Concessionaria per la progettazione, realizzazione e gestione del collegamento stabile tra la Sicilia e il Continente Organismo di Diritto Pubblico
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PONTE SULLO STRETTO DI MESSINA

PROGETTO DEFINITIVO

EUROLINK S.C.p.A.

IMPREGILO S.p.A. (MANDATARIA)
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INDICE

1 Introduction

This report summarise the preliminary calculations carried out for the dehumidification design for:

- The main cables
- The suspended deck, road and railway box girders and cross beams
- The terminal structures
- The tower saddles
- The towers
- The anchor block chambers

1.1 Report Outline

This report is organized into the following sections:

- Section 1 includes this introduction.
- Section 2 provides a list design specifications, design codes, material specifications and reference drawings.
- Section 3 provides the dehumidification system requirements.
- Appendix provides the verifications

2 Design References

2.1 Design Specifications

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

2 GCG.F.05.03 “Design Development – Requirements and Guidelines,” Stretto di Messina, 2004 October 22.

3 GCG.G.03.02 "Structural Steel Works and Protective 5 Coatings," Stretto di Messina, 2004 July 30.

2.2 Design Codes and Material Specifications

The design and construction of the dehumidification systems shall be in accordance with applicable European standards or code of practice.

Special attention will be paid to standards or code of practice for the following areas:

- Ventilation, Safety, Materials, Vibration, Acoustics
- Machinery Directive 2006/42/EF
- Low Voltage Equipment Directive 2006/95/EC
- Electromagnetic Compatibility (EMC) 89/336/EEC.
- CE Mark
- EN 779 Particulate air filters for general ventilation - Determination of the filtration performance.
- EN 1506 Sheet metal air ducts and fittings with circular cross-section - Dimensions.
- EN 1507 Sheet metal air ducts with rectangular section - Requirements for strength and leakage.
- EN 1751 Ventilation for buildings - Air terminal devices - Aerodynamic testing of dampers and valves.
- EN 1822-1 High efficiency air filters (HEPA and ULPA) - Part 1: Classification, performance testing, marking.
- EN 1822-2 High efficiency air filters (HEPA and ULPA) - Part 2: Aerosol production, measuring equipment, particle counting statistics.
- EN 1886 Air handling units - Mechanical performance.
- EN 12097 Ductwork - Requirements for ductwork components to facilitate maintenance of ductwork systems.

- EN 12220 Ductwork - Dimensions of circular flanges for general ventilation.
- EN 12236 Ductwork hangers and supports - Requirements for strength.
- EN 12237 Ductwork - Strength and leakage of circular sheet metal ducts.
- EN 12599 Test procedures and measuring methods for handing over installed ventilation and air conditioning systems.
- EN 12792 Symbols, terminology and graphical symbols.
- EN ISO 5801 Industrial fans - Performance testing using standardized airways.
- EN ISO 11204 Acoustics - Noise emitted by machinery and equipment - Determination of emission sound pressure levels at a work station and at other specified positions applying accurate environmental corrections.
- EN ISO 14122-3 Safety of machinery - Permanent means of access to machinery - Part 3: Stairs, stepladders and guard-rails.
- EN ISO 16032 Measurement of sound pressure level from service equipment in buildings - Engineering method.
- ISO 281 Rolling bearings - Dynamic load ratings and rating life.
- ISO 1460 Metallic coatings - Hot dip galvanized coatings on ferrous materials - Gravimetric determination of the mass per unit area.
- ISO 1940/1 Vibration and chock - Balance quality of rigid rotors - Part 1: Determination of permissible residual balance tolerances.
- ISO 8501 Preparation of steel substrates before application of paints and related products - Visual assessment of surface cleanliness - Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings.
- ISO 10816 Mechanical vibration - Evaluation of machine vibration by measurements on non-rotating parts - Part 1: General guidelines.

2.3 Drawings

The drawings relevant for this report are listed in Table 1.

