

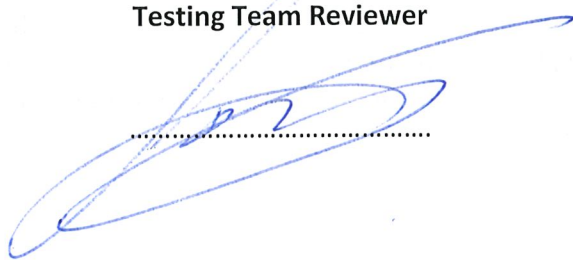
EVALUATION REPORT

Internal Reference:	TR20220315-01.REV01 cancel and replace TR20220315-01
Object:	Analysis on full-scale balustrade assemblies testing results
Reference standard(s)	Documento Básico SE-AE Acciones en la edificación
Reference test report(s):	<ul style="list-style-type: none">• TR20220210-01• TR20220210-02• TR20220210-03• TR20220210-04• TR20220210-05• TR20220210-06• TR20220210-07• TR20220210-08• TR20220210-09• TR20220210-10• TR20220210-11• TR20220210-12• TR20220210-13• TR20220210-14• TR20220210-15• TR20220210-16
Report Date:	15/03/2022

NOTICE

This report is not a certificate of conformity of the product(s), results only refer to the tested samples and provide evidence of the behaviour under the specific test conditions described.

Dr. Eng. Ph.D L. R. Piscitelli
Testing Team Reviewer



LOGLI MASSIMO S.p.A. A SOCIO UNICO
Via Chemnitz, 49/51 - 59100 PRATO
Tel. 0574/701035 - Fax 0574/527574
C.F. e P.IVA: 02221630779



Logli Massimo s.p.a.

Società a socio unico
Sede legale: Via Giovanni Benzi, 8
20152 Milano, Italia
Tel. +39 02 42431
Sede Operativa: Via Chemnitz, 49/51
59100 Prato, Italia
Tel. +39 0574 701035

Registro Imprese Milano Monza Brianza
Lodi n. 02221630779
R.E.A. MI - 2519149
Capitale Sociale € 120.000,00 i.v.
Codice Fiscale e P.IVA 02221630779
loglimassimospa@legalmail.it

www.loglimassimo.it
www.saint-gobain.it

INTRODUCTION

Tests TR20220210-01 to TR20220210-16 were carried out by Logli Massimo SpA, to assess the performance of several cantilevered glass railing systems, using assemblies of several systems and laminated glass panels. These sixteen above-mentioned TEST REPORTS are the base of this EVALUATION REPORT and are must be considered as an intrinsic part of it, describing in greater detail both the conditions for testing and results obtained.

Tests were performed in accordance to actions required by Spanish code *Documento Básico SE-AE Acciones en la edificación*, by applying and measuring a linear horizontal load on top of the elements.

Tests were carried out for balustrade assemblies installed for a total protection height of 1100 mm.

Additionally, this evaluation report provides extrapolation based on these test results, aiming to provide insight on expected performance, had the glass panes been of a different height.

TEST SAMPLE AND TEST METHOD

All of the systems tested consisted of an aluminium profile, which by use of dedicated gaskets and clamps, was used to secure specific laminated glass (LG) panels, to be used as balustrades. The glass panes were assembled using un-tempered glass and a plastic interlayer. Glass panes for the tests were supplied by *La Veneciana GLASSOLUTIONS Saint-Gobain*, Cima do Alle-Filgueira 36500-Lalín (PONTEVEDRA).

Testing consist in the application of a horizontal load line, at a design height which is determined in accordance to reference standard code guideline and further detailed in the following.

The load was applied using the A.S.S.O experimental testing apparatus, which is equipped with 5 servo-controlled electromechanical actuators, capable of applying a uniformly distributed load on the previously defined line. The load applied by each actuator is monitored by a load cell, in such a way that the movement of each piston is in turn calibrated to follow a design load curve.

The load ramp consists in an approaching phase of 60 seconds, allowing for all each one of the actuators to be put in contact with minimum load over the design area (30 N per actuator). The approaching phase is followed by a linearly increasing load ramp phase, which was set to continue indefinitely up to ultimate failure of the system or the maximum load capability of the testing array (5.000 N total). The speed of the load ramp was set to $1.0 \text{ Nm}^{-1}\text{s}^{-1}$.



