REPORT

Contact person
Mats Axelson
Building Technology
+46 10 516 51 15
mats.axelson@sp.se

Date 2016-06-29
Reference 5P06979EN
Page 1 (10)

Bygg- och Miljöteknik GRANAB AB
att. Fredrik Blom
Box 172
447 24 VÅRGÅRDA

Load testing and testing of shock absorption and vertical deformation of test floors for sports purposes, round 2

General

Following from the results of SP Report 5P069079-A – Load testing and determination of shock absorption and vertical deformation of test floors for sports purposes, round 1 – round 2 involved testing two different designs of test floor with selected point-elastic mats. The point-elastic mats were conditioned in a boiler room to achieve a temperature in the range 23±2°C for testing ball bounce, vertical deformation and shock absorption.

The testing was carried out on 21–22/04/2016.

Table 1 Test floors and tests

Surface	Subfloor	Screws	Dampeners	Shock absorption	Load capacity
24 mm P30 Plywood	7000	150	2x12	x	x
22 mm + 22 mm Contifloor type P6	7000	150	2x12	x	x

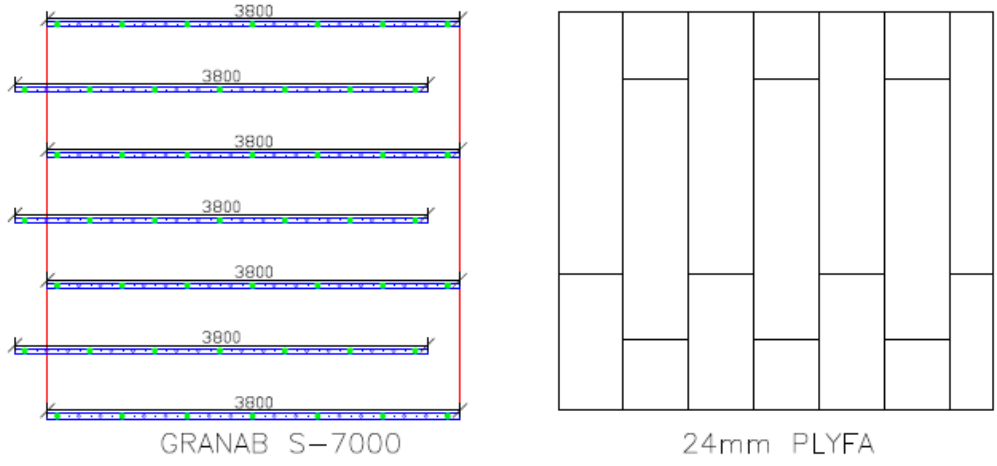

Figure 1 Floor battens with 24 mm P30 plywood. The tongue and groove boards are glued at all joints with Bostik Super 730 exterior wood glue and screwed and glued to the battens with Bostik Multifog 2640.

The boards were marked: CE 0402 CPD 169002 EN 13986 636-2 S E1 MOELVEN Vänerply 16 P30* CP C 24,0 2016-03-02 02.24