Drawing Title	**Drawing Number**
Dehumidification, System key plan	CG1000-P-1L-D-P-SS-R4-00-00-00-00-01-B
Dehumidification, Anchor block chambers	CG1000-P-1A-D-P-SS-R4-00-00-00-00-01-B
Dehumidification, Main cables	CG1000-P-1A-D-P-SS-R4-00-00-00-00-02-B
Dehumidification, Suspended deck, Road and railway girders	CG1000-P-1A-D-P-SS-R4-00-00-00-00-03-B
Dehumidification, Towers	CG1000-P-1A-D-P-SS-R4-00-00-00-00-04-B
Dehumidification, Terminal structures	CG1000-P-1A-D-P-SS-R4-00-00-00-00-05-B

Table 1: Drawings concerning dehumidification systems

3 Dehumidification system requirements

3.1 General

The purpose of the dehumidification systems in the bridge is to dehumidify the air inside the bridge structures and thereby protect the interior surfaces of the structures form corrosion. To ensure this the bridge will be equipped with dehumidification plants with ventilation fans for circulation of the dehumidified air, with an average year round value of 40% relative humidity as a maximum and with an extreme value over 1 hour/day of 50% relative humidity. This will prevent corrosion of the internal steel surfaces.

The preset limit value for the relative air humidity shall not be higher than 40% and the relative air humidity shall not exceed 50% for more than one hour per day. These values are determined for operation of the systems and are verified by data from operation and maintenance of dehumidification systems in existing large bridge structures.

The dehumidification plants dehumidify the air in the bridge structures as well as the ambient air entering for equalisation of pressure in the structures, which will occur because of climate conditions.

The systems will consist of a minimum number of dehumidification plants with low electrical consumption and all plants will be easily accessible.

The systems will require some ductwork, but the use of ductwork will be minimised due to utilisation of the structural elements as ducts.

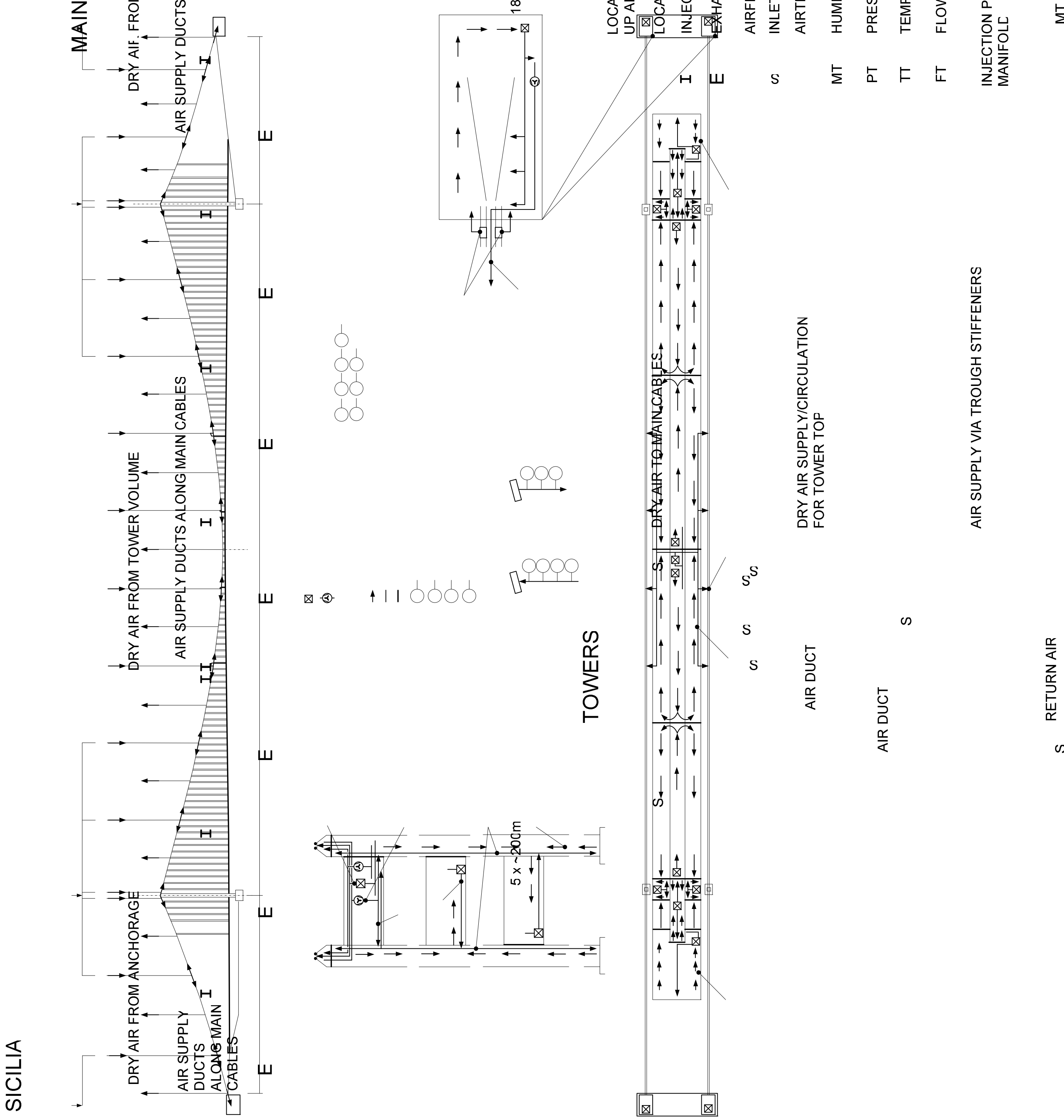
The structures shall be as airtight as possible to minimize the infiltration of ambient air.

