IRCCOS
Istituto di Ricerca e Certificazione per le Costruzioni Sostenibili
Notified Body No. 1994 in accordance with Regulation CPR (EU) No. 305/2011

TECHNICAL RELATION

RT/445/2022

EXPERIMENTAL VERIFICATION OF RESISTANCE PERFORMANCE TO
WIND LOAD UNDER DYNAMIC PRESSURE
AND IMPACT RESISTANCE
OF SKIN CLADDING SYSTEMS:
BATTENS 30
BATTENS 50
CLADDING

Applicant:

FORME S.r.l.
S.S. 275, KM 14,400
73030 Surano (LE)

The Laboratory Technician
Katia Foti
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Samarate (VA), 11th July 2022

SUMMARY

1 Objectives of the conducted experimental evaluation

The intervention conducted by IRCCOS on behalf of the company FORME S.r.l. was aimed at evaluating the dynamic wind load resistance and impact resistance performance of cladding systems with several types of attachment. The tests were conducted at the TCLab section of the BFL - Building Future Lab located at the "Mediterranea" University of Reggio Calabria (RC).

The above-mentioned tests were carried out with the aim of assessing the performance of the cladding systems and types of fasteners to the stresses deriving from wind thrusts and the impacts of impacts.

The tests were held on 19th-20 th May 2022 and 06 th June 2022, in the presence of the following persons:

- Katia Foti	IRCCOS S.r.l. (NB1994) – Laboratory Technician
- Rocco Musolino	IRCCOS S.r.l. (NB1994) – Laboratory Technician
- Andrea Giachero	FORME S.r.l. – Technical Manager
- Martino Milardi	Sezione TCLab del BFL – Scientific Manager
- Mariateresa Mandaglio	Sezione TCLab del BFL – Laboratory Technician

2 Identification of the test sample

The samples under test are No. 3 cladding systems, with different types of attachment, belonging to the commercially named systems: "BATTENS 30", "BATTENS 50" and "CLADDING 150" produced by FORME S.r.l.

The description and the technical drawings that follow, referred to the test specimen, were declared/supplied by the applicant under his own responsibility.

- System: BATTENS 30
- Materials: extruded aluminum alloy EN AW-6060 (UNI EN 573-3), supply status T5 and T6 compliant with UNI EN 515 with dimensional tolerances and thicknesses in accordance with UNI EN 12020-2
- Profiles:
  - spar profile code BA30002,
  - batten profile 30x25mm code BA30003,
  - 20mm spacer profile code BA30001,

  all produced by FORME S.r.l., Surano (LE).
- Docking system:
  - clip nylon code FA30001,
  - wall bracket profile code BA30004,
  - guarnizione ammortizzatore code FA30005,

  all produced by FORME S.r.l., Surano (LE).

- System — BATTENS 50
- Materials: — extruded aluminum alloy EN AW-6060 (UNI EN 573-3), supply status T5 and T6 compliant with UNI EN 515 with dimensional tolerances and thicknesses in accordance with UNI EN 12020-2
- Profiles:
  - spar profile — art. BA50002,
  - batten profile 50x100mm — art. BA50001,

  all produced by FORME S.r.l., Surano (LE).
- Docking system:
  - docking bracket kit — art. FA50001,
  - cover profile and wall fixing — art. BA50003,

  all produced by FORME S.r.l., Surano (LE).

- System — CLADDING 150
- Materials: — extruded aluminum alloy EN AW-6060 (UNI EN 573-3), supply status T5 and T6 compliant with UNI EN 515 with dimensional tolerances and thicknesses in accordance with UNI EN 12020-2
- Profiles:
  - slatted profile 150mm — art. HCP0150
  - start profile — art. HCP2103,
  - terminal compensation profile — art. HCP1102,
  - terminal compensation cover — art. HCP1101,

  all produced by FORME S.r.l., Surano (LE).
- Docking system:
  - clip — art. HCM15x101,
  - shock absorber gasket — art. FA30005,

  all produced by FORME S.r.l., Surano (LE).