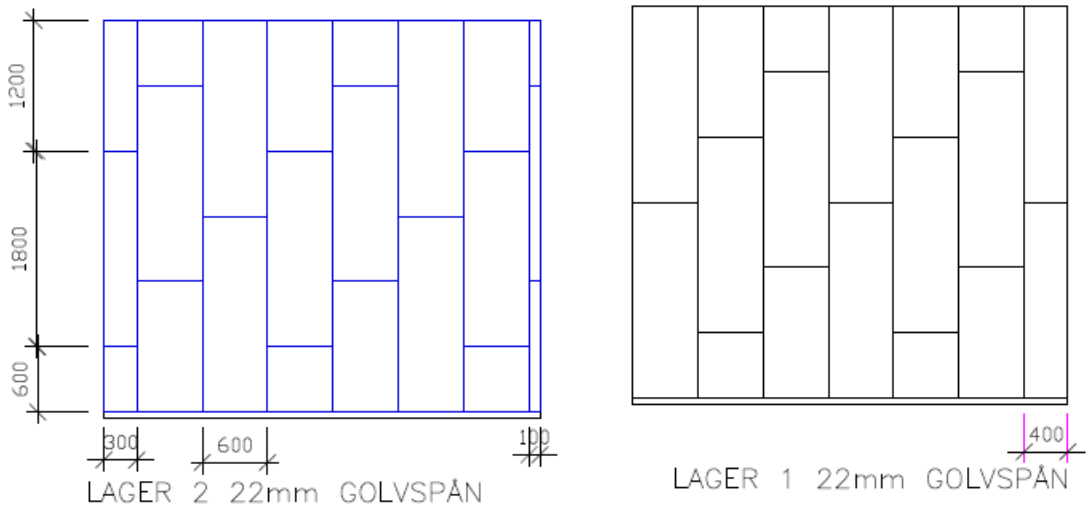

Figure 2 The batten positions and type are shown in figure 1. Floor has a double layer of Contifloor 22 mm boards. The long and short edges of the boards are glued with Bostik Super 730 exterior wood glue and are screwed and glued to the battens with Bostik Multifog 2640. Layer 2 was screwed to layer 1 with a longitudinal screw spacing of 600 mm and a transverse screw spacing of 300–400 mm.

The boards used in the tests were conditioned at 20 ±2°C and 65±5% RH in SP's conditioning room, then delivered to the test location at Granab's premises in Vårgårda for assembly around two days before testing.

The chipboard was marked: Denna sida ner (This side down) CE-0402-CPR-112012-Byggelit Sverige AB 14 160303 EN 13986 Flooring P6.

For details on the construction of the subfloor metal battens, see SP report 4P02040, dated 28/05/2014.

Table 2. Point-elastic mats that were available for testing were tested together with the floors.

Make	**Point-elastic classification according to EN 14808:2005**	**Nominal thickness [mm]**	**Test stage** **S**hock absorption/**D**eformation/**B**all bounce
Taraflex®t M Performance	P2	9	S/D/B
Taraflex® Sport M Evolution	P1	7	S/D/B
Omnisport Reference 6.5	P1	5	-
Omnisport Reference	P1	3	-
Velox Mondosport 3.5	P1	4	-

Shock absorption according to EN 14808

Table 3. Classification of relevant floor types for shock absorption according to EN 14808:2005 Surfaces for sports areas. Determination of shock absorption.

Class	Area-elastic %	Combi-elastic %
1	-	-
2	-	-
3	40 ≤ A <55	45 ≤ C <55
4	55 ≤ A <75	55 ≤ C <75

Results of tests on 24 mm plywood floor

Shock absorption testing according to EN 14808:2005

Table 4. Shock absorption of 24 mm P30 plywood, 2x12 mm dampeners, System 7000, 150 mm screws, Taraflex® 7 mm M Sport Evolution P1 mat.

Test point	Requirement level met by floor types %	Area-elastic	Combi-elastic
Point 1 long joint between battens	70	4	4
Point 2 long joint on batten	66	4	4
Point 3 short joint on batten	65	4	4
Average	**67**	**4**	**4**
Max.	**70**		
Min.	**65**		
Max. deviation from average	**3**		

It appears that class 4 could be met by Taraflex® 7 mm M Evolution P1 mat.

Table 5. Shock absorption of 24 mm P30 plywood, 2x12 mm dampeners, System 7000, 150 mm screws, Taraflex® 9 mm M Performance P2 mat.

Test point	Requirement level met by floor types %	Area-elastic	Combi-elastic
Point 1 middle of board	68	4	4
Point 2 middle of board over batten	66	4	4
Point 3 long joint between battens	71	4	4
Point 4 long joint on batten	67	4	4
Point 5 short joint on batten	66	4	4
Point 6 T-joint	66	4	4
Average	**67**	**4**	**4**
Max.	**71**		

Test point	Requirement level met by floor types %	Area-elastic	Combi-elastic
Min.	**66**		
Max. deviation from average	**4**		

It appears that class 4 could be met by Taraflex® 9 mm M Performance P1 mat.