Logli Massimo s.p.a.

Società a socio unico
Sede legale: Via Giovanni Bensi, 8
20152 Milano, Italia
Tel. +39 02 42431
Sede Operativa: Via Chemnitz, 49/51
59100 Prato, Italia
Tel. +39 0574 701035

Registro Imprese Milano Monza Brianza
Lodi n. 02221630979
R.E.A. MI - 2519149
Capitale Sociale € 120.000,00 i.v.
Codice Fiscale e P.IVA 02221630979
loglimassimospa@legalmail.it

www.loglimassimo.it
www.saint-gobain.it

The measurement of the horizontal displacements was made by means of a laser comparator pointed at a contrast plate on the glass surface, external side, the position of which is further detailed in the corresponding TEST REPORT.

Summary of the testing performed is as follows:

Table 1 - tests performed

Test reference	Retaining system			Laminated glass			
	reference	n° of clamps	n° of anchors	Reference	Height of the pane H _g	Composition	interlayer reference*
TR20220210-01	DF88PICO	4	4	Stadip	1085	88.2	PVB
TR20220210-03	DF88XP	4	4	Stadip	1085	88.2	DG41
TR20220210-02	DF88PICO	4	4	Stadip Builder	1085	88.2	PVB
TR20220210-04	DF88XP	4	4	Stadip Builder	1085	88.2	DG41
TR20220210-05	DF88LM	4	3	Stadip	1075	88.2	PVB
TR20220210-06	DF88LM	4	3	Stadip Builder	1075	88.2	DG41
TR20220210-07	DF1010LM	4	3	Stadip Builder	1075	1010.2	DG41
TR20220210-08	DF1010LM	4	3	Stadip	1075	1010.2	PVB
TR20220210-09	DF88FR	4	3	Stadip	1195	88.2	PVB
TR20220210-10	DF88FR	4	3	Stadip Builder	1195	88.2	DG41
TR20220210-11	DF1010FR	4	3	Stadip	1195	1010.2	PVB
TR20220210-12	DF1010FR	4	3	Stadip Builder	1195	1010.2	DG41
TR20220210-13	DF88MS	4	3	Stadip	1075	88.2	PVB
TR20220210-14	DF88MS	4	3	Stadip Builder	1085†	88.2	DG41
TR20220210-15	DF1010MS	4	3	Stadip	1075	1010.2	PVB
TR20220210-16	DF1010MS	4	3	Stadip Builder	1075	1010.2	DG41

For all tests, installed width was 1000mm, protection height was 1100 and the glass type was float annealed (not tempered) with polished edge finish.

* information provided by the glass manufacturer

† testing was performed as if the glass was 1075mm high



Logli Massimo s.p.a.

Società a socio unico
Sede legale: Via Giovanni Bensi, 8
20152 Milano, Italia
Tel. +39 02 42431
Sede Operativa: Via Chemnitz, 49/51
59100 Prato, Italia
Tel. +39 0574 701035