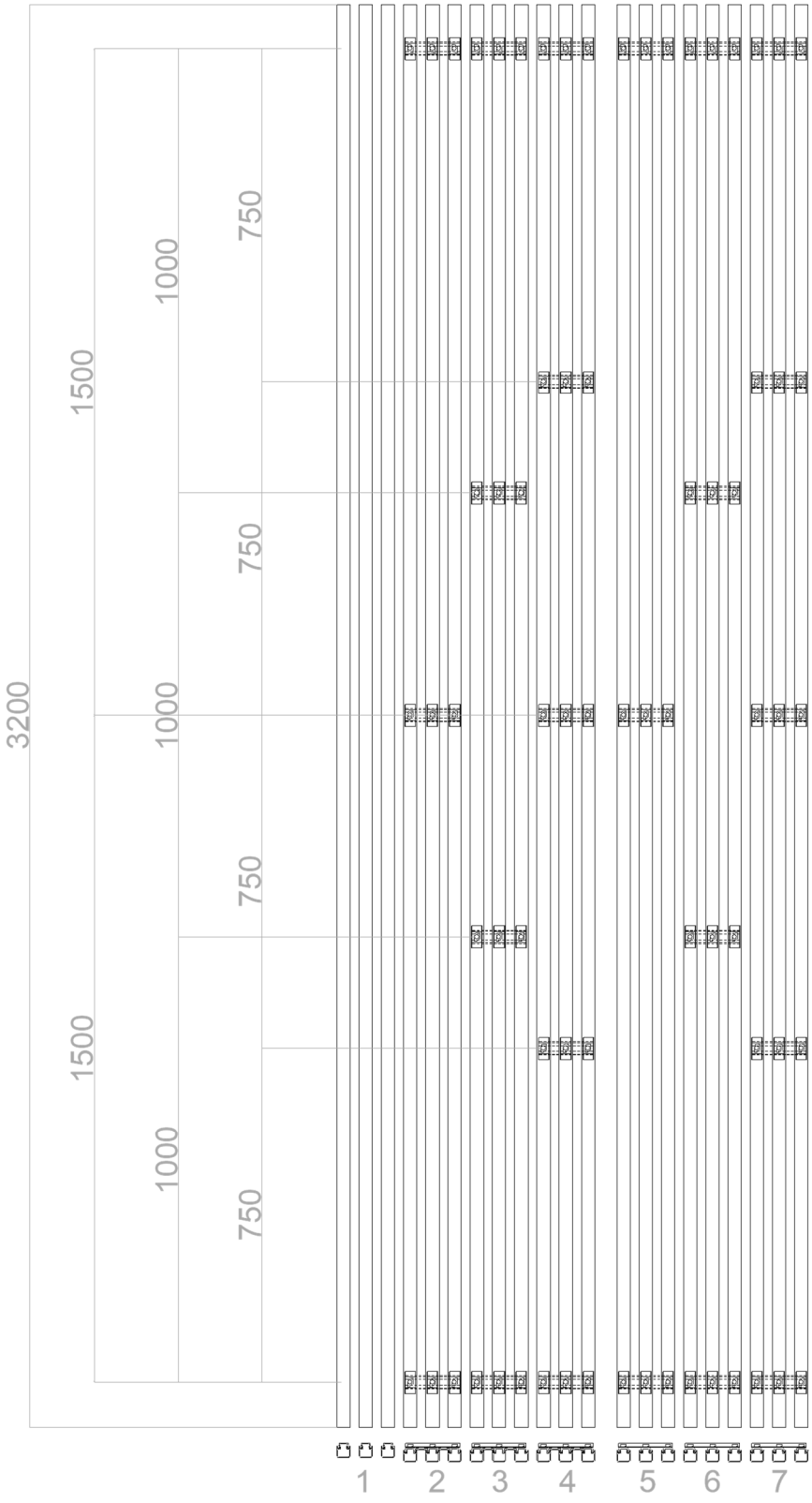


Fig. 1: Elevation and section of the sample tested_Battens 30

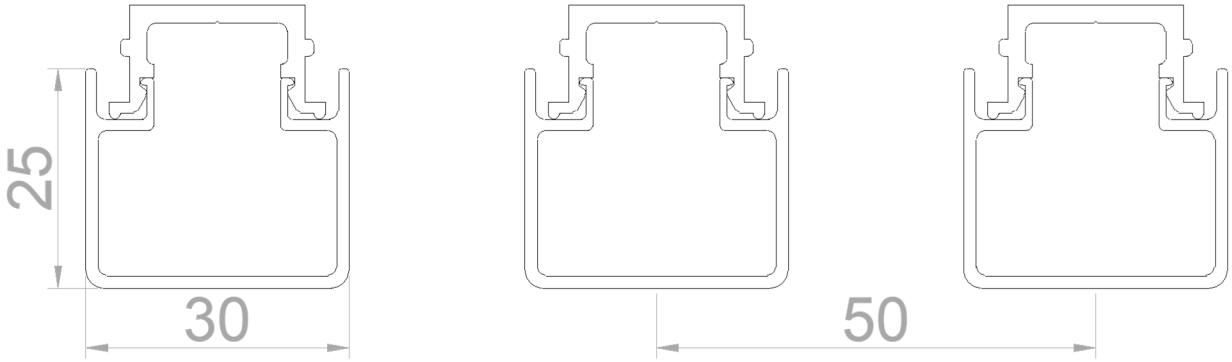


Fig. 2: Docking system detail_Battens 30/1

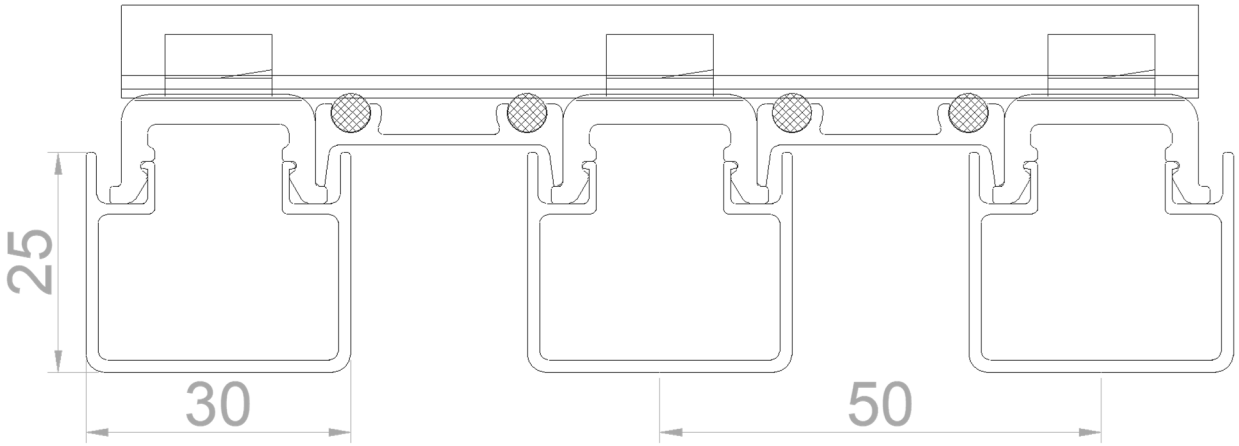


Fig. 3: Docking system detail _Battens 30/2 - 30/3 - 30/4

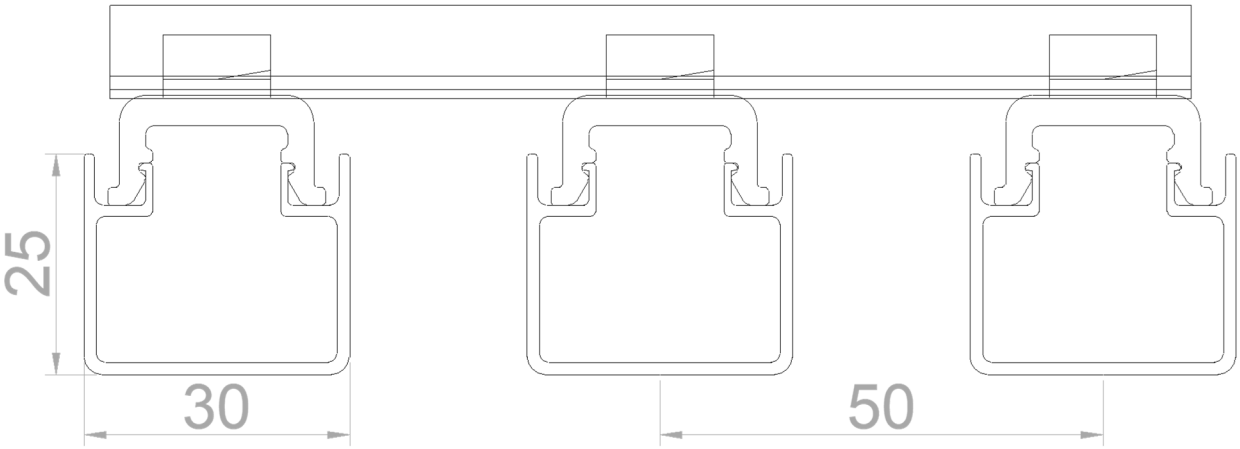


Fig. 4: Docking system detail _Battens 30/5 - 30/6 - 30/7