The dehumidification systems will be designed for unmanned and unattended operation, 24 hours a day, 7 days week. They will be durable and require a minimum of maintenance.

Ventilation fans for circulation of air and for dry air supply to main cables will run continuously. The dehumidification units will not run continuously but automatically start and run when necessary to dehumidify the air inside the bridge structures and stop when the relative air humidity is brought down to the acceptable limit.

General maintenance is normally required once every year and should be performed during spring or autumn, i.e. outside the summer period. Any unexpected acute maintenance during summer can be carried out at night or early morning. The structures must as far as possible be kept closed during inspections and maintenances.

3.2 Dehumidification concept



3.3 Design conditions

The preliminary calculation for the dehumidification systems is based on the following set of design data.

Ambient conditions:

- Maximum air temperature +40 °C
- Minimum air temperature 3 °C
- Average air temperature +18.1 °C
- Maximum air humidity 0.0187 kg water vapour/kg air
- Atmospheric air pressure 101.3 kPa.
- Maximum internal air temperature +60 °C.

The ambient conditions will be assumed to fluctuate within a 12 hour period as follows:

- Temperature: ±15 °C
- Atmospheric air pressure: ±2.5 kPa.

3.4 General design requirements

- Infiltration of ambient air 2% of structure volume/hour.
- Relative air humidity inside structures max 40% yearly average and operation preset limit value shall not be higher than 40%.
- Relative air humidity inside structures shall not exceed 50% for more than one hour per day.
- Dehumidification max power consumption 1.45 kW/kg water per hour at 20 °C and 60% RH.
- The friction loss of the ductwork max: 1 Pa/m.
- Max air velocity in the ducts: 6 m/s.
- Max air velocity in the air intake: 2.5 m/s.
- Max working load/operation range ratio of the components: 75%.

3.5 Infiltration of ambient air

Control calculation for infiltration of ambient air into the dehumidified structures volumes, conservative consideration. Infiltration due to extreme temperature drop for girder air max 30 °C during 12 hours:

- Start: T_1 = 40 °C at 40% RH air density ρ_1 = 1.127 kg/m³
- End: T_2 = 10 °C 40% RH air density ρ_2 = 1.247 kg/m³

Density change (1-1.127/1.247)/12h*100 = 9.6%/12h = 0.8%/h, i.e. less than the 2% used as design requirement for system capacity.

The temperature variations inside the anchor block chambers will be very slow and therefore not a part of the calculations above.

