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Testing of Industrial Door panels

1. Test object

Panels for vertically moving Industrial doors equipped with FlexiForce hardware. The size of the fully assembled door was 4000 mm daylight width and 3500 mm daylight height for testing of wind load, air permeability and water penetration in an air chamber. The tests were performed in accordance with EN 13241-1 annex ZA.3 Initial type testing.

2. Date of testing

The testing was performed from 2005-02-29 to 2005-07-26. The panels were selected by the client without assistance from SP. The test result shown in this report refers only to the tested sample.

3. Testing

Following tests were performed: Resistance to wind load, determination of air permeability, determination of resistance to water penetration, dangerous substances and thermal resistance.

3.1 Resistance to wind load

3.1.1 Testing of fully assembled door

The door was fitted in the opening of an airtight chamber, with its exterior facing inwards towards the chamber and tested in accordance with *EN 12444 Resistance to wind load – testing and calculation*. Before the test steps were taken to eliminate air leakage in the door and its supporting construction. An inner air pressure was increased in steps in accordance with the different classes given in *EN 12424 Resistance to wind load – classification*. The air pressure was then increased until the door ruptured. The test was performed at ambient temperature.

3.1.2 Testing of door panels

Door panels were subjected to four-point bending tests in accordance with *EN 12444 Resistance to wind load – testing and calculation*. The loading points were symmetrical positioned in the test set-up. The distance between the loading points was half of the distance between the points of support. The applied load was increased in steps in accordance with the different classes given in *prEN 12424 Resistance to wind load – classification*. The test was performed at ambient temperature.

3.2 Determination of air permeability

The door was fitted in the opening of an airtight chamber, with its exterior facing inwards towards the chamber and tested in accordance with *EN 12427 Air permeability – test method*. The air leakage was measured at a positive air pressure of 50 Pa.

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3.3 Resistance to water penetration

The door was fitted in the opening of an airtight chamber, with its exterior facing inwards towards the chamber and tested in accordance with *EN 12489 Resistance to water penetration – test method*. Water was supplied through three horizontal rows of nozzles with ten nozzles in each.

3.4 Dangerous substances

The panels were examined in accordance with the requirements of the Construction Products Directive, CPD, (89/106/EEC). The interpretative Document Essential Requirements No 3 related to the CPD identifies aspects where hygiene, health and the environment may be concerned. Technical specifications are required to define release of pollutants to indoor air, outdoor air, soil and water, taking account of the concentration of pollutants in the products.

3.5 Thermal resistance

Calculation of the U-values of the door sections was performed using the FRAM 5.1 program. The tests were performed in heat-flow meter apparatus HFM2000 single specimen symmetrical configuration with double heat-flow meters.

4 Test result

4.1 Resistance to wind load

4.1.1 Test of fully assembled door

The inner pressure in the air chamber was increased in steps. Following doors were tested:

Table 1 Fully Assembled doors

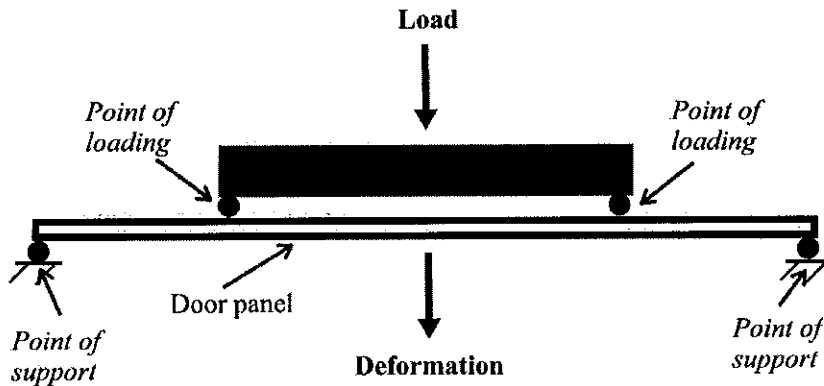
Door (panel) type	Width [m]	Height [m]	Wind load class	Maximum pressure [Pa]
Thyssen-Krupp-Hoech covered, non fingersafe	4.00	3.50	4	-
Thyssen-Krupp-Hoesch covered t=40 mm fingersafe	4.00	3.50	3	-

4.1.1.1 Measurement uncertainty wind load

The total calculated measurement uncertainty is for the wind load < 1.5% and for the deformations < 1.5%. Reported uncertainty corresponds to an approximate 95 % confidence interval around the measured value. The interval has been calculated in accordance with GUM (The ISO guide to the expression of uncertainty in measurements), which is normally accomplished by quadratic addition of the actual standard uncertainties and multiplication of the resulting combined standard uncertainty by the coverage factor $k=2$.

4.1.2 Bending test of door panels

The door panels were subjected to four-point bending tests in accordance with *prEN 12444 Resistance to wind load – testing and calculation*. The panels were supported and the load was applied as shown in Figure 1. The loading points were symmetrical positioned in the test set-up.



