
  – Cabin construction
  – Hinged cabin doors
  – Rack-and-pinion lift system

  Lift stabilizing system (guide, rail, brake, shock etc.)

  – Guide wheels on rail
  – Brake systems
  – Shock absorbers

  Accessories

  – Emergency ladders inside each lift shaft going from bottom to top
  – Doors leading from lift shafts to staircase area shall be provided at each lift level (Totally 26 levels in each leg)

– The lift cabin shall accommodate an escape stretcher W x H = 0.7 x 2.1 m)

Power supply and distribution systems

– A dedicated switchboard for each lift shall be installed
– Two separate independent feeders shall be provided. (Redundancy)
– The lift installation shall be provided with a socket for external power supply at ground level in case of emergency
– The Subcontractors installation shall include earthing and equipotential bonding.

Lift control & monitoring system

– Simple push button
– SCADA interconnection
– Signal for position of cabin
– Signal for travel direction
– Alarm indication of overload
– Alarm indication of technical fault
– Reserved signal, prepared for connection to SCADA

Safety & operation controls (brake, lock, escape etc.)

– Automatic and manual brake/stop systems
– Manual door locks
– Escape hatch in top of cabin

- **Access lifts to tower base (4 pieces)**

Lift cabin

– Base lift cabin
– Cabin construction
– Hinged cabin doors
– Rack-and-pinion lift system

Lift stabilizing system (guide, rail, brake, shock etc.)

– Guide wheels on rail
– Brake systems
– Shock absorbers

Accessories

– Emergency ladders

– The lift cabin shall accommodate an escape stretcher W x H = 0.7 x 2.1 m

Power supply and distribution systems

– A dedicated switchboard for each lift shall be installed
– The Subcontractors installation shall include earthing and equipotential bonding.

Lift control & monitoring system

– Simple push button
– SCADA interconnection
– Signal for position of cabin
– Signal for travel direction
– Alarm indication of overload
– Alarm indication of technical fault
– Reserved signal, prepared for connection to SCADA

Safety & operation controls (brake, lock, escape etc.)

– Automatic and manual brake/stop systems
– Manual door locks
– Escape hatch in top of cabin

Shelter for storing the lift

- **Access stairs in tower (4 pieces)**

– Base stair
– Intermediate deck
– Hand rails
– Safety rails

- **Access doors in towers**

– Tower base (8 pieces)
– Stairway to ladder/lift (432 pieces)
– Lift escape to stairway (216 pieces)
– Bottom of cross beam (12 pieces)
– On top of cross beam (8 pieces)
– Access road deck (4 pieces)
– To climbing gantries (12 pieces)
– Enclosed stair to saddle (4 pieces)
– Saddle room openings (64 pieces)

Access hatches in top of cross beam 3 (2 pieces)

- **Inspection and escape ladders in towers (24 pieces)**
  - Base ladder
  - Intermediate deck
  - Cage
  - Handrails
  - Safety rails

- **Access stairs and mobile telescopic platforms in tower cross beams**
  - Base stair (2 pieces)
  - Intermediate deck
  - Ladders
  - Mobile telescopic platform (6 pieces)
  - Hand rails
  - Safety rails

- **Access to main cable saddle (4 pieces)**
  - Stairway
  - Enclosure
  - Handrails
  - Safety rails

5.8 Materials

5.8.1 General

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

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. Emphasis must be placed on selection of lightweight materials with a minimum of maintenance required during the service life.

5.8.2 Corrosion protection

The facilities 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.

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

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

Attention must be paid to the corrosive environment 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.

5.9 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.

6 Access facilities to the main cable for inspection and maintenance

6.1 Introduction

These technical specifications contain the requirements for the access facilities for inspection and maintenance of the main cable of the suspension Messina Strait Bridge.