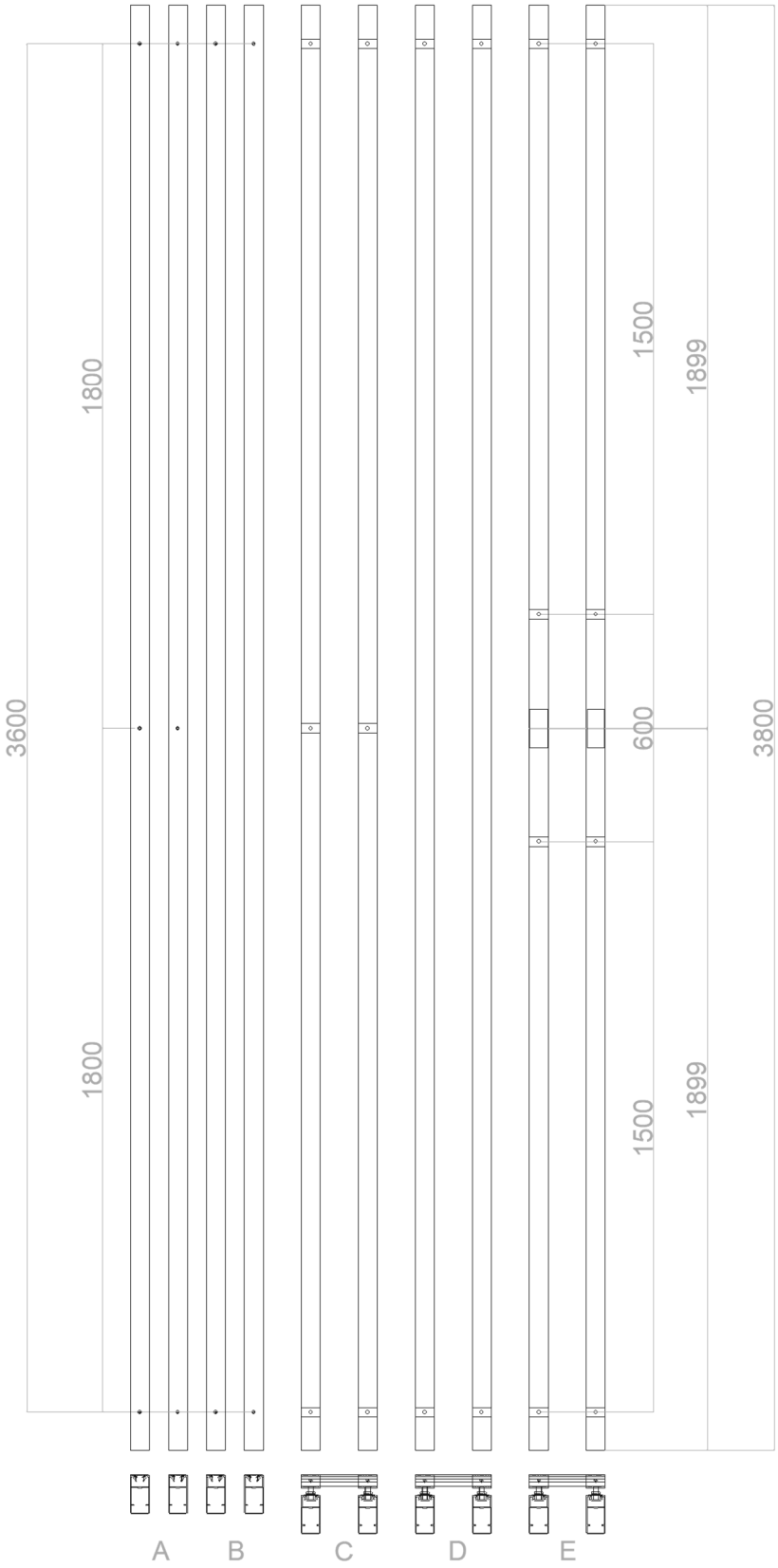


Fig. 5: Elevation and section of the sample tested _Battens 50

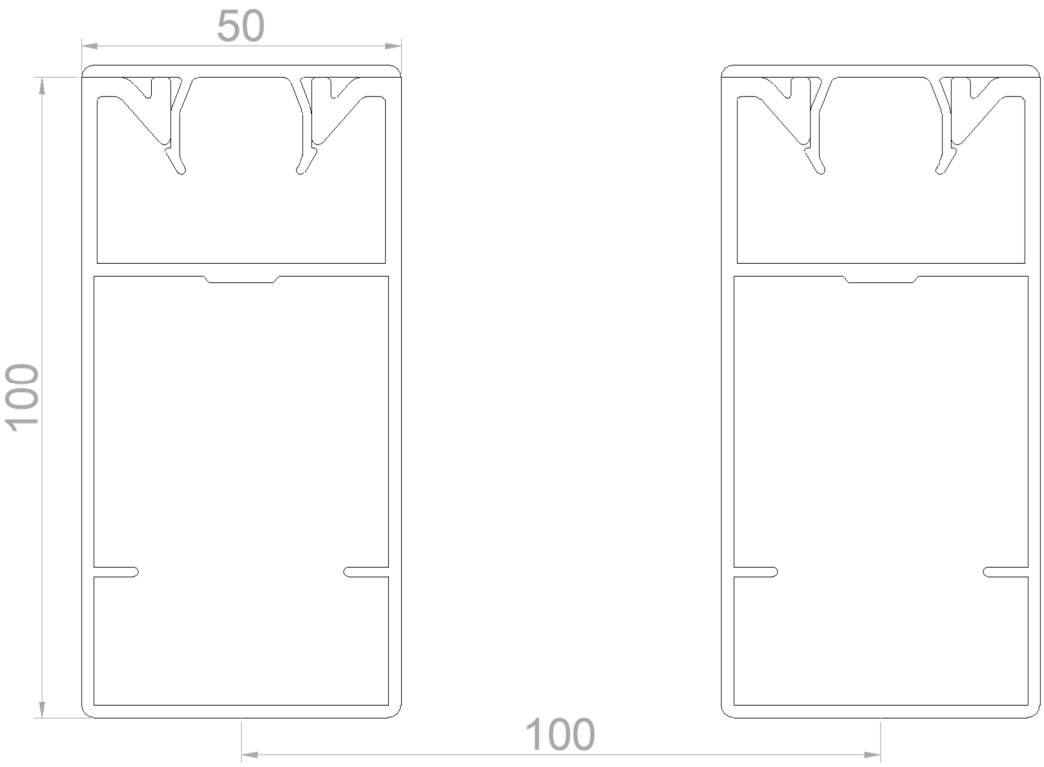


Fig. 6: Docking system detail _Battens 50/A – 50/B

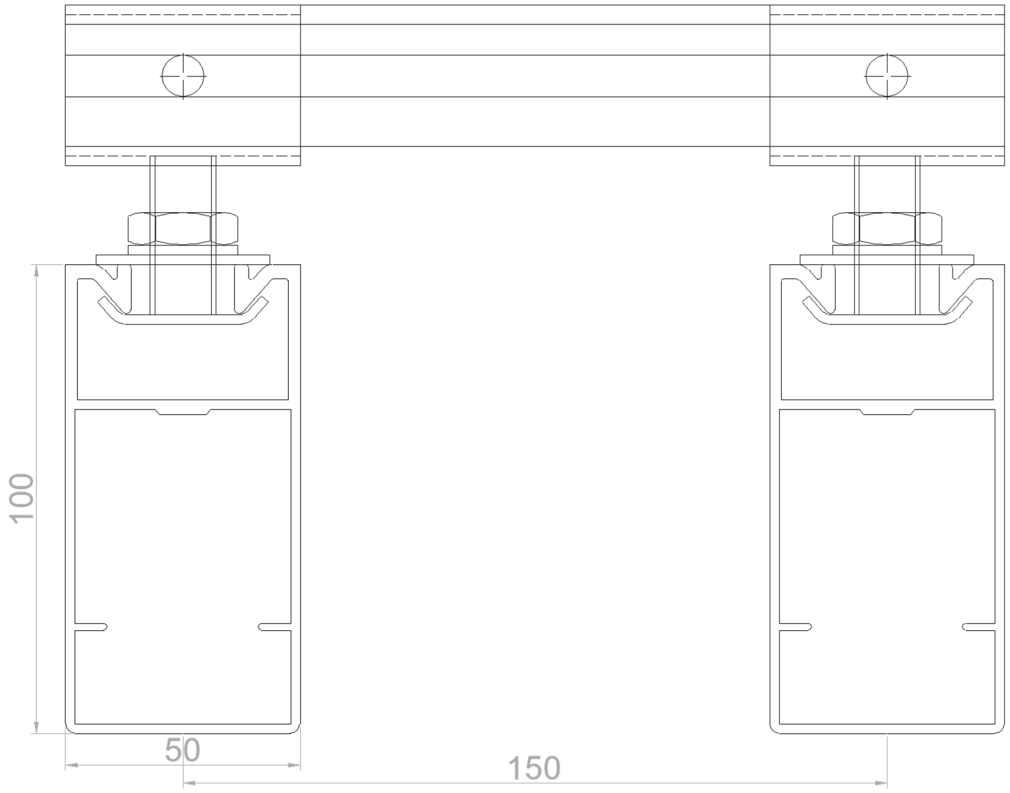


Fig. 7: Docking system detail_ Battens 50/C – 50/D – 50/E

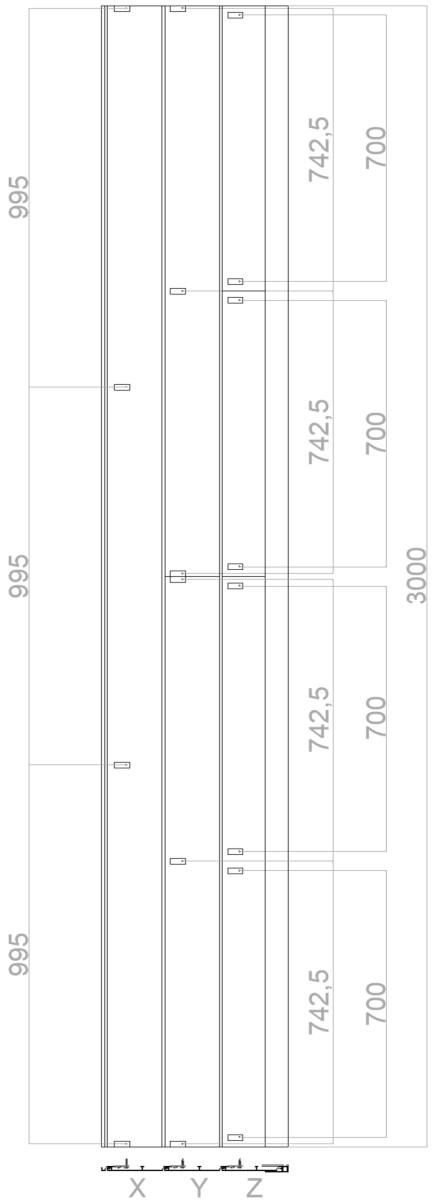


