

FOREST project
Physical and Mechanical Properties of Densified Veneer Wood
for Structural Applications

Part 2.2a

Embedding Strength of Densified Veneer Wood
for Dowel-type Fasteners

Report prepared by

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Embedding Strength of Densified Veneer Wood for Dowel-type Fasteners

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1 Introduction

The embedding strength of wood-based materials is a governing property for determining the load-carrying capacities of joints with dowel-type fasteners. The embedding strength depends on the type of fastener, the manufacturing of the joint and quality of the wood-based materials. Thus, the embedding strength is not a special material property, but a system property.

Many research work has been done to describe this property and to collect sufficient test data. The test methods used differed, however, in many cases significantly so that the results can not be compared without any reservation. It was therefore an important task of the responsible European standardization committee to produce a test standard. A proposal was presented by the CEN - TC 124 as prEN 383 "Timber Structures - Test Methods - Determination of Embedding Strength and Foundation Values for Dowel-type Fasteners".

The embedding strength of densified veneer wood (dvw) made of beech, poplar and maritime pine compressed to different densities was tested in line with the main principles of this European proposal of a harmonized test method. The tests were made under two angles between load direction and grain direction of the face ply using dowel-type fasteners with diameter of 17 mm.

2 Test method

In prEN 383 the embedding strength is defined as the average compressive stress at maximum load in a specimen of timber or wood-based sheet product under the action of a stiff linear fastener with the fastener's axis perpendicular to the surface of the specimen. The fastener itself is loaded perpendicular to its axis. For wood based sheet products, the thickness of the specimen shall correspond to the full thickness of the panel. The dimensions of the specimens for testing the embedding strength are shown in Fig. 1. The loading may be in compression (Fig. 1a) or tension (Fig. 1b). When performing tests under compression, the value of l_1 (see prEN 383) was reduced from $7d$ to $3d$, because there are no splitting effects in this material. The maximum load, F_{\max} and the embedding strength derived from F_{\max} is defined as the maximum load or embedding strength before the deformation of the specimen has reached a limit of 5 mm. Fig. 2 and Fig. 3 show the test set-up.