3.6 System capacity

3.6.1 Design conditions

Following design conditions are basis for the calculations. The calculations compensate for both higher and lower temperature conditions inside the bridge structures. The capacity of the adsorption dehumidifiers is sufficient for the temperature variations in the bridge:

- Ambient 40 °C at 40% RH
- Inside steel structures 25 °C at 40% RH
- Inside main cables 20 °C at 40% RH
- Inside concrete structures 15 °C at 25% RH

3.6.2 Main cables

- Internal volumes including 25% leakage rate to be dehumidified, approx.: 3 x 1450 m^3
- Min 24 times of net structure volume is injected to the cables as dry air per 24 hours.
- Supplementary dehumidification plants for main cables: Min capacity 2.5 g (water)/hour per m^3 dehumidified structure volume.
- Distance between injection points max 400m corresponding to airtight cables.

- Air pressure at injection points max 2 kPa.

Generally the air is not re-circulated. The air will escape in exhaust manifolds.

3.6.2.1 Result

- Three dehumidification units with dehumidification capacity of $(x_2-x_1)*\rho_{12}*V_{12}/1000$ = 4.9 kg (water)/hour at condition of 40% RH and 20 °C. Verification: 4.9 > 2.5*1450/1000.
- Three circulation fans, working load/operation capacity: 2000 m^3/h at ΔP = 450 Pa (filter, duct etc., fan, inlet and outlet).
- Three injection fans, working load/operation capacity: 1500 m^3/h at ΔP = 2500 Pa (filter, duct etc., main cable, fan, inlet and outlet).
- Four injection fans in anchor block chambers see section 3.10.

3.7 Suspended deck

3.7.1 Road and railway box girders, section 4 and 5

- Internal volumes to be dehumidified, approx.: 2 x 63000 m^3
- Min 2 times air circulation of structure volume per 24 hours.
- Dehumidification plants including make-up air for main cables: Min capacity 0.55 g (water)/hour per m^3 dehumidified structure volume.

3.7.1.1 Result 1

- Two dehumidification units with dehumidification capacity of $(x_2-x_1)*\rho_{12}*V_{12}/1000$ = 35 kg (water)/hour at condition of 40% RH and 25 °C. Verification: 35 > 0.55*63000/1000.
- Two circulation fans, working load/operation capacity: 7000 m^3/h at ΔP = 650 Pa (filter, duct etc., fan, inlet and outlet).

3.7.1.2 Result 2

Conservative calculation and verification of the pressure loss in road and railway box girders:

- Pressure loss in railway box girder $0.5 * \rho_{12} * v^2 * n * \xi = 0.5 * 1.2 * 1.024^2 * 53 * 2.8 = 75$ Pa
  - Where;
    Air density: $\rho_{12} = 1.2$ kg/m^3
    Air velocity through openings: $v = (V-V_1/2)/A = (5250-2700/2)/3600/1.18 = 1.024$ m/s
    Circulation airflow: $V = 63000*(2/24) = 5250$ m^3/h
    Airflow to cross beams: $V_1 = n_1 * 100$ m^3/h $= 27 * 100 = 2700$ m^3/h
    Area of openings, approx.: $A = 0.6 * 1.3 + 0.4 = 1.18$ m^2
    Number of diaphragms/access openings: $n = 53$
    Number of cross beams: $n_1 = 27$
    Resistance factor: $\xi = 2.8$

- Pressure loss in road box girders $0.5 * \rho_{12} * v^2 * (n+1) * \xi = 0.5 * 1.2 * 0.515^2 * 54 * 2.8 = 24$ Pa
  - Where;
    Air density: $\rho_{12} = 1.2$ kg/m^3
    Air velocity through openings: $v = ((V_2+(V_3/2))A_1 = (2625+1350/2)/3600/1.78 = 0.515$ m/s
    Circulation airflow: $V_2 = V/2 = 5250/2 = 2625$ m^3/h
    Airflow to from beams: $V_3 = n_1 *100/2 = 27 * 50 = 1350$ m^3/h
    Area of openings, approx.: $A_1 = 0.6 * 1.3 + 1 = 1.78$ m^2
    Number of diaphragms/access openings: $n+1 = 54$
    Resistance factor: $\xi = 2.8$

- Total pressure loss in box girders = 75 + 24 = 99 Pa

This pressure is in accordance with experience from earlier suspension bridge dehumidification designs and operation and maintenances.