Fig. 8: Elevation and section of the sample tested _Cladding 150

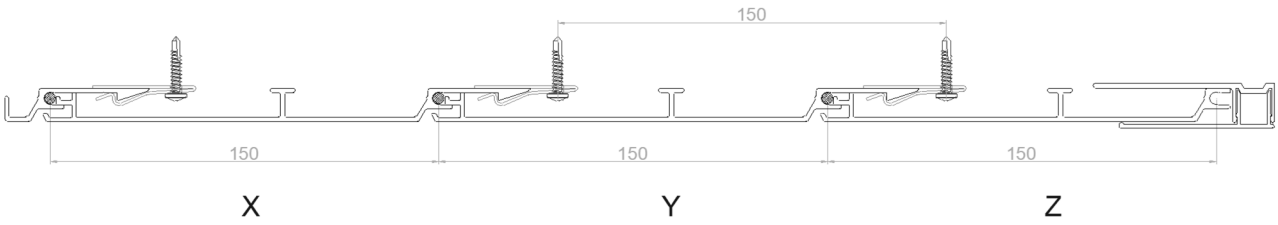


Fig. 9: Docking system detail _Cladding 150

3 Test Mode

3.1 Resistance to wind load under dynamic pressures

In the absence of specific regulations and being an experimental test activity, the tests were conducted using a methodology developed ad hoc by the laboratory.