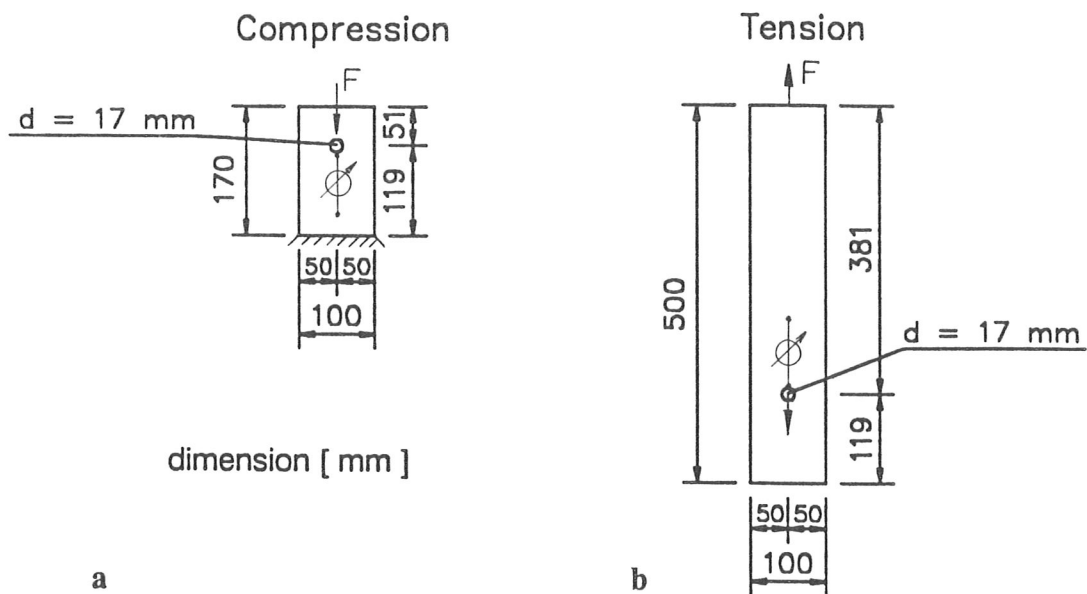


Figure 1: Test specimen

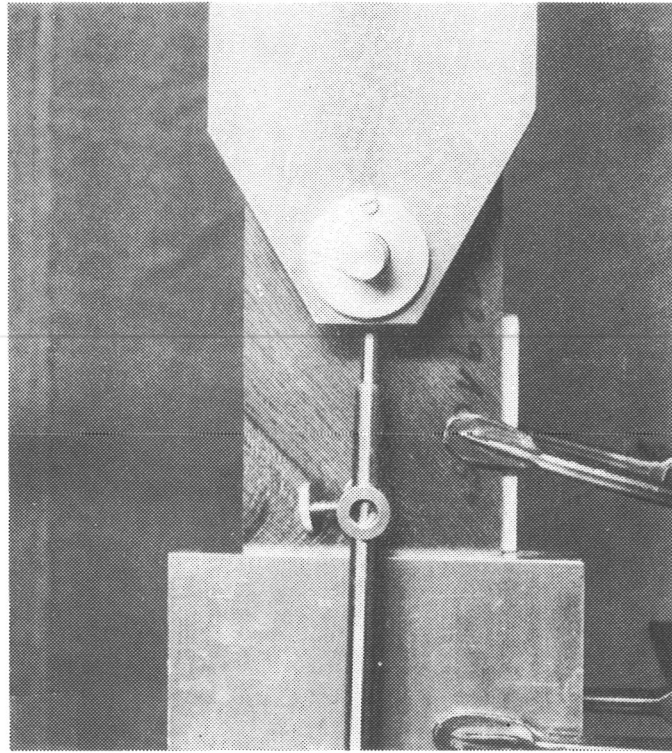


Figure 2: Test set-up and specimen loaded in compression

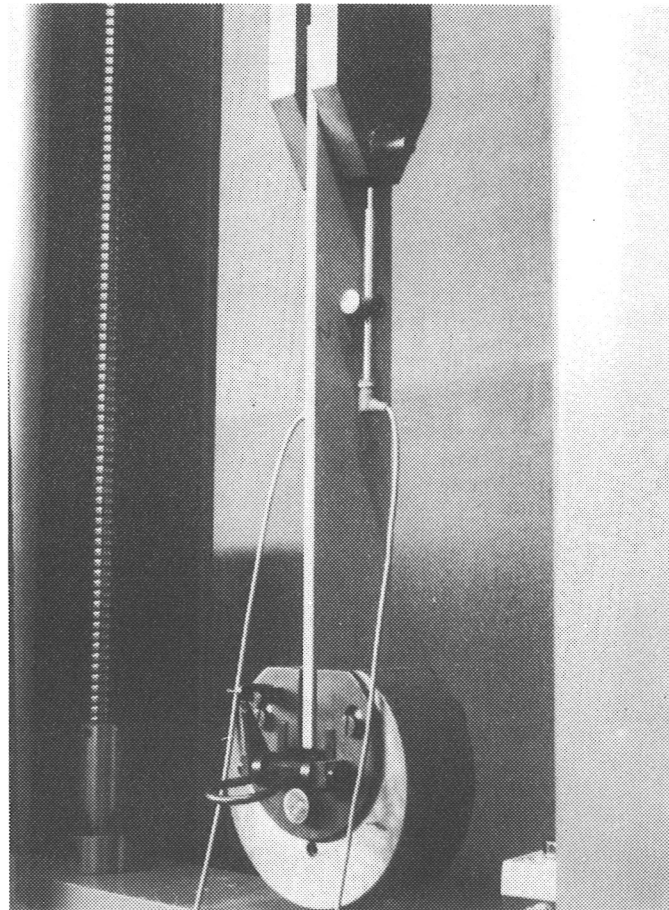


Figure 3: Test set-up and specimen loaded in tension

For the densified veneer wood made of beech, poplar and maritime pine in total 216 tests were carried out under compression (C) and tension (T) load with a dowel diameter of 17 mm. The panels were loaded at an angle of $0^\circ/90^\circ$ and 45° between the load direction and grain direction of the face ply. The veneers of some panels were not balanced; therefore, the load - grain angle on one side was 0° and on the other side 90° . For structural use the densified veneer wood should be balanced. **Fig. 4** shows the cutting schedule of the panels and the numbering of the specimens. From one panel 18 specimens were cut. The panel thickness and the density of all specimen were determined. The panels with the following numbers were tested:

dvw made of beech	B2, B5, B12 and B13
dvw made of poplar	P1, P3, P5 and P7
dvw made of maritime pine	M1, M2, M7 and M8