6.2 Scope of Work

The scope of work for the access facilities to the main cables includes following elements:

- Midspan access stairway
- Access from saddle to cable walkway
- Access from anchor block to cable walkway
- Access to splay saddle (inside anchor block)
- Mobile aerial platform
- Anti-vandal protection

Design of the access facilities 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 sleeve 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

- Power supply and electrical systems
- Dehumidification system
- Corrosion protection systems
- Control and monitoring systems
- Safety and operation control/SCADA
- Communication systems

6.3 General Requirements

The technical specification for the tender design of the access facilities summarises the:

- Functional requirements
- Operational requirements
- Structural requirements
- M & E requirements
- Material requirements
- Documentation
- Codes and standards

The suspended bridge main cables access facilities located in side- and main-spans on both sides of the bridge shall be designed in such a way that the following main objectives are fulfilled:

- Midspan access stairways shall give access to cable walkways from the service lane in the midspan
- Stairways at the tower saddle shall give access to cable walkway.
- Stairways at anchor blocks shall give access to cable walkway.

6.3.1 Access to cable walkway

Access stairways at anchor blocks, in the midspan and at the saddle shall give access to cable walkways and the cable carriage.

Access facilities shall prevent unauthorised personnel to enter the cable walkway.

Anchor block area shall be protected in a way that it is not possible to reach the cable from the terrain level.

Access facilities should not deteriorate or damage corrosion protection of the main cable neither any other bridge elements.

Access facilities inside the anchor block shall allow inspection and maintenance of the splayed cable.

All external openings shall be equipped with a surveillance system with intrusion alarms and lacking closure.

All access facilities shall be equipped with necessary installations to provide safe transport and working conditions, e.g. normal and emergency lighting, emergency telephones, alarms etc.

6.3.2 Mobile aerial platform

The mobile aerial platform shall give access to all external parts for inspection and maintenance in the midspan area which is not available by cable carriage.

In the midspan main cable and hangers must be accessible from a mobile aerial platform from service lane.

The mobile aerial platform shall give access to cable walkway as well as to the carriage as a supplement to the midspan access stairway.

If the anti-vandal protection is mounted in the side span then the mobile aerial platform shall give access to the lowest part of the main cable above the anchor block.

6.4 Functional Requirements

6.4.1 Midspan access stairway

Midspan access stairway is a foldable stairway between cable walkway and service lane which can be opened from cable walkway or from service lane only by authorized personnel.

The stairway shall have sufficient working space to facilitate the access to cable walkway and parking of the carriages with inspection and maintenance equipment onboard.

6.4.2 Access from saddle

Access door at the tower top shall serve in both directions i.e. give an access to cable walkway and cable carriage and in case of emergency facilitate escape exit from cable walkway.

Provisions at the saddle shall allow inspection of the saddle and the cable sleeve.

The handstrands running along cable walkway are anchored at the saddle with steel frames.

Handstrands shall be continuing along the cable sleeve with constant spacing between them, however the internal handstrands are not necessary over the saddle.

The dehumidification system requires sealing of the top of the saddle just above the top trough plate of the main cable.

Top cover plates sealing the saddle shall be removed easily during inspection without removing fixation frames of the handstrands

Small transverse platform shall be provided below the joint of the sleeve and saddle. This platform shall be accessible from a staircase leading from the cross-beam of the tower to the saddle.

Small transverse platform will form a base/fixing point for a demountable inspection platform. Demountable inspection platform may be fitted to allow full inspections of the underside of the cable sleeve.

Provisions for leading winch haul ropes shall be made. The winch line shall exit the tower in its transverse face along the centreline of the main cable pair, close to the end of the saddle.

The outlet of the towing wire from the saddle shall be constructed in a way to diminish the flow of the dehumidified air out from the saddle.

All deviators and penetration holes for towing wire of the cable carriage within tower and saddle shall be inspectable.

Four dehumidification inlets will be provided -two for each cable, one at each end of the saddle. The inlets will be mounted on the top of the saddle cover plates, between the end of the saddle trough plates and the start of the cable sleeve

6.4.3 Access from anchor block (outside)

At the anchor block there is a stairway which allows for entering cable walkway. Inspection of the lowest part of the cable above the anchor block is not possible due to the sleeve above the anchor block.