- ***Principle of test***: the test consists of a visual verification of the stresses resulting from the application of dynamic wind pressure, to the different cladding systems in the different attachment types. A wind generation device capable of reproducing a dynamic pressure equivalent to the agreed wind speed was used.
- ***Test procedure***: the tests was conducted at different wind speeds. During each step the pressure was maintained for at least 3 minutes, at the end of which the wind generator was turned off to check for any damage to the samples. This was followed by increasing the wind speed on the test samples. The tests were conducted partly by keeping the generator orthogonal to the sample and partly by tilting the generator 45° to the sample plane

The wind speed applied to the samples was determined with reference to the AAMA 501.1-17 standard "Standard Test Method for Water Penetration of Windows, Curtain Walls and Doors Using Dynamic Pressure"

Wind speed in Km/h	Wind speed in m/s	Wind generator location
50	13,89	Orthogonal to the sample
80	22,22	Orthogonal to the sample
100	27,78	Orthogonal to the sample
125	34,72	Orthogonal to the sample / inclined by 45°
150	41,67	Inclined by 45°
180	50,0	Inclined by 45°
200	55,56	Inclined by 45°
240	66,67	Inclined by 45°

Tab. 1 Incremental sequence to which the sample was subjected

3.2 Impact resistance

The tests were carried out with reference to the methods provided for in the EAD guideline 090062-00-0404 "Kits for External Wall Claddings Mechanically Fixex" (Annex G, cfr. § G.2 Table G.1 "Resistance to Hard Body Impact" e "Resistance to Soft Body Impact", § G.3 Tabella G.2 "Impact use categories").

- ***Principle of test:*** the test consists of applying soft-body impacts at different impact energy values to the external side of the sample in order to determine its impact resistance and assess its safety in use and integrity. The impacts simulate the impact caused by large soft bodies that can accidentally occur.
- ***Test procedure:*** the impact tests are performed by means of a pendulum drop of the impacting body on the specimen restrained to a rigid structure; the impacting body will be suspended by means of a ring with a system of ropes, pulley and snap hooks for release, in order not to change the established impact energy. The impact points will be selected considering the configuration of the sample, taking into account the fastening systems and the dimensions of the cladding slabs.

  The following drop heights will be considered:

- S3 e S4: 0,61 mt and 0,82 mt for large soft body shocks of 50 kg (corresponding to 300 and 400 Joules respectively).

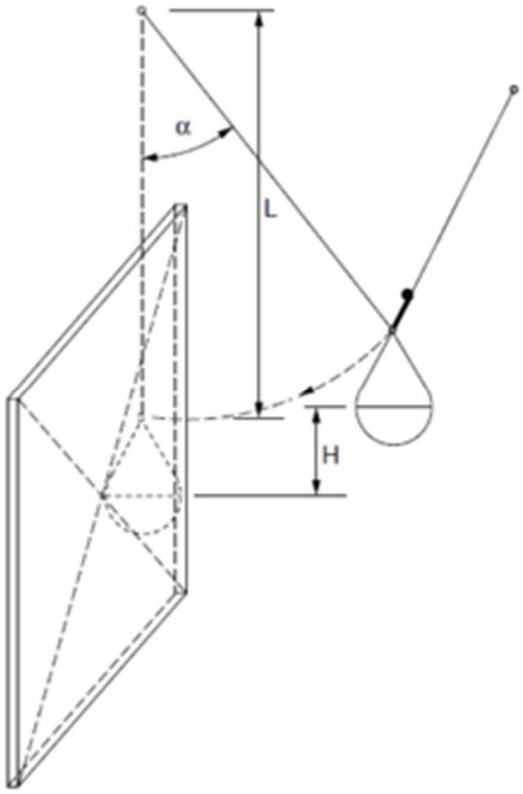


Fig. 10: Impact test device diagrams: large spring body

- ***Observations during the test*:** for the purpose of evaluating the performance behavior of the test samples, the breakage mode and / or damage will be photographed and noted, providing information regarding presence and type of micro cracks, fractures, formation of any sharp sides or similar.

4 Test equipment

The equipment used to perform the test, consist of:

- a rigid steel structure on which to bind the test sample;
- a suspension device consisting of steel cables and brackets fixed to the main frame, to ensure that the suspension point remains stationary during the test and positioned in such a way as to allow the impactor to strike the sample at the specified points;
- an impactor release mechanism that allows it to be raised and positioned at any specified drop height, then release it so that it swings freely and strikes the sample;
- a large soft body consisting of a spherical-conical bag made up of eight segments of canvas, assembled and sewn together using saddlery technique, reinforced on the bottom and with a ring hook for suspension; the spherical part of the body has a diameter of 400 mm while the top of the conical part is 400 mm from the center of the sphere; the total mass of the body is equal to 50 ± 0.5 kg;
- millimeter rod for measuring the falling heights of impactors.
- a wind generation device, with an aircraft propeller, electrically powered, capable of reproducing a wind current equivalent to the test pressure.

5 Results obtained

5.1 Resistance to wind load under dynamic pressures

Misurando	height (mm)	No. fixing points	spacing docking system
BATTENS 30_1	3200	2	3000
BATTENS 30_2	3200	3	1500
BATTENS 30_3	3200	4	1000
BATTENS 30_4	3200	5	750
BATTENS 30_5	3200	3	1500
BATTENS 30_6	3200	4	1000
BATTENS 30_7	3200	5	750
BATTENS 50_A	3800	3	1800
BATTENS 50_B	3800	2	3600
BATTENS 50_C	3800	3	1800
BATTENS 50_D	3800	2	3600
BATTENS 50_E	1899x2 (elements)	4	1500+600
CLADDING 150_X	3000	4	995
CLADDING 150_Y	1500x2	6	742,5
CLADDING 150_Z	750x4(elements)	8	700

Tab. 2

IRCCOS TECHNICIAN	DATE OF TEST	ENVIRONMENTAL PARAMETERS OF THE TEST SITE	
		Temperature (°C)	Relative humidity (%)
Katia Foti	2022/05/19	T_x= 25,0	U_{rel}= 65,2

Tab. 3

Note: in agreement with the customer, up to the pressure corresponding to 125 km / h an air flow orthogonal to the sample under test was applied, while for the subsequent pressures an inclined air flow of 45 ° to the sample under test was applied.