3.7.2 Road and railway box girders, section 3 and 6

- Internal volumes to be dehumidified, approx.: 2 x 63000 m^3
- Min 2 times air circulation of structure volume per 24 hours.
- Dehumidification plants: Min capacity 0.25 g (water)/hour per m^3 dehumidified structure volume.

3.7.2.1 Result

- Two dehumidification units with dehumidification capacity of $(x_2-x_1)*\rho_{12}*V_{12}/1000$ = 16 kg (water)/hour at condition of 40% RH and 25 °C. Verification: 16 > 0.25*63000/1000.

- Two circulation fans, working load/operation capacity: 5500 m^3/h at ΔP = 650 Pa (filter, duct etc., fan, inlet and outlet).

3.7.3 Road and railway box girders, section 1 and 8

- Internal volumes to be dehumidified, approx.: 2 x 13500 m^3

- Min 2 times air circulation of structure volume per 24 hours.

- Dehumidification plants: Min capacity 0.25 g (water)/hour per m^3 dehumidified structure volume.

3.7.3.1 Result

- Two dehumidification units with dehumidification capacity of $(x_2-x_1)*\rho_{12}*V_{12}/1000$ = 4.9 kg (water)/hour at condition of 40% RH and 25 °C. Verification: 4.9 > 0.25*13500/1000.

- Two circulation fans, working load/operation capacity: 1500 m^3/h at ΔP = 650 Pa (filter, duct etc., fan, inlet and outlet).

3.7.4 Road and railway box girders, section 2 and 7

- Internal volumes to be dehumidified, approx.: 4 x 3.000 m^3

- Min 2 times air circulation of structure volume per 24 hours.

- Dehumidification plants: Min capacity 0.25 g (water)/hour per m^3 dehumidified structure volume.

3.7.4.1 Result

- Four dehumidification units with dehumidification capacity of $(x_2-x_1)*\rho_{12}*V_{12}/1000$ = 1.8 kg (water)/hour at condition of 40% RH and 25 °C. Verification: 1.8 > 0.25*3000/1000

- Four circulation fans, working load/operation capacity: 250 m^3/h at ΔP = 450 Pa (filter, duct etc., fan, inlet and outlet).

3.8 Terminal structures

3.8.1 Sicilia

- Internal volumes to be dehumidified, approx.: 1 x 45000 m^3
- Min 2 times air circulation of structure volume per 24 hours.
- Dehumidification plants: Min capacity 0.25 g (water)/hour per m^3 dehumidified structure volume.

3.8.1.1 Result

- One dehumidification unit with dehumidification capacity of $(x_2-x_1)*\rho_{12}*V_{12}/1000$ = 12.3 kg (water)/hour at condition of 40% RH and 25 °C. Verification: 12.3 > 0.25*45000/1000
- One circulation fan, working load/operation capacity: 4000 m^3/h at ΔP = 800 Pa (filter, duct etc., fan, inlet and outlet).

3.8.2 Calabria

- Internal volumes to be dehumidified, approx.: 1 x 32000 m^3
- Min 2 times air circulation of box girder volume per 24 hours.
- Dehumidification plants: Min capacity 0.25 g (water)/hour per m^3 dehumidified structure volume.

3.8.2.1 Result

- One dehumidification unit with dehumidification capacity of $(x_2-x_1)*\rho_{12}*V_{12}/1000$ = 9.2 kg (water)/hour at condition of 40% RH and 25 °C. Verification: 9.2 > 0.25*32000/1000
- One circulation fan, working load/operation capacity: 3000 m^3/h at ΔP = 800 Pa (filter, duct etc., fan, inlet and outlet).

3.9 Towers including saddles

- Internal volumes to be dehumidified, approx.: 4 x 63000 m^3
- Min 4 times air circulation of structure volume per 24 hours.

- Dehumidification plants including make-up air for main cables: Min capacity 0.55 g (water)/hour per m^3 dehumidified structure volume.