Optionally:
Anti-vandal protection is mounted above the anchor block at such a height where it is not possible to reach the main cable with the ladder or rope. Anti vandal protection must be equipped with door which shall be opened only by authorised personnel.

Due to safety risk safety solutions might be applied:

- the area of the anchor block is fenced,
- the stairway to the main cable at the anchor block is equipped with door,
- anti-vandal protection is mounted on the main cable.

6.4.4 Access to splay saddle (inside anchor block)

Stairways and platform provide access to the splay chamber, splay saddle and main cable inlet. Access to each strand of the splayed cable shall be possible if necessary.

The interior walkways in the anchor block shall be accessed by watertight door which can be opened from inside without a key in emergencies.

6.4.5 Mobile aerial platform

Mobile aerial platform shall provide access for inspection and maintenance of the main cables, hangers and hanger clamps where the cable carriage cannot be used.

In the midspan the approximate height of the main cable above the deck is approx. 5.9 m.

6.4.6 Size of access facilities

The size of the access facilities must be (approx.):

All hatches in access facilities W x H = 0.8 x 2.0 m

Access stairways to main cables W ≥ 0.8 m

Mobile aerial platform L x W x H = 5 x 2.5 x 2-12 m

6.5 Operational Requirements

6.5.1 Midspan access stairway

Midspan access stairways to main cables and cable carriage shall be constructed without interferences with the road clearance and the service lane clearance profile.

Since the cable carriage shall be able to pass the whole main span under special conditions, the midspan access stairway shall not interfere during cable carriage passage.

6.5.2 Access from saddle

Access door at the saddle shall be easy to open from inside/ outside the tower for authorised personnel only.

The saddle is sealed so that the dehumidification system can be applied. Inside of the saddle (first layer of cable strands) shall be inspectable. Cover plates sealing the saddle shall be removable during inspection without removing other elements of the saddle or handstrands.

A permanent transverse platformfor inspection of joint between saddle and cable sleave shall be provided.

Despite the cable sleeve at the saddle is not inspectable by cable carriage the inner side and underside of the cable sleeve as well as joint between sleeve and saddle shall be inspectable.

Provisions for leading, replacing and storing winch haul ropes shall be considered in the saddle area.

Provisions for replacing handstrands in the future shall be made.

Due to increasing width of the cable sleeve, the cable carriage will not be designed to reach saddle. The underside of the sleeve may be inspected from temporary platform attached to the transverse platform below the joint of the sleeve and saddle.

6.5.3 Access from anchor block

There shall be measures which prevents unauthorised personnel to enter the main cable at anchor blocks. Door to the stairway leading to the cable shall be mounted above every anchor block. Door at the anti-vandal protection shall be mounted if anti-vandal protection is applied.

Cable sleeve around the cable shall be removable in parts for cable inspection.

6.5.4 Access to splay saddle (inside anchor block)

The railing at the plateau inside the splay chamber and above the splayed cable enables safe visual inspection of the splayed cable.

Despite the dehumidification facilities inside the splay chamber in the lowest part of the splay chamber there is a pump sump.

6.5.5 Mobile aerial platform

The mobile aerial platform shall give access for inspection and maintenance of the main cables, hangers and hanger clamps in the midspan in a length of approx. 350 m and in height ranging from 6 to 12 m above bridge deck.

The mobile aerial platform shall be provided with an anti-collision system to safeguard against any interference with the suspension systems or any other bridge structures.

Cable inspection just above the anchor block where the cable sleeve is mounted shall be executed from mobile aerial platform or scaffolding.

If the anti-vandal protection is mounted then inspection of the cable with cable carriage is impossible. In this situation inspection from the mobile aerial platform or scaffolding shall be considered at the longer stretch.

Sufficient lighting for inspection shall be provided.

6.5.6 Clearances for mobile aerial platform

The minimum clearances must be preserved:

Main cable	c = 0.2 m
Hangers	c = 0.2 m
Access stairway	c = 0.2 m
Sleeves at the anchor block	c = 1.0 m
Anchor block	c = 1.0 m
Suspended bridge deck	c = 0.5 m (vertically)
Wind screens	c = 1.0 m
Road clearance profile	c = 1.0m

6.6 Structural Requirements

For all access facilities following loads shall be applied:

Uniformly distributed load with a characteristic value of 2kN/m^2

For the design of local elements a concentrated load of 3kN acting alone on a square surface of 0.2x0.2m shall be applied.