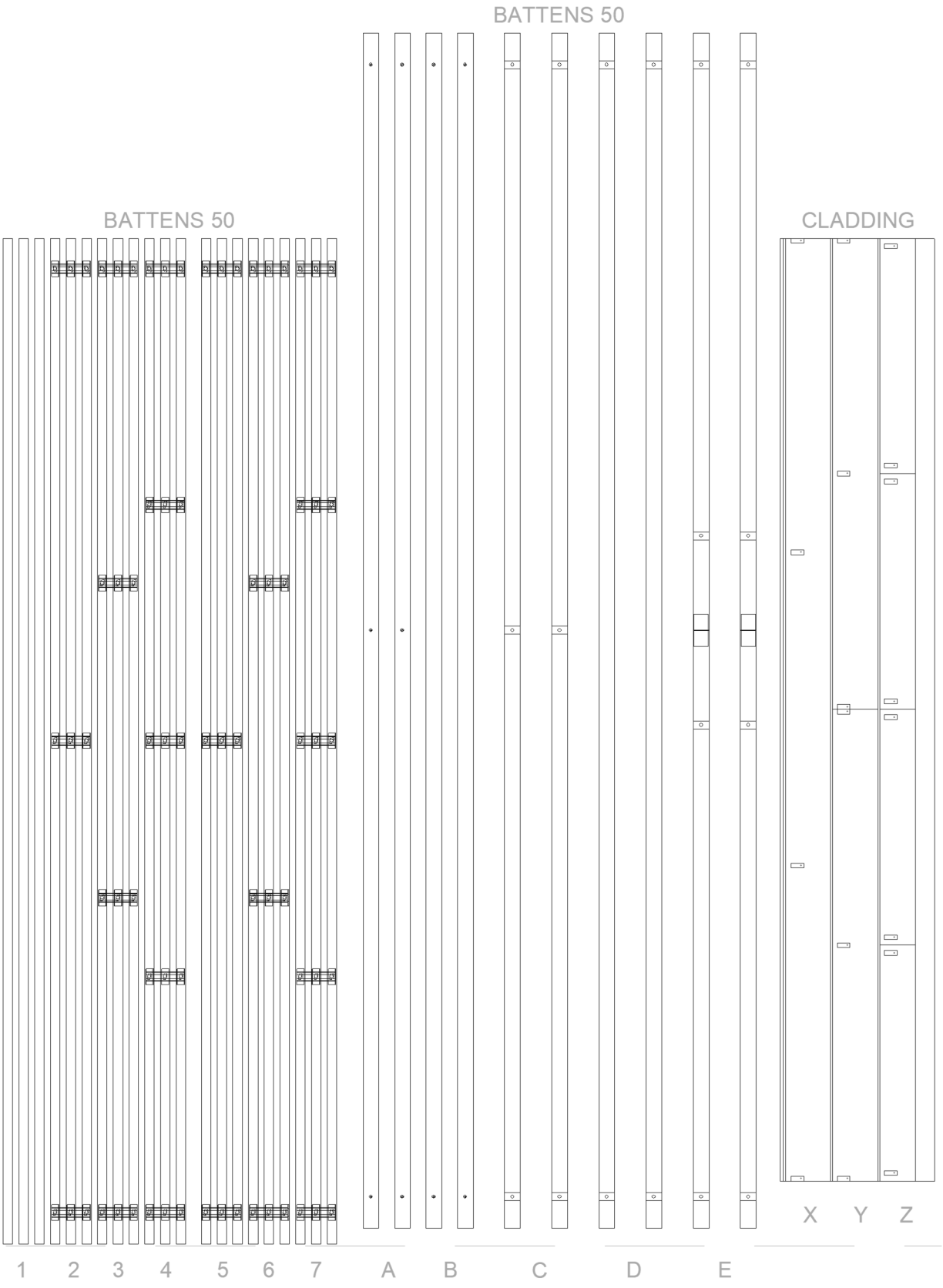


Fig. 11. Experimental set-up for test execution

	Wind speed in Km/h	Wind speed in m/s	Observations
BATTENS 30_1	50	13,89	None
	80	22,22	None
	100	27,78	None
	125	34,72	None
	150	41,67	None
	180	50,0	None
	200	55,56	None
	240	66,67	None

	Wind speed in Km/h	Wind speed in m/s	Observations
BATTENS 30_2	50	13,89	None
	80	22,22	None
	100	27,78	None
	125	34,72	None
	150	41,67	None
	180	50,0	None
	200	55,56	None
	240	66,67	None

	Wind speed in Km/h	Wind speed in m/s	Observations
BATTENS 30_3	50	13,89	None
	80	22,22	None
	100	27,78	None
	125	34,72	None
	150	41,67	None
	180	50,0	None
	200	55,56	None
	240	66,67	None

	Wind speed in Km/h	Wind speed in m/s	Observations
BATTENS 30_4	50	13,89	None
	80	22,22	None
	100	27,78	None
	125	34,72	None
	150	41,67	None
	180	50,0	None
	200	55,56	None
	240	66,67	None

	Wind speed in Km/h	Wind speed in m/s	Observations
BATTENS 30_5	50	13,89	None
	80	22,22	None
	100	27,78	None
	125	34,72	None
	150	41,67	None
	180	50,0	None
	200	55,56	None
	240	66,67	None

	Wind speed in Km/h	Wind speed in m/s	Observations
BATTENS 30_6	50	13,89	None
	80	22,22	None
	100	27,78	None
	125	34,72	None
	150	41,67	None
	180	50,0	None
	200	55,56	None
	240	66,67	None

	Wind speed in Km/h	Wind speed in m/s	Observations
BATTENS 30_7	50	13,89	None
	80	22,22	None
	100	27,78	None
	125	34,72	None
	150	41,67	None
	180	50,0	None
	200	55,56	None
	240	66,67	None

	Wind speed in Km/h	Wind speed in m/s	Observations
BATTENS 50_A	50	13,89	None
	80	22,22	None
	100	27,78	None
	125	34,72	None
	150	41,67	None
	180	50,0	None
	200	55,56	None
	240	66,67	None

	Wind speed in Km/h	Wind speed in m/s	Observations
BATTENS 50_B	50	13,89	None
	80	22,22	None
	100	27,78	None
	125	34,72	None
	150	41,67	None
	180	50,0	None
	200	55,56	None
	240	66,67	None

	Wind speed in Km/h	Wind speed in m/s	Observations
BATTENS 50_C	50	13,89	None
	80	22,22	None
	100	27,78	None
	125	34,72	None
	150	41,67	None
	180	50,0	None
	200	55,56	None
	240	66,67	None

	Wind speed in Km/h	Wind speed in m/s	Observations
BATTENS 50_D	50	13,89	None
	80	22,22	None
	100	27,78	None
	125	34,72	None
	150	41,67	None
	180	50,0	None
	200	55,56	None
	240	66,67	None

	Wind speed in Km/h	Wind speed in m/s	Observations
BATTENS 50_E	50	13,89	None
	80	22,22	None
	100	27,78	None
	125	34,72	None
	150	41,67	None
	180	50,0	None
	200	55,56	None
	240	66,67	None

	Wind speed in Km/h	Wind speed in m/s	Observations
CLADDING 150_X	50	13,89	None
	80	22,22	None
	100	27,78	None
	125	34,72	None
	150	41,67	None
	180	50,0	None
	200	55,56	None
	240	66,67	None

	Wind speed in Km/h	Wind speed in m/s	Observations
CLADDING 150_Y	50	13,89	None
	80	22,22	None
	100	27,78	None
	125	34,72	None
	150	41,67	None
	180	50,0	None
	200	55,56	None
	240	66,67	None

	Wind speed in Km/h	Wind speed in m/s	Observations
CLADDING 150_Z	50	13,89	None
	80	22,22	None
	100	27,78	None
	125	34,72	None
	150	41,67	None
	180	50,0	None
	200	55,56	None
	240	66,67	None

Tab. 4

5.1.1 Test results

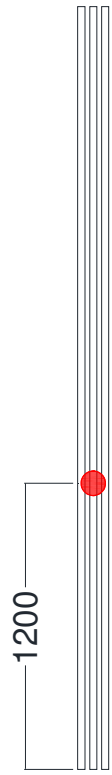
The test sample maintained its initial conditions, both in terms of the integrity of the elements and in docking system.