Deformation according to EN 14809:2009

Table 6. Requirement levels for vertical deformation of relevant floor types according to EN 14809:2005 Surfaces for sports areas. Determination of vertical deformation.

Class	Area-elastic [mm]	Combi-elastic [mm]
1	-	-
2	-	-
3	$1.8 \leq A < 3.5$	$1.8 \leq K < 5.0$*
4	$2.3 \leq A < 5.0$	$2.3 \leq K < 5.0$*

*Requirement for point-elastic component $0.5 \leq Kp < 2.0$

Table 7. Deformation measurement for 24 mm P30 plywood, 2x12 mm dampeners, System 7000, 150 mm screws, Taraflex® 7 mm M Evolution mat.

Test point	Requirement level met by floor types [mm]	Area-elastic	Combi-elastic
Point 1 long joint between battens	4.1	4	4
Point 2 long joint on batten	2.7	4	4
Point 3 short joint on batten	2.7	4	4
Average	**3.1**	**4**	**4**
Max.	**4.1**		
Min.	**2.7**		
Max. deviation from average	**0.9**		

Table 8. Deformation measurement for 24 mm P30 plywood, 2x12 mm dampeners, System 7000, 150 mm screws, Taraflex® 9 mm M Performance mat.

Test point	[mm]	Requirement level met by floor types Area-elastic	Combi-elastic
Point 1 middle of board	3.3	4	4
Point 2 middle of board over batten	2.9	4	4
Point 3 long joint between battens	4.3	4	4
Point 4 long joint on batten	2.9		
Point 5 short joint on batten	3.0		
Point 6 T-joint	2.9		
Average	**3.2**	**4**	**4**
Max.	**4.3**		
Min.	**2.9**		
Max. deviation from average	**1.1**		

Ball bounce according to EN 12235:2013

Table 9. Ball bounce calibration on concrete, on location.

Test	Ball bounce [m]
1	1.05
2	1.04
3	1.05
4	1.04
5	1.05
Average	**1.05**

Table 10. Ball bounce, 24 mm P30 plywood, 2x12 mm dampeners, System 7000, 150 mm screws, Taraflex® 7 mm M Sport Evolution P1 mat.

Test	Ball bounce [m]	Ball bounce [%]
1	0.90	86.2
2	0.86	81.9
3	0.90	86.2
4	0.90	85.8
5	0.90	85.8
	Average	**85**

The ball bounce does not meet the requirement of $\geq$ 90%. The combination with P2 mat cannot meet this requirement either, so the alternatives with 24 mm P30 plywood were excluded for sports floors.

Results of testing with 2x22 mm Contifloor chipboard boards

Shock absorption testing according to EN 14808:2005

Table 11. Shock absorption of 2x22 mm Contifloor chipboard, 2x12 mm dampeners, System 7000, 150 mm screws, Taraflex® 7 mm M Sport Evolution P1 mat.

	Requirement level met by floor types		
Test point	**%**	**Area-elastic**	**Combi-elastic**
Point 1 middle of board	59	4	4
Point 2 middle of board over batten	54	3	3
Point 3 long joint between battens	62	4	4
Point 4 long joint on batten	59	4	4
Point 5 short joint on batten	57	4	4
Point 6 T-joint	55	4	4
Average	**58**	**4**	**4**
Max.	**62**		
Min.	**54**		
Max. deviation from average	**5**		

Table 12. Shock absorption of 2x22 mm Contifloor chipboard, 2x12 mm dampeners, System 7000, 150 mm screws, Taraflex® 9 mm M Performance P2 mat.