3.9.1.1 Result

- Four dehumidification units with dehumidification capacity of $(x_2\text{-}x_1)*\rho_{12}*V_{12}/1000$ = 35 kg (water)/hour at condition of 40% RH and 25 °C. Verification: 35 > 0.55*63000/1000
- Four circulation fans, working load/operation capacity: 12000 m^3/h at ΔP = 650 Pa (filter, duct etc., fan, inlet and outlet).
- Four circulation fans, tower top/saddles, working load/operation capacity: 1000 m^3/h at ΔP = 650 Pa (filter, duct etc., fan, inlet and outlet).
- Four circulation fans, foundation bolts, working load/operation capacity: 100 m^3/h at ΔP = 300 Pa (duct etc., fan, inlet and outlet).

3.10 Anchor block chambers

3.10.1.1 Anchor block chambers

- Internal volumes in anchor block chambers to be dehumidified, approx.: 4 x 6500 m^3
- Min 2 times air circulation of structure volume per 24 hours.
- Dehumidification plants including make-up air for main cables: Min capacity 0.45 g (water)/hour per m^3 dehumidified structure volume.

3.10.1.2 Main cables

- Internal volumes in main cables including 25% leakage rate to be dehumidified, approx.: 4 x 200 m^3
- Min 24 times of net structure volume is injected to the cables as dry air per 24 hours.

3.10.1.3 Result

- Four dehumidification units with dehumidification capacity of $(x_2-x_1)*\rho_{12}*V_{12}/1000$ = 3 kg (water)/hour at condition of 25% RH and 15 °C. Verification: 3 > 0.45*6500/1000
- Four circulation fans, working load/operation capacity: 550 m^3/h at ΔP = 650 Pa (filter, duct, fan, inlet and outlet).
- Four injection fans, main cables, working load/operation capacity: 200 m^3/h at ΔP = 2000 Pa (filter, duct, main cable, fan, inlet and outlet).

3.11 Power consumption

Based on the above design conditions for ambient air, requirements for infiltration of ambient air, relative air humidity inside dehumidified structures, continuous air supply to main cables including leakage rate and continuous air circulation in the dehumidified structures the total power consumption for all the dehumidification systems is assumed to be:

658000 kWh/year / 646000 m^3 corresponding to approx. 1 kWh/m^3 structure volume per year

Where;
The power consumption for dehumidifiers approx. 10% * 500 * 8760 = 438000 kWh/year
The power consumption for fans approx. 25 * 8760 = 220000 kWh/year
The total power consumption is approx. = 438000 + 220000 = 658000 kWh/year
The total air volume in dehumidified structures approx. 646000 m^3