For the railing a line load of 1kN/m shall be applied.

6.7 Mechanical & Electrical Requirements

6.7.1 General

The mechanical and electrical work covered in the access facilities scope of work can be stated in headlines as follow:

Access stairways/ladders (10 pieces)

- Midspan access stairway (2)
- Access from saddle to cable walkway (4)
- Access to permanent transverse platform under joint of cable sleeve and saddle (8)
- Access from permanent transverse platform under joint of cable sleeve and saddle to temporary platform under cable sleeve (8)
- Access from anchor block to cable walkway (4)
- Access to splay saddle (inside anchor block)
- Safety & operation controls
- Communication

Anti-vandal protection

Mobile aerial platform (2 pieces)

- Mobile aerial platform
- Control & monitoring
- Safety & operation controls
- Communication

6.8 Materials

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

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.

6.8.1 Corrosion protection

The access facilities 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.

Measures must be taken to prevent long-term water ingress into any structural hollow box sections forming part access facilities.

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

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

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

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

6.9 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.

7 Inspection of Terminal Structure and Drop-in Span

7.1 Introduction

These technical specifications contain the requirements for the mobile aerial platform and access to bearings, expansion joints and buffers at the tower and access to terminal structure, which are to be used for inspection and maintenance of elements of Messina Strait Bridge.

The mobile aerial platform, access to bearings, expansion joints and buffers at the tower and access to terminal structure, shall give access for inspection and maintenance to all external parts in the suspended deck in the drop-in span and at terminal structure.

The design shall provide an optimal and safe operation without damage to any bridge elements or the corrosion protection. In particular the surface treatment of the bridge elements shall be protected.

7.2 Scope of Work

The scope of work for the inspection and maintenance of the terminal structures and drop-in spans includes following elements:

- Mobile aerial platforms
- Access spot and access road
- Access to bearings, expansion joints and buffers at the tower
- Access to terminal structure

The scope of work covers:

- Design: Detailed and workshop design of the mobile aerial platforms 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 and trials; dismantling, inspection, quality assurance activities.

- Installation and trial running: Supply, installation, site trials and adjustments, testing and commissioning.
- 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 access facilities shall include integration of them 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:

- Suspended deck
- Towers
- Articulation system
- Power supply and electrical systems.
- Corrosion protection systems.
- Control and monitoring systems.
- Safety and operation control/SCADA.
- Communication systems.

7.3 General Requirements

7.3.1 General

The technical specification for the tender design of the mobile aerial platforms and access to bearings, expansion joints and buffers at the tower, access to terminal structure summarises the:

- Functional requirements
- Operational requirements
- Structural requirements

- M & E requirements
- Material requirements
- Documentation
- Codes and standards

All access facilities shall be achievable for authorised personnel only.

All access facilities shall be equipped with necessary installations to provide safe transport and working conditions, e.g. normal and emergency lighting, emergency telephones, alarms etc.

All access facilities should not deteriorate or damage corrosion protection of any bridge elements.

7.3.2 Mobile aerial platform

The mobile aerial platforms (2 pieces) for terminal structure and the drop-in spans shall be provided. One for each side span and terminal structure of the bridge.

The mobile aerial platform shall give access from the terrain below the suspended deck for inspection and maintenance to all external parts in the suspended deck in the drop-in span which are not available by inspection gantry for suspended deck. Mobile aerial platform shall give access from the terrain below the suspended deck for inspection and maintenance to all external parts at terminal structure which are not available by terminal structure walkways.

The mobile aerial platforms shall be designed in such a way that the following main objectives are fulfilled:

- Mobile aerial platforms shall give safe and stable access during inspection and maintenance works.
- Mobile aerial platforms shall be easy to erect and to operate
- All relevant safety aspects are provided.
- Mobile aerial platform is robust and have a long service lifetime.