Schematic figure of test set-up

4.1.2.1 Results from four point bending test

Table 2 Description of Thyssen-Krupp-Hoesch door panels

Thyssen-Krupp-Hoesch a	4000*610*40, fingersafe
Thyssen-Krupp-Hoesch b	4000*610*40, fingersafe, 4 windows
Thyssen-Krupp-Hoesch c	6000*610*40, fingersafe
Thyssen-Krupp-Hoesch d	6000*610*40, fingersafe, 6 windows
Thyssen-Krupp-Hoesch e	7500*610*40, fingersafe, reinforcement profile 65S
Thyssen-Krupp-Hoesch f	8500*610*40, fingersafe, reinforcement profile 110S
Thyssen-Krupp-Hoesch g	7500*610*40, fingersafe, 7 windows, reinforcement profile 65S
Thyssen-Krupp-Hoesch h	8500*610*40, fingersafe, 8 windows, reinforcement profile 110S
Thyssen-Krupp-Hoesch i	4000*610*40
Thyssen-Krupp-Hoesch j	4000*610*40, 4 windows
Thyssen-Krupp-Hoesch k	6000*610*40
Thyssen-Krupp-Hoesch l	6000*610*40, 6 windows
Thyssen-Krupp-Hoesch m	7500*610*40, reinforcement profile 65S
Thyssen-Krupp-Hoesch n	8500*610*40, reinforcement profile 110S
Thyssen-Krupp-Hoesch o	7500*610*40, 7 windows, reinforcement profile 65S
Thyssen-Krupp-Hoesch p	8500*610*40, 8 windows, reinforcement profile 110S



Table 3 Summary of Thyssen-Krupp-Hoesch test results of resistance to wind load

Door panel	Wind load class		Maximum pressure [Pa]	Remarks/Fracture
		[Pa]		
Thyssen a	5	1094	1504	BoP at loading point
Thyssen b	3	-	1037	BoP at window 2
Thyssen c	2	-	705	BoP at loading point
Thyssen d	0	-	392	BoP at window 3
Thyssen e	2	-	809	BoP at loading point
Thyssen f	3	-	1050	BoP at loading point
Thyssen g	1	-	516	BoP at window 3
Thyssen h	2	-	834	BoP at window 4
Thyssen i	5	1242	1707	BoP at loading point
Thyssen j	2	-	871	BoP at windows 1,2,3
Thyssen k	2	-	673	BoP at loading point
Thyssen l	1	-	422	BoP at window 3
Thyssen m	2	-	808	BoP at loading point
Thyssen n	3	-	1198	BoP at loading point
Thyssen o	1	-	604	BoP at windows 3 and 4
Thyssen p	2	-	933	BoP at windows 3, 4, 5 and 6

BoP = Buckling of the panel

Wind load vs. displacement are shown in appendix 36.

4.1.2.2 Measurement uncertainty bend test

The total calculated measurement uncertainty is for the wind load < 1.5% and for the deformations < 1.5%. Reported uncertainty corresponds to an approximate 95 % confidence interval around the measured value. The interval has been calculated in accordance with GUM (The ISO guide to the expression of uncertainty in measurements), which is normally accomplished by quadratic addition of the actual standard uncertainties and multiplication of the resulting combined standard uncertainty by the coverage factor $k=2$.

4.2 Determination of air permeability

Table 4 Summary determination of air permeability

Door type	Width [m]	Height [m]	Air permeability class	See appendix No.
Thyssen-Krupp-Hoech covered, non fingersafe	4.00	3.50	4	24
Thyssen-Krupp-Hoesch covered t=40 mm fingersafe	4.00	3.50	4	25



4.3 Resistance to water penetration

Table 5 Summary resistance to water penetration

Door type	Width [m]	Height [m]	Water penetration class	See appendix No.
Thyssen-Krupp-Hoesch covered t=40 mm with All windows Cylinder lock no. F	4.00	3,50	3 (150 Pa) 0	23
Thyssen-Krupp-Hoesch covered, non fingersafe	4.00	3,50	2	24
Thyssen-Krupp-Hoesch covered t=40 mm fingersafe	4.00	3,50	3 (70 Pa)	25

4.4 Dangerous substances

Door components described in this report are made of material that complies with the Construction Products Directive (89/106/EEC).

4.5 Thermal resistance

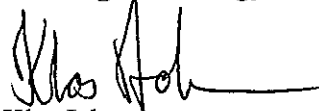
Calculations with an industrial door with width (W) = 8.50 m and height (H) 7.00 m;

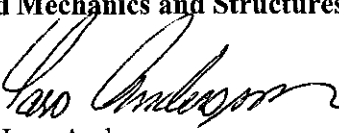
Table 6 Thermal resistance

Type of panels	Thermal transmittance, W/(m ² K)					
	p	pw	pd	pwd	g	gd
Thyssenkrupp Hoesch, fingersafe	1.2	1.2	1.3	1.3	-	-
Thyssenkrupp Hoesch, standard	1.0	1.0	1.1	1.1	-	-

- p = Door with covered panels only
- pw = covered panels with windows
- pd = covered panels with a pass door
- pwd = covered panels with windows and a pass door
- g = fully glazed door
- gd = glazed door with a pass door

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