	Requirement level met by floor types		
Test point	**%**	**Area-elastic**	**Combi-elastic**
Point 1 middle of board	60	4	4
Point 2 middle of board over batten	56	4	4
Point 3 long joint between battens	63	4	4
Point 4 long joint on batten	60	4	4
Point 5 short joint on batten	58	4	4
Point 6 T-joint	57	4	4
Average	**59**	**4**	**4**
Max.	**63**		
Min.	**56**		
Max. deviation from average	**4**		

Table 13. Deformation measurement for 2x22 mm Contifloor chipboard, 2x12 mm dampeners, System 7000, 150 mm screws, Taraflex® 7 mm M Performance mat.

Test point	Requirement level met by floor types [mm]	Area-elastic	Combi-elastic
Point 1 middle of board	2.3	4	4
Point 2 middle of board long joint below	2.3	4	4
Point 3 long joint top board	2.6	4	4
Point 4 short joint between screws	2.4	4	4
Point 5 Short joint on screws	2.3	4	4
Point 6 T-joint bottom board	2.1	4	4
Average	**2.4**	**4**	**4**
Max.	**2.6**		
Min.	**2.1**		
Max. deviation from average	**0.3**		

Table 14. Deformation measurement for 2x22 mm Contifloor chipboard, 2x12 mm dampeners, System 7000, 150 mm screws, Taraflex® 9 mm M Performance mat.

Test point	Requirement level met by floor types [mm]	Area-elastic	Combi-elastic
Point 1 middle of board	2.6	4	4
Point 2 middle of board long joint below	2.6	4	4
Point 3 long joint top board	2.9	4	4
Point 4 short joint between screws	2.6	4	4
Point 5 Short joint on screws	2.6	4	4
Point 6 T-joint bottom board	2.4	4	4
Average	**2.6**	**4**	**4**
Max.	**2.9**		
Min.	**2.4**		
Max. deviation from average	**0.3**		

Ball bounce according to EN 12235:2013

Table 15. Ball bounce on 2x22 mm Contifloor chipboard, 2x12 mm dampeners, System 7000, 150 mm screws, Taraflex® 7 mm M Sport Evolution P1 mat.

Test point	[m]	[%]
Point 1 middle of board	0.99	95
Point 2 middle of board long joint	0.99	94

Test point	[m]	[%]
below		
Point 3 long joint top board	0.98	93
Point 4 short joint between screws	0.96	92
Point 5 Short joint on screws	0.96	92
Average		**93**
Max.		**95**
Min.		**92**
Max. deviation from average		**2**

Table 16. Ball bounce on 2x12 mm Contifloor chipboard, 2x12 mm dampeners, System 7000, 150 mm screws, Taraflex® 9 mm M Performance P2 mat.

Test point	[m]	[%]
Point 1 middle of board	0.97	93
Point 2 middle of board long joint below	1.00	95
Point 3 long joint top board	0.98	94
Point 4 short joint between screws	0.96	92
Point 5 Short joint on screws	0.98	94
Average		**93**
Max.		**95**
Min.		**92**
Max. deviation from average		**2**

Summary of shock absorption, deformation and ball bounce

2x22 mm Contifloor with types P1 and P2 mats meet the classification requirements for type A area-elastic and type C combi-elastic sports floors and the ball bounce requirement for sports floors in accordance with EN 14904:2006.

The mats that were used are CE marked according to EN 14904:2006.

Appendix 1 is a separate report from testing of shock absorption, deformation and ball bounce.

Results from failure load testing.

Load testing was only carried out on flooring constructed with 2 x 22 mm Contifloor. Testing was carried out with a point load with a load area of 50 x 50 mm^2 over a load duration of around five minutes until failure. The requirement levels were calculated as follows, based on Eurocodes design rules, as applied by the Swedish National Board of Housing, Building and Planning, for premises in category C4: Areas with possible physical activities, e.g. dance halls, gymnastic rooms, stages; and category C5: Areas susceptible to large crowds, e.g. in buildings for public events like concert halls, sports halls including stands, terraces and access areas and railway platforms:

Required values to be achieved when testing chipboard between battens can be estimated as follows:

$$F_{\max 0.05} = \gamma_d \cdot \gamma_M \cdot \gamma_Q \cdot \frac{Q_k}{k_{\mathrm{mod}}} = 0.83 \cdot 1.3 \cdot 1.5 \cdot \frac{4}{0.70} = 9.25$$

For category C4: 9.25 kN; and for category C5: 10.40 kN.