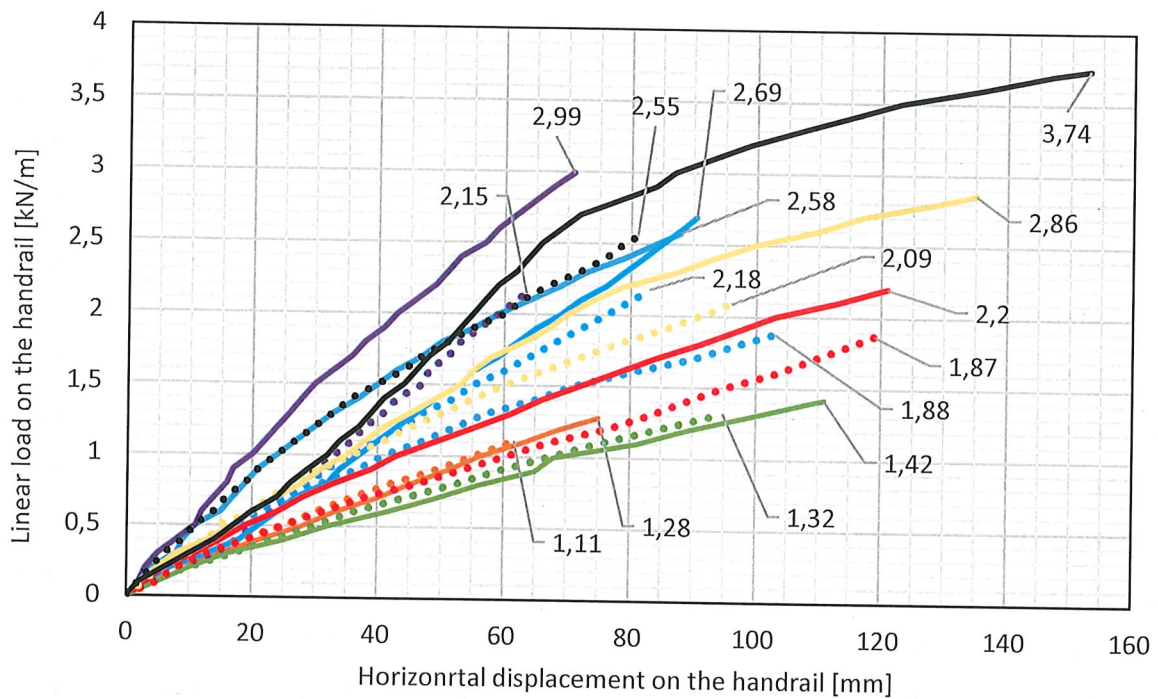
Registro Imprese Milano Monza Brianza
Lodi n. 02221630979
R.E.A. MI - 2519149
Capitale Sociale € 120.000,00 i.v.
Codice Fiscale e P.IVA 02221630979
loglimassimospa@legalmail.it

www.loglimassimo.it
www.saint-gobain.it

TEST RESULTS

Horizontal deflection over applied horizontal line load was measured as follows, along with maximum load upon failure. For all tests, failure was observed within the laminated glass panel.

Refer to individual tests reports for additional information.



- TR20220210-01 DF88PICO 88.2 STADIP
- TR20220210-02 DF88PICO 88.2 STADIP BUILDER
- TR20220210-03 DF88XP 88.2 STADIP
- TR20220210-04 DF88XP 88.2 STADIP BUILDER
- TR20220210-05 DF88LM 88.2 STADIP
- TR20220210-06 DF88LM 88.2 STADIP BUILDER
- TR20220210-08 DF1010LM 1010.2 STADIP
- TR20220210-07 DF1010LM 1010.2 STADIP BUILDER
- TR20220210-09 DF1010FR 1010.2 STADIP
- TR20220210-10 DF1010FR 1010.2 STADIP BUILDER
- TR20220210-12 DF88FR 88.2 STADIP
- TR20220210-11 DF88FR 88.2 STADIP BUILDER
- TR20220210-13 DF88MS 88.2 STADIP
- TR20220210-14 DF88MS 88.2 STADIP BUILDER
- TR20220210-15 DF1010MS 88.2 STADIP
- TR20220210-16 DF1010MS 88.2 STADIP BUILDER



Logli Massimo s.p.a.

Società a socio unico
Sede legale: Via Giovanni Bensi, 8
20152 Milano, Italia
Tel. +39 02 42451
Sede Operativa: Via Chemnitz, 49/51
59100 Prato, Italia
Tel. +39 0574 701035

Registro Imprese Milano Monza Brianza
Lodi n. 02221630979
R.E.A. MI - 2519149
Capitale Sociale € 120.000,00 i.v.
Codice Fiscale e P. IVA 02221630979
loglimassimospa@legalmail.it