4 Appendix

4.1 Dehumidification system calculations

	Units	Volume	Total volume	Circulating / supply air flow	Total Circulating / supply air flow	Make-up air	Total make-up air	Infiltration of air	Total infiltration of air	Water to be removed	System capacity requirement (structure volume)	Total water to be removerd	Unit specific capacity	Total specific capacity	Reactivation heater	Pressure loss	Total installed power	Grand total installed power
	nos.	m^3	m^3	m^3/h	m^3/h	m^3/h	m^3/h	m^3/h	m^3/h	kg/h	$g/(hm^3)$	kg/h	kg/h	kg/h	kW	Pa	kW	kW
Anchor block chambers including supply to main cables																		
DH	4	6500	26000	690		110	441	46	185	2,9	0,44	11,5	3	12	5		8	32,00
Circulation fan	4			542	2167											650	0,13	0,52
Air supply fan, main cables	4			184	735											2000	0,14	0,54
Local panel, monitoring etc.	4																0,5	2,00
Tower, centre cross beam including make-up air for main cables																		
DH	2	63000	126000	5000		1411	2822	1260	2520	34,0	0,54	68,0	35	70	59		60	120,00
Circulation fan	2			11225	22450											650	2,70	5,40
Circulation fan, tower tops	4			1000	4000											650	0,24	0,96
Local panel, monitoring etc.	2																0,5	1,00
Tower, low cross beam including make-up air for main cables																		
DH	2	61000	122000	5000		1411	2822	1220	2440	33,5	0,55	67,0	35	70	59		60	120,00
Circulation fan	2			10892	21783											650	2,62	5,24
Local panel, monitoring etc.	2																0,5	1,00
Tower, top cross beam, dry air supply to main cables																		
DH	2	1450	2900	690		1450	2900	0	0	3,6	2,47	7,2	4,9	9,8	6		8	16,00
Circulation fan	1			1104												450	0,18	0,18
Air supply fan, main cables	2			1450	2900											2500	1,34	2,69
Local panel, monitoring etc.	2																0,5	1,00
Girder section 4 and 5 including make-up air for main cables																		
DH	2	63000	126000	5000		1375	2751	1260	2520	33,5	0,53	67,1	35	70	59		60	120,00
Circulation fan	2			5975	11950											650	1,44	2,88
Local panel, monitoring etc.	2																0,5	1,00
Girder section 4/5, dry air supply to main cables																		
DH	1	1450	1450	690		1450	1450	0	0	3,6	2,47	3,6	4,9	4,9	6		8	8,00
Circulation fan	1			1104												450	0,18	0,18
Air supply fan, main cables	1			1450	1450											2500	1,34	1,34
Local panel, monitoring etc.	1																0,5	0,50
Girder section 3 and 6																		
DH	2	63000	126000	2300		0	0	1260	2520	16,1	0,25	32,1	16	32	28		30	60,00
Circulation fan	2			5250	10500											650	1,26	2,53
Local panel, monitoring etc.	2																0,5	1,00
Girder section 1 and 8																		
DH	2	13500	27000	690		0	0	270	540	3,4	0,25	6,9	4,9	9,8	6		8	16,00
Circulation fan	2			1125	2250											650	0,27	0,54
Local panel, monitoring etc.	2																0,5	1,00
Girder section 2 and 7																		
DH	4	3000	12000	270		0	0	60	240	0,8	0,25	3,1	1,8	7,2	1		3	12,00
Circulation fan	4			250	1000											450	0,04	0,17
Local panel, monitoring etc.	4																0,5	2,00
Terminal structure, Sicilia																		
DH	1	45000	45000	1700		0	0	900	900	11,5	0,25	11,5	12,3	12,3	20		21	21,00
Circulation fan	1			3750	3750											800	1,11	1,11
Local panel, monitoring etc.	1																0,5	0,50
Terminal structure, Calabria																		
DH	1	31500	31500	1350		0	0	630	630	8,0	0,25	8,0	9,2	9,2	14		16	16,00
Circulation fan	1			2625	2625											800	0,78	0,78
Local panel, monitoring etc.	1																0,5	0,50
Total			645850			7208	13186	6906	12495	151	8	286		307	264			577

4.2 Ducts and openings 1

Anchor block chambers including supply to main cables								**Openings in structures**				
								Reactivation air in / out				
Reactivation air in / out	Ø 125	mm	duct	256	m3/h	5,8	m/s		Ø 200	mm	2,3	m/s
Process air in / out	Ø 200	mm	duct	690	m3/h	6,1	m/s					
								Make-up air				
Circulation air, main 1	Ø 200	mm	duct choise						Ø 160	mm	2,5	m/s
Max velocity	6	m/s										
d, duct	Ø 179	mm										
Tower, centre cross beam including make-up air for main cables												
								Reactivation air in / out				
Reactivation air in / out	Ø 350	mm	duct	1667	m3/h	4,8	m/s		Ø 400	mm	3,7	m/s
Process air in / out	Ø 560	mm	duct	5000	m3/h	5,6	m/s					
								Make-up air				
Circulation air, main 1	Ø 900	mm	duct choise						Ø 400	mm	3,1	m/s
Max velocity	6	m/s										
d, duct	Ø 813	mm						**Pressure relife**				
									Ø 400	mm		
								Circulation air for tower top			3	nos.
									Ø 300	mm	3,9	m/s
								Air supply to cables				
									Ø 300	mm	3	nos.
Tower, low cross beam including make-up air for main cables												
								Reactivation air in / out				
Reactivation air in / out	Ø 315	mm	duct	1667	m3/h	5,9	m/s		Ø 400	mm	3,7	m/s
Process air in / out	Ø 560	mm	duct	5000	m3/h	5,6	m/s					
								Make-up air				
Circulation air, main 1	Ø 800	mm	duct choise						Ø 400	mm	3,1	m/s
Max velocity	6	m/s										
d, duct	Ø 801	mm						**Pressure relife**				
									Ø 400	mm		
Tower, top cross beam, dry air supply to main cables												
								Reactivation air in / out				
Reactivation air in / out	Ø 125	mm	duct	230	m3/h	5,2	m/s		Ø 200	mm	2,0	m/s
Process air in / out	Ø 200	mm	duct	690	m3/h	6,1	m/s					
Air supply	Ø 315	mm	duct choise									
Max velocity	6	m/s										
d, duct	Ø 292	mm										
Girder section 4 and 5 including make-up air for main cables												
								Reactivation air in / out				
Reactivation air in / out	Ø 315	mm	duct	1667	m3/h	5,9	m/s		Ø 400	mm	3,7	m/s
Process air in / out	Ø 560	mm	duct	5000	m3/h	5,6	m/s					
								Make-up air				
Circulation air, main 1	Ø 600	mm	duct choise						Ø 400	mm	3,0	m/s
Max velocity	6	m/s										
d, duct	Ø 593	mm						**Pressure relife**				
									Ø 400	mm		
								Circulation air at end of section				
									Ø 900	mm	1,3	m/s