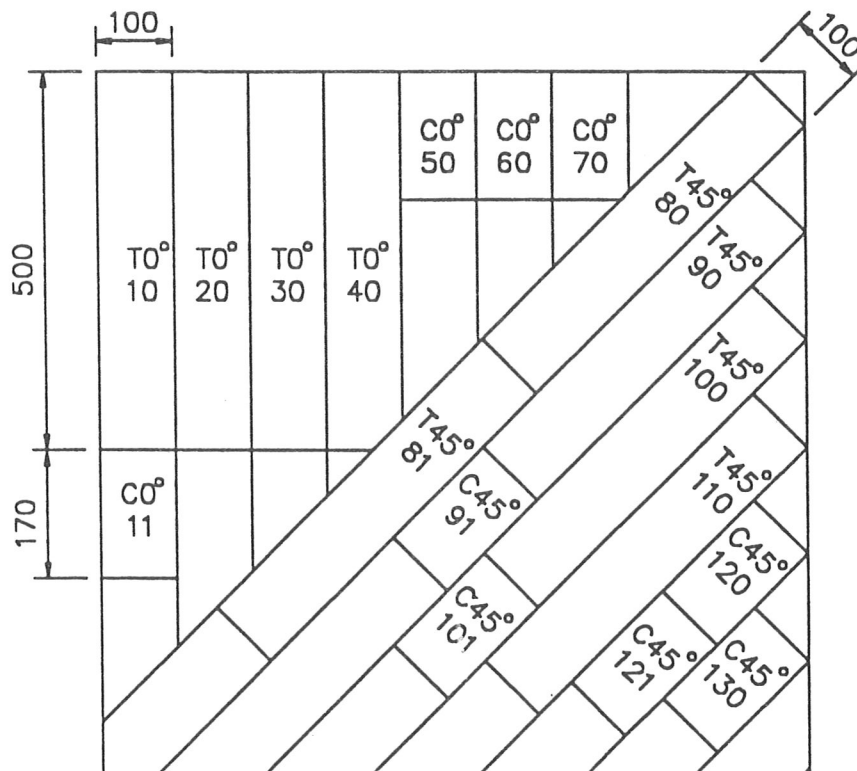


Figure 4: Cutting schedule of the panels

3 Test results

The load-deformation curves of all test are given in **Annex 1 - 24**. These curves indicate an elastic behaviour up to a certain proportional limit followed by a plastic deformation. After buckling of the outer veneers the load decreases. The results of all embedding tests are given in **Annex 25 - 36**.

From the load-deformation curves the deformation and foundation values are evaluated as follows:

initial deformation	w_i	$= w_{04}$
modified initial deformation	$w_{i,mod}$	$= \frac{4}{3} \cdot (w_{04} - w_{01})$
elastic deformation	w_e	$= \frac{2}{3} \cdot (w_{14} + w_{24} - w_{11} - w_{21})$
deformation at $0,6 \cdot F_{max}$	$w_{0,6}$	
deformation at $0,8 \cdot F_{max}$	$w_{0,8}$	
initial foundation modulus	K_i	$= \frac{0,4 \cdot f_{h,est}}{w_i}$
foundation modulus	K_s	$= \frac{0,4 \cdot f_{h,est}}{w_{i,mod}}$
elastic foundation modulus	K_e	$= \frac{0,4 \cdot f_{h,est}}{w_e}$

The deformation values w_{01} , w_{11} , w_{04} , w_{14} and w_{24} are those measured at the appertaining loading points as given in prEN 383 and $f_{h,est}$ is the estimated embedding strength calculated with the following formula:

$$f_{h,est} = \frac{F_{max,est}}{d \cdot t}$$

The deformation and foundation values are listed in **Annex 37 - 48**.

The test results are summarized in **Table 1 - 3**. In these tables are given the panel thickness, the mean values and the coefficients of variation of the densities of the specimens as well as the mean values of the embedding strengths and their coefficients of variation.

Table 1: Results of the embedding tests with densified veneer wood made of beech for dowel-type fasteners with $d = 17$ mm
(Mean values and coefficients of variation of four or five tests)

Panel	Kind of loading	Load-grain angle α (°)	Panel thickness t (mm)	Mean density ρ (kg/m ³)	Coefficient of variation (density) (%)	Mean embedding strength f_h (N/mm ²)	Coefficient of variation (f_h) (%)
B2	comp.	0°/90°	8,8	1186	5,34	124	6,48
	comp.	45°	8,7	1198	1,34	129	2,24
	tension	0°/90°	8,5	1176	4,55	120	2,09
	tension	45°	8,6	1216	6,09	124	5,10
Mean			8,6	1196	4,43	124	4,71
B5	comp.	0°/90°	7,0	1196	2,20	118	3,42
	comp.	45°	6,7	1237	1,59	130	1,59
	tension	0°/90°	7,0	1185	2,17	111	4,77
	tension	45°	6,8	1228	2,79	121	3,06
Mean			6,9	1214	2,73	121	6,63
B12	comp.	0°/90°	7,2	1180	3,39	113	6,30
	comp.	45°	7,4	1166	2,88	117	9,75
	tension	0°/90°	7,1	1264	3,33	111	2,88
	tension	45°	7,4	1154	1,22	112	6,12
Mean			7,3	1187	4,27	114	6,68
B13	comp.	0°/90°	7,5	1392	1,66	168	4,18
	comp.	45°	7,5	1365	2,53	165	2,33
	tension	0°/90°	7,6	1387	1,37	148	4,84
	tension	45°	7,7	1366	1,91	163	3,82
Mean			7,6	1376	1,99	161	5,92