γ_d is the partial coefficient for the safety class. In this case 0.83 for safety class 1.

γ_M is the partial coefficient for the material. In this case 1.3. For the load on battens over screws, a geometric average value is obtained from:

γ_Q is the partial coefficient for loading to failure. In this case 1.5 for safety class 1.

Q_k is the typical point load for the premises category. In this case 4.0 for premises in category 4, and 4.5 for premises in category 5.

k_{mod} is the partial coefficient for load duration and climate class. In this case 0.70, according to Eurocode 199.5-1-1:2004 for chipboard type P6.

For points where several different materials act together, the partial coefficient for the material and the load duration and climate class are estimated by applying a geometric average value.

For loads over battens covered by board and supported by sheet steel dampeners and screws, the following assessment is made:

$$\gamma_M = \sqrt[4]{1.3 \cdot 1.1 \cdot 1.1 \cdot 1.1} = 1.15$$

$$k_{\mathrm{mod}} = \sqrt[4]{0.7 \cdot 1.0 \cdot 0.3 \cdot 0.3} = 0.5$$

The required values to be achieved when testing chipboard on battens above screws can be estimated at:

$F_{\max 0.05} = \gamma_d \cdot \gamma_M \cdot \gamma_Q \cdot \frac{Q_k}{k_{\mathrm{mod}}} = 0.83 \cdot 1.15 \cdot 1.5 \cdot \frac{4}{0.5} = 11.45$ kN for premises in category C4, and 12.88 kN for premises in category C5

Table 17. Load testing on 2x22 mm Contifloor. Load between battens over long joints in top layer.

Test point	Max. load [kN]	Deformation at max. load [mm]	Remarks
	12.65	36.48	punching failure
	12.3	28.39	”-”
	12.3	33.13	”-”
Average value	12.42	32.67	
Stand. dev.	0.20	4.06	
CoV	0.02	0.12	
Typical $F_{max0.05}$	11.78		

The value of the load between battens exceeds the calculated requirement value for premises in categories C4 and C5.

Table 18. Load testing on 2x22 mm Contifloor. Load over battens, T-joints in top layer and above screws.

Test point	Failure load [kN]	Deformation at max. load [mm]	Remarks
	18.5	23.58	limit of load-testing rig, no failure
	19.2	20.32	”-”
	18.9	21.02	”-”
Average value	18.9	21.64	
Stand. dev.	0.35	1.72	
CoV	0.02	0.08	
Typical $F_{max0.05}$	17.69		

The value of the load reached during testing exceeds the calculated requirement value for premises in categories C4 and C5. The failure load is probably even higher.

A load was applied between battens in the middle of a board in the top layer and above a long joint in the bottom layer. The failure load was measured at 13.8 kN in punching failure mode. The load reached is similar to the loads measured in table 15.

Summary of floor tests in round 2

A floor built using Granab’s system 7000, with battens at 600 mm centres, 150 mm screws at 600 mm centres, 2x12 mm dampeners and 2x22 mm Contifloor, laid as shown in figure 2 in this report, and covered with Taraflex® 7 mm M Sport Evolution P1 or Taraflex® 9 mm M Performance P2 mats, meets the requirements for floors for sports purposes. The mats must be CE marked in accordance with EN 14904:2006.

This is a translation from the Swedish original document. In the event of any dispute as to the content of the document, the Swedish text shall take precedence.

SP Technical Research Institute of Sweden
Building Technology - Wood Building Technology

Performed by

Signed by: Mats Axelson
Reason: I am the author of this document
Date & Time: 2017-02-13 16:40:08 +01:00

Mats Axelson

Examined by

Signed by: Karin Sandberg
Reason: I am the author of this document
Date & Time: 2017-02-15 13:29:42 +01:00

Karin Sandberg