4.3 Ducts and openings 2

Girder section 4/5, dry air supply to main cables											
								Reactivation air in / out			
Reactivation air in / out	Ø 125	mm	duct	230	m3/h	5,2	m/s	Ø 200	mm	2,0	m/s
Process air in / out	Ø 200	mm	duct	690	m3/h	6,1	m/s				
Air supply	Ø 315	mm	duct choise								
Max velocity	6	m/s									
d, duct	Ø 292	mm									
Girder section 3 and 6											
								Reactivation air in / out			
Reactivation air in / out	Ø 250	mm	duct	852	m3/h	4,8	m/s	Ø 300	mm	3,3	m/s
Process air in / out	Ø 400	mm	duct	2300	m3/h	5,1	m/s				
								Pressure relife			
Circulation air, main 1	Ø 600	mm	duct choise					Ø 400	mm		
Max velocity	6	m/s									
d, duct	Ø 556	mm									
Girder section 1 and 8											
								Reactivation air in / out			
Reactivation air in / out	Ø 125	mm	duct	256	m3/h	5,8	m/s	Ø 200	mm	2,3	m/s
Process air in / out	Ø 200	mm	duct	690	m3/h	6,1	m/s				
								Pressure relife			
Circulation air, main 1	Ø 315	mm	duct choise					Ø 200	mm		
Max velocity	6	m/s									
d, duct	Ø 258	mm									
								Circulation air at end of section			
								Ø 400	mm	1,2	m/s
Girder section 2 and 7											
								Reactivation air in / out			
Reactivation air in / out	Ø 100	mm	duct	100	m3/h	3,5	m/s	Ø 150	mm	1,6	m/s
Process air in / out	Ø 160	mm	duct	270	m3/h	3,7	m/s				
Circulation air, main 1	Ø 160	mm	duct choise								
Max velocity	6	m/s									
d, duct	Ø 121	mm									
Terminal structure, Sicilia											
								Reactivation air in / out			
Reactivation air in / out	Ø 200	mm	duct	630	m3/h	5,6	m/s	Ø 300	mm	2,5	m/s
Process air in / out	Ø 315	mm	duct	1700	m3/h	6,1	m/s				
								Pressure relife			
Circulation air, main 1	Ø 500	mm	duct choise					Ø 400	mm		
Max velocity	6	m/s									
d, duct	Ø 470	mm									
Terminal structure, Calabria											
								Reactivation air in / out			
Reactivation air in / out	Ø 200	mm	duct	500	m3/h	4,4	m/s	Ø 300	mm	2,0	m/s
Process air in / out	Ø 315	mm	duct	1350	m3/h	4,8	m/s				
								Pressure relife			
Circulation air, main 1	Ø 400	mm	duct choise					Ø 400	mm		
Max velocity	6	m/s									
d, duct	Ø 393	mm									