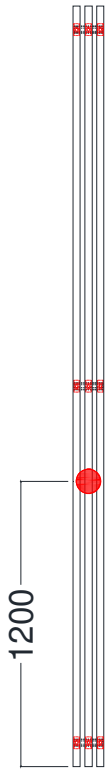
5.2 Soft body impact with 50 kg bag

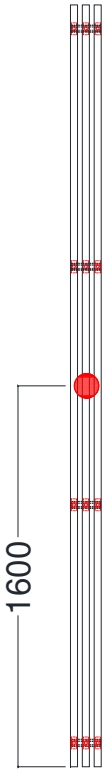
IRCCOS TECHNICIAN	DATE OF TEST	ENVIRONMENTAL PARAMETERS OF THE TEST SITE	
		Temperature (°C)	Relative humidity (%)
Katia Foti	2022/06/06	T_x= 30,0	U_{rel}= 45,5

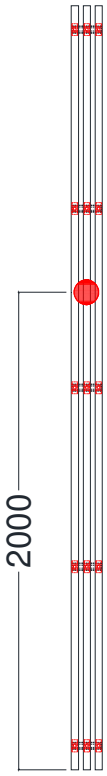
Tab. 5

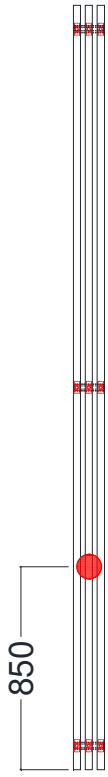
Different impact points were considered for each of the S3 and S4 categories. Any alterations observed on the sample and the position for each impact are shown below in Table 6.

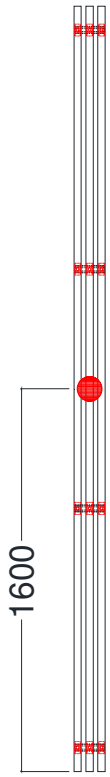
BATTENS 30_1		
Impact energy [J]	**Point of impact position on the sample (mm)**	**Observations**
S3_300 S4_400		Slight deformation with 300 J

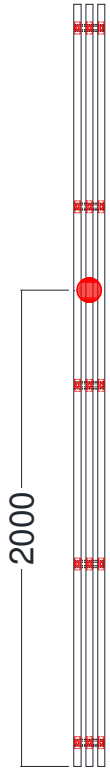
BATTENS 30_2		
Impact energy [J]	**Point of impact position on the sample (mm)**	**Observations**
S3_300 S4_400		None

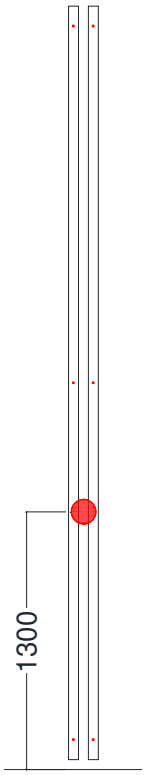
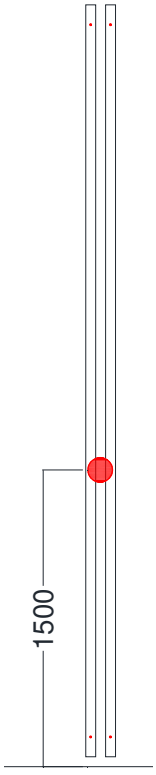
BATTENS 30_3		
Impact energy [J]	**Point of impact position on the sample (mm)**	**Observations**
S3_300 S4_400		None

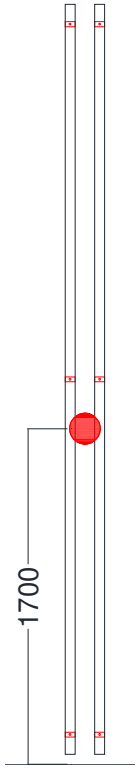
BATTENS 30_4		
Impact energy [J]	**Point of impact position on the sample (mm)**	**Observations**
S3_300 S4_400		None

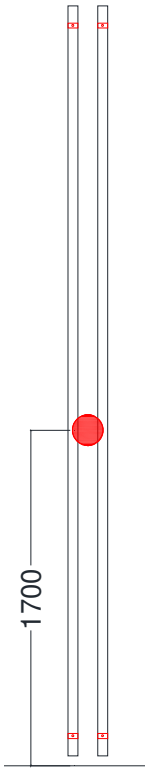
BATTENS 30_5		
Impact energy [J]	**Point of impact position on the sample (mm)**	**Observations**
S3_300 S4_400		None

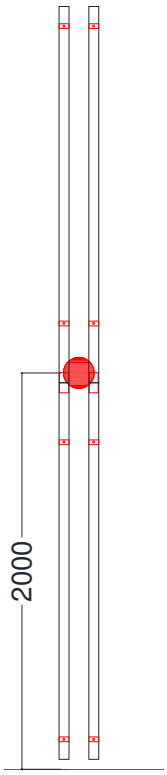
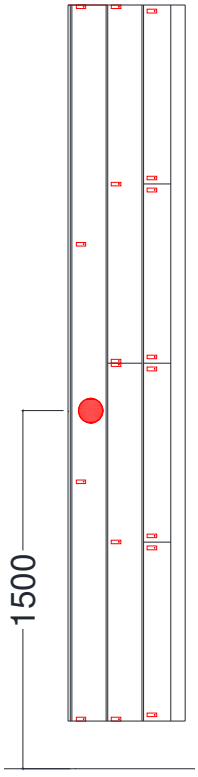
BATTENS 30_6		
Impact energy [J]	**Point of impact position on the sample (mm)**	**Observations**
S3_300 S4_400		None