Access road leads to access spots.

The access spots must be safe and allow for using fully loaded mobile aerial platform.

Access road and access spots allow for manoeuvres with mobile aerial platform

7.3.3 Access to bearings, expansion joints and buffers at the tower

Access walkways, platforms, ladders and stairways under drop-in span shall give access and allow inspection and maintenance of the whole articulation system including the lower surfaces of articulation system beams.

All walkways and stairways of access to bearings, expansion joints and buffers at the tower shall accommodate the movements and rotations of the articulation system.

7.3.4 Access to terminal structure

Access to terminal structure gives an access to bearings and expansion joints at the terminal structure.

7.4 Functional Requirements

7.4.1 Mobile aerial platform

The mobile aerial platform shall give access from the terrain below the suspended deck for inspection and maintenance to all external parts in the suspended deck in the side span and drop-in span which is not achievable by access to bearings, expansion joints and buffers at the tower, access to terminal structure and gantry for suspended deck.

Access to terminal structures cannot give a full access to the buffers and bearings therefore those elements shall be inspected by mobile aerial platform.

The area of operation which is covered by mobile aerial platform in the side span shall overlap at least 6m at the joint of the drop-in span and main span with area covered by suspended deck gantry in the main span.

Floor of the basket shall be covered with anti-slide material.

7.4.2 Access to bearings, expansion joints and buffers at the tower

Access stairways and walkways below drop-in span shall give access and allow inspection and maintenance of the articulation system.

The access stairways will be accessible from bridge girder openings and from hatches in the service lane deck.

All openings/ doors shall be equipped with a surveillance system with intrusion alarms and lacking closure.

The stairway and walkways shall have sufficient working space to facilitate the access to walkway and with inspection and maintenance equipment.

7.4.3 Access to terminal structure

Access to terminal structures allows for the inspection and maintenance works of bearings and expansion joints at the terminal structure.

Access to terminal structure for expansion joints and bearings is achievable from roadway girder.

Access to terminal structures shall be able to accommodate movements of expansion joints at the side span.

Access to the terminal structures allow for inspection of underside of road expansion joints.

Railway girder expansion joint at the terminal structure is achievable by access ladder. Detailed inspection of the railway girder expansion joint shall be executed during the night under the closed railway traffic.

Bearings at the terminal structures are not fully achievable from access walkways and shall also be inspected from mobile aerial platform.

Hydraulic buffers for terminal structures are not accessible for inspection from side span of suspended girder access walkways and therefore they shall be inspected from stairs inside pier and/or stairs inside terminal bridge deck.

7.4.4 Size of access facilities

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

Mobile aerial platform

Height	H ≤ 65 m
Basket	L x W = 5.0 x 2.5
Hand rail	H = 1.5 m
Wind screen	Mesh 50% closed

Access to bearings, expansion joints and buffers at the tower W x H = 3.2 x 2 m

Walkways for bearings	L x W = 120 x 1.5 m
Platform, lateral bracing	L x W = 20 x 5 m
Walkways for bracing	L x W = 150 x 3.2 m
Platform, longitudinal buffers	L x W = 36 x 5 m
Platform, transverse buffers	L x W = 8 x 7 m

7.5 Operational Requirements

7.5.1 Mobile aerial platform

The mobile aerial platform must be designed to perform all operations in wind speed:

v_b = 20 m/s (10-minute average at the present mobile aerial platform position)

The mobile aerial platform shall be equipped with an anemometer which is able to give the 10-minutes average value.

The movement and run quality of the mobile aerial platform shall be smooth and shall not cause any uncomfortable impact.

Free swinging of the mobile aerial platform shall be restricted to allow safe working conditions.

The mobile aerial platform shall be provided with an anti-collision system which will alert personnel about possible interference with bridge structures.

Handrails of the basket shall prevent falling out of the mobile aerial platform basket and allow attaching safety harnesses with two hooks.

7.5.2 Access to bearings, expansion joints and buffers at the tower

Provisions for replacing bearings, expansion joints and hydraulic buffers in the future shall be made.