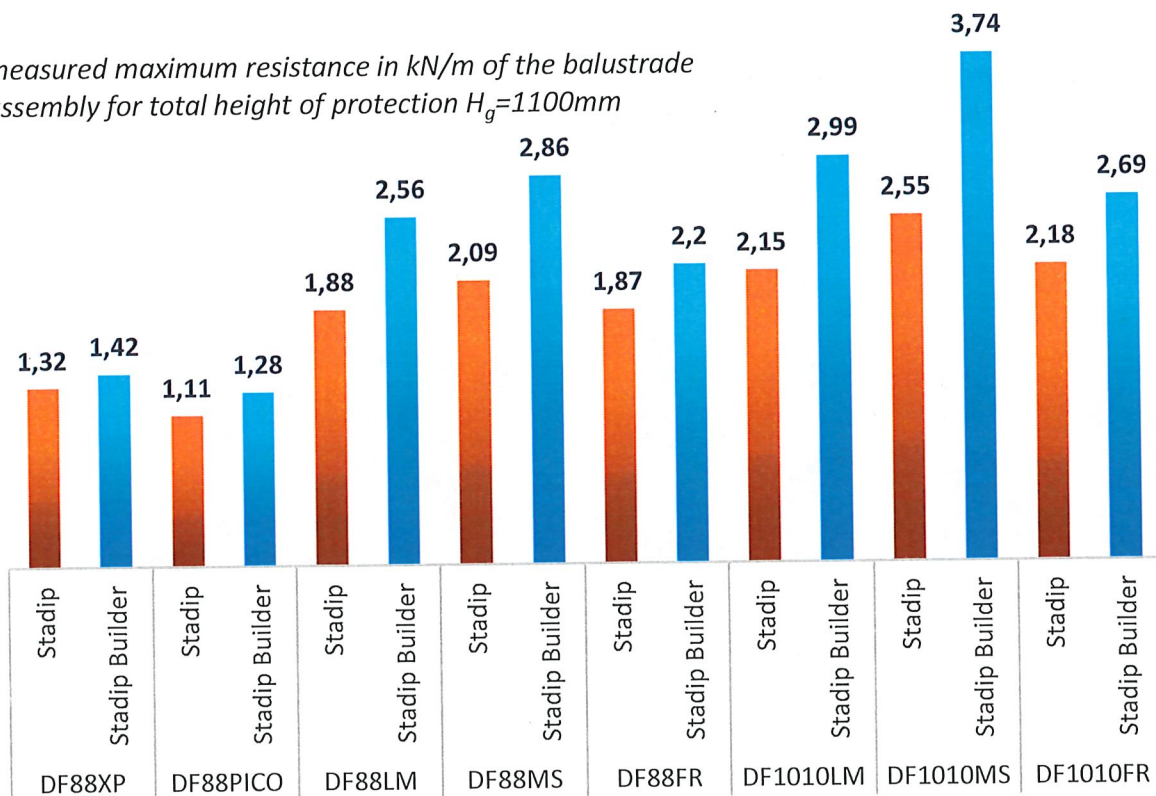
www.loglimassimo.it
www.saint-gobain.it

Results are consistent in the observation that, for the same boundary conditions provided by a given retaining system, STADIP BUILDER laminates maximum resistance is greater than STADIP laminates counterpart. Gain in resistance is 27% on average.

Tests for systems with 57mm high constraint over the glass laminates at the base (i.e. DF88XP and DF88PICO) show that the stiffness is about the same with different glass panes. The similar stiffness measured for both systems is likely to be attributed to the reduced capacity of small-height systems to provide a rigid constraint at the base of the glass pane. Furthermore, the database is believed to be too small for a definite assessment concerning the stiffness of these assemblies, signalling that further evaluations should to be performed if the deflection comparison is a parameter of interest.

Tests for systems with 95mm high constraint over the glass laminates at the base (i.e. DF88LM, DF88FR, DF88MS, DF1010LM, DF1010FR and DF1010MS) show that the stiffness is consistently greater with use of STADIP BUILDER products.

measured maximum resistance in kN/m of the balustrade assembly for total height of protection $H_g=1100mm$



Logli Massimo s.p.a.

Società a socio unico
 Sede legale: Via Giovanni Bensi, 8
 20152 Milano, Italia
 Tel. +39 02 42431
 Sede Operativa: Via Chemnitz, 49/51
 59100 Prato, Italia
 Tel. +39 0574 701035