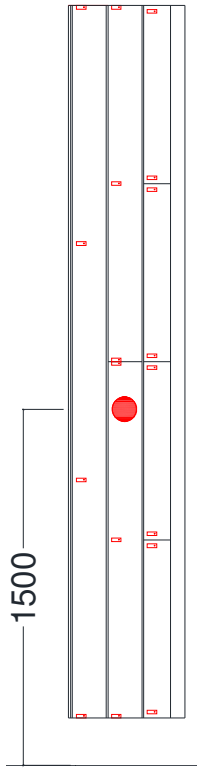
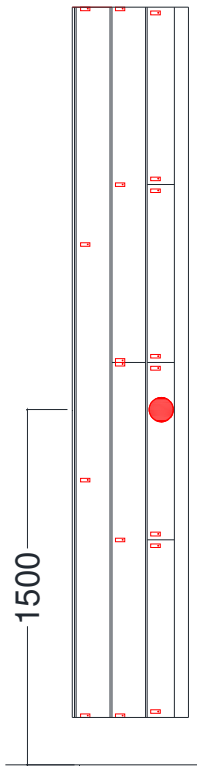
BATTENS 30_7		
Impact energy [J]	**Point of impact position on the sample (mm)**	**Observations**
S3_300 S4_400		None

BATTENS 50_A		
Impact energy [J]	**Point of impact position on the sample (mm)**	**Observations**
S3_300 S4_400		None
BATTENS 50_B		
Impact energy [J]	**Point of impact position on the sample (mm)**	**Observations**
S3_300 S4_400		Lower latch point release with 300 J

BATTENS 50_C		
Impact energy [J]	**Point of impact position on the sample (mm)**	**Observations**
S3_300 S4_400		None

BATTENS 50_D		
Impact energy [J]	**Point of impact position on the sample (mm)**	**Observations**
S3_300 S4_400		None

BATTENS 50_E		
Impact energy [J]	**Point of impact position on the sample (mm)**	**Observations**
S3_300 S4_400		Slight deformation with both impact forces 
CLADDING 150_X		
Impact energy [J]	**Point of impact position on the sample (mm)**	**Observations**
S3_300 S4_400		None

CLADDING 150_Y		
Impact energy [J]	**Point of impact position on the sample (mm)**	**Observations**
S3_300 S4_400		None
CLADDING 150_Z		
Impact energy [J]	**Point of impact position on the sample (mm)**	**Observations**
S3_300 S4_400		None

Tab. 6: Results obtained for soft body impacts with 50 kg bag

6 Photographs of the tested sample

Foto 1. Sample tested in the experimental setup

Foto 2. Tested sample undergoing resistance to wind load under dynamic pressures – orthogonal flow

Foto 3. Tested sample undergoing resistance to wind load under dynamic pressures – air flow iclinated to 45°

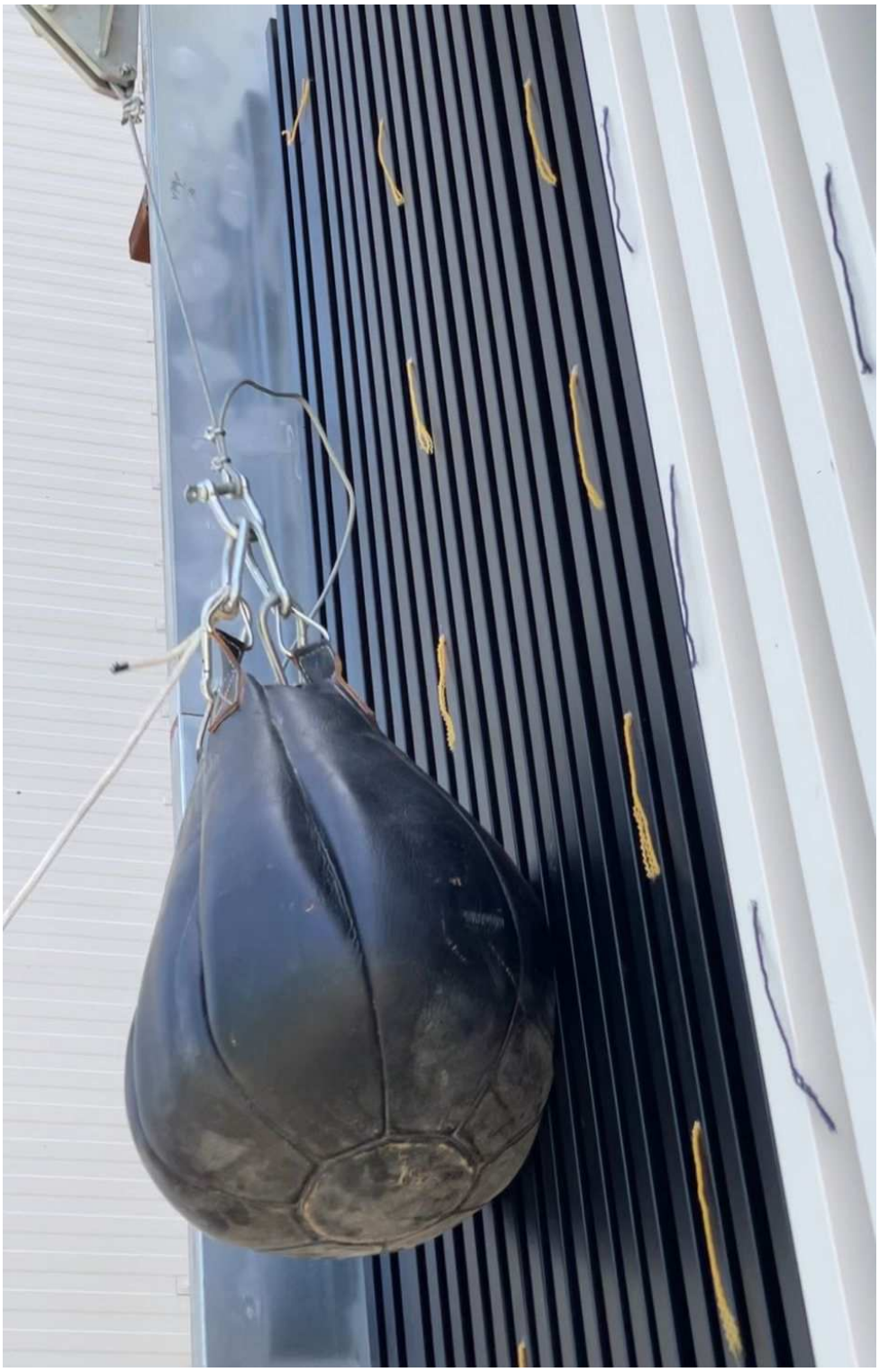


Foto 4. Test sample undergoing impact resistance with soft body_BATTENS 30

Foto 5. Test sample undergoing impact resistance with soft body _BATTENS 50

Foto 6. Test sample undergoing impact resistance with soft body _CLADDING 150

---------- End of Technical Relation No. RT/445/2022 ----------