7.5.3 Access to terminal structures

All clearances in the access to terminal structures shall be provided disregarding expansion joint movements.

7.5.4 Clearances

The minimum clearances between mobile aerial platform and structures must be preserved:

Articulation system c = 0.5 m

The external elements of the basket shall be provided with fenders which can lean against suspended deck or tower if the local geometry allows for that.

7.5.5 Safety

Safety notices

Appropriate safety notices, warning signs and instructions shall be provided on the mobile aerial platform. These shall include, for example, notices clearly stating the safe working loads on the various parts of the mobile aerial platform and operating instructions.

During operation of the mobile aerial platform the area around access spot must be restricted so that only authorised personnel is present at the access spot.

Travel control

Provisions to prevent the mobile aerial platform from running into any part of the towers, during operation must be provided.

An anemometer must be installed on each basket to prevent operations in wind speeds exceeding the maximum operation wind speed.

Power cut-pieces

Floors shall be provided with power cut pieces.

Emergency stops

Controls for emergency stop shall be provided at strategic position in the basket. The emergency stop shall override the normal controls.

Prevention of falling

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

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

Fixation rods

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

Service lifetime

The mobile aerial platform must be robust and have a service lifetime of minimum 25 years.

7.6 Structural Requirements

7.6.1 Design loads

The nominal forces shall include dynamic effects generated by normal operation and maintenance activities and wind.

The safe operational load of mobile aerial platform must be designed for min. 3 times the maximum load in the basket.

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.

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

7.6.1.1 Mobile aerial platform design load

Variable live loads (approx.)

Personnel	2 kN
Equipment (painting)	2 kN
Concentrated load on 0.1x0.1 m	2 kN

Variable environmental loads (approx.)

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

Access to bearings, expansion joints and buffers at the tower

For access facilities following loads shall be applied:

Uniformly distributed load with a characteristic value of 2kN/m^2

For the design of local elements a concentrated load of 3kN acting alone on a square surface of 0.2x0.2m shall be applied.

Access to terminal structure

The same requirements as for access to bearings, expansion joints and buffers at the tower apply to access to terminal structure

7.7 Mechanical & Electrical Requirements

7.7.1 General

The mechanical and electrical work covered in the mobile aerial platform scope of work can be stated in headlines as follows:

Mobile aerial platform (2 pieces):

- Vehicle

- Basket
- Mobile aerial platform crane
- Fenders
- Wind screen panels
- Fire extinguishing system
- Power supply/generator
- Earthing and equipotential bonding.
- Electrical & instrumentation systems
- Control & monitoring
- Safety & operation controls
- Communication

Access to bearings, expansion joints and buffers at the tower (2 pieces)

- Access from the suspended deck and service lane
- Access walkways, platforms, ladders and stairways
- Hand and safety rail
- Power supply and distribution systems
- Monitoring
- Safety

Access to terminal structure (2 pieces)

- Access from the suspended deck and service lane
- Access walkways, platforms, ladders and stairways
- Hand and safety rail

- Power supply and distribution systems
- Monitoring
- Safety

7.7.2 Power supply

Power supply to mobile aerial platform

Power supply in the mobile aerial platform shall be provided by electrical cable attached from external power generator located at the terrain level or from batteries.

Power supply shall work at any location of the mobile aerial platform basket.

Lighting

- The installations shall include lighting along access walkways and the working area.
- The luminaries shall be manufactured in such a way that it is easy to replace lamps or tubes with new ones, only by using hand tools.
- Lamps or tubes shall be of a type with a long life time and the ballasts in the luminaries shall be electronics.
- 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 luminaries must not dazzle the road-users or the ships.

Safety

Handstrands and all elements of mobile aerial platform shall be earthed during any operation and maintenance works.

7.8 Materials

7.8.1 General

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

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.

7.8.2 Corrosion protection

The mobile aerial platform 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.

Measures must be taken to prevent long-term water ingress into any structural hollow box section forming any part of the mobile aerial platform.

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

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

Attention must be paid to the corrosive environment 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 mobile aerial platform.

7.8.3 Codes and Standards

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