Registro Imprese Milano Monza Brianza
 Lodi n. 02221630979
 R.E.A. MI - 2519149
 Capitale Sociale € 120.000,00 i.v.
 Codice Fiscale e P. IVA 02221630979
 loglimassimospa@legalmail.it

www.loglimassimo.it
www.saint-gobain.it

EVALUATION FOR HIGHER PROTECTION HEIGHT

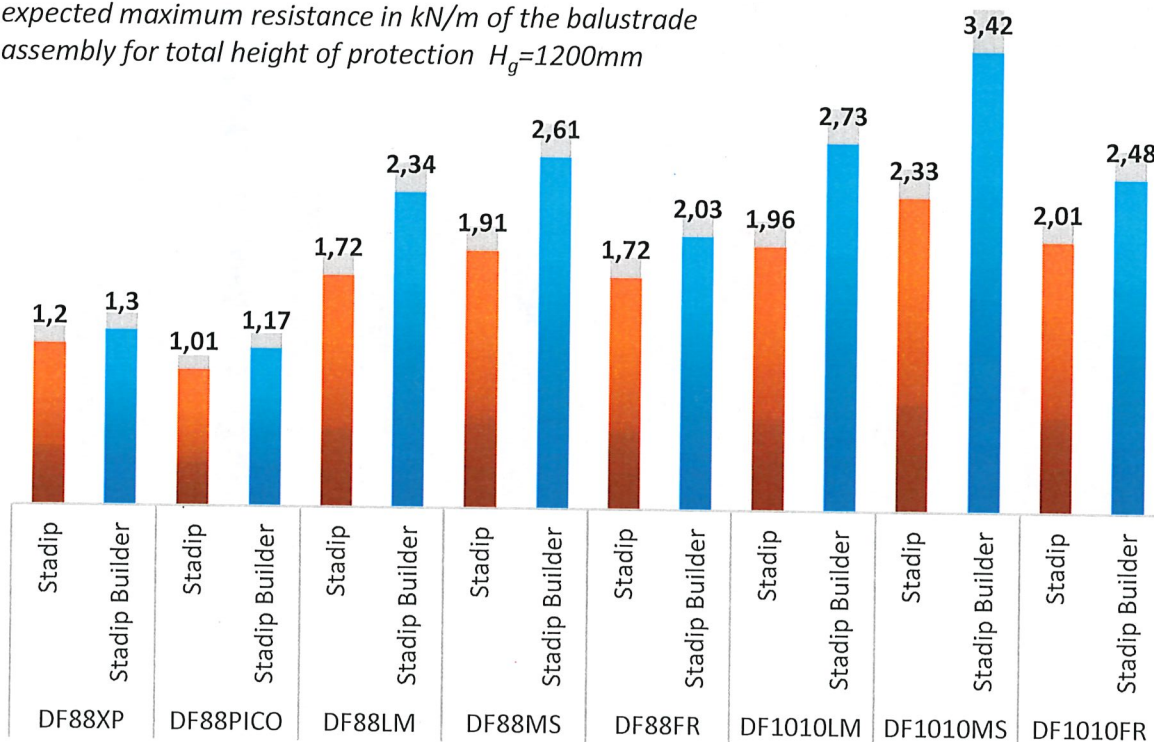
Based on direct experimental measurements, given the non-redundant cantilevered static scheme with which the glass is held in place, the way that the load is applied and the stress distributed, it is reasonable to extrapolate from direct evidence the expected maximum load-bearing capacity Q_U , had the installed glass panes been of a different height H_g , compared to tested height $H_{g,(H=1100mm)}$ given in Table 1:

$$Q_U(H_g) = Q_{U,(H=1100mm)} \frac{H_{g,(H=1100mm)}}{H_g}$$

It is recommended that this practice is limited to $900mm \leq H_g \leq 1200mm$ in order to obtain meaningful results.

In the noteworthy case of glass height H_g of 1200mm, expected results in terms of maximum load bearing capacity of the system limited by glass failure are as follows (light grey for reference of tested system original data):

expected maximum resistance in kN/m of the balustrade assembly for total height of protection $H_g=1200mm$



Logli Massimo s.p.a.

Società a socio unico
 Sede legale: Via Giovanni Bensi, 8
 20152 Milano, Italia
 Tel. +39 02 42431
 Sede Operativa: Via Chernitz, 49/51
 59100 Prato, Italia
 Tel. +39 0574 701035

Registro Imprese Milano Monza Brianza
 Lodi n. 02221630979
 R.E.A. MI - 2519149
 Capitale Sociale € 120.000,00 i.v.
 Codice Fiscale e P.IVA 02221630979
 loglimassimospa@legalmail.it

www.loglimassimo.it
www.saint-gobain.it