Table 2: Results of the embedding tests with densified veneer wood made of poplar for dowel-type fasteners with $d = 17$ mm
(Mean values and coefficients of variation of four or five tests)

Panel	Kind of loading	Load-grain angle α (°)	Panel thickness t (mm)	Mean density ρ (kg/m ³)	Coefficient of variation (density) (%)	Mean embedding strength f_h (N/mm ²)	Coefficient of variation (f_h) (%)
P1	comp.	0°/90°	7,7	1145	1,49	113	8,14
	comp.	45°	7,0	1236	1,38	126	3,88
	tension	0°/90°	7,3	132	4,05	115	6,07
	tension	45°	7,0	1270	1,47	121	3,15
Mean			7,2	1225	4,31	119	6,45
P3	comp.	0°/90°	7,9	1210	2,17	117	5,71
	comp.	45°	7,7	1236	2,57	130	5,21
	tension	0°/90°	7,7	1222	0,75	111	2,89
	tension	45°	7,6	1237	1,73	125	7,10
Mean			7,7	1227	2,01	121	7,99
P5	comp.	0°/90°	9,0	1281	1,97	129	1,62
	comp.	45°	9,2	1210	2,25	125	5,40
	tension	0°/90°	8,9	1257	2,08	124	2,87
	tension	45°	9,3	1201	1,13	121	5,60
Mean			9,1	1234	3,20	124	4,57
P7	comp.	0°/90°	7,0	1259	4,47	126	10,5
	comp.	45°	7,2	1241	2,00	127	2,39
	tension	0°/90°	7,0	1218	1,49	107	0,90
	tension	45°	7,1	1241	1,39	123	2,99
Mean			7,1	1240	2,60	121	8,36

Table 3: Results of the embedding tests with densified veneer wood made of maritime pine for dowel-type fasteners with $d = 17$ mm
(Mean values and coefficients of variation of four or five tests)

Panel	Kind of loading	Load-grain angle α (°)	Panel thickness t (mm)	Mean density ρ (kg/m ³)	Coefficient of variation (density) (%)	Mean embedding strength f_h (N/mm ²)	Coefficient of variation (f_h) (%)
M1	comp. comp.	0°/90°	8,1	1271	6,89	126	9,75
		45°	8,3	1220	1,51	120	5,30
	tension tension	0°/90°	8,5	1190	0,82	116	5,94
		45°	8,4	1210	2,16	121	4,25
Mean			8,3	1223	4,07	120	6,55
M2	comp. comp.	0°/90°	7,0	1202	3,95	116	8,09
		45°	7,2	1171	2,52	112	6,20
	tension tension	0°/90°	6,9	1208	4,23	111	11,0
		45°	7,2	1143	2,98	120	9,96
Mean			7,1	1178	3,85	115	8,79
M7	comp. comp.	0°/90°	7,5	1306	1,61	115	6,07
		45°	7,5	1358	2,22	122	5,90
	tension tension	0°/90°	7,5	1349	1,34	117	6,91
		45°	7,6	1348	1,81	126	7,07
Mean			7,5	1342	2,23	120	6,90
M8	comp. comp.	0°/90°	7,2	1163	2,45	104	6,74
		45°	7,0	1211	2,65	118	5,45
	tension tension	0°/90°	7,0	1234	3,79	117	4,46
		45°	7,0	1217	1,40	121	4,83
Mean			7,1	1207	3,20	115	7,51

4 Conclusions

From the test data the following may be argued:

- *Signification of tension and compression tests*

Due to the fact that both tension and compression tests are considered in prEN 383 it was important to perform tests with both kinds of loading. The embedding strength of dw under compression loading and under tension loading turned out to be approximately the same. The ratio $f_{h,tension}/f_{h,comp}$ ranges between 0,88 and 1,13 (mean value 0,98).

- *Influence of angle between load and grain direction of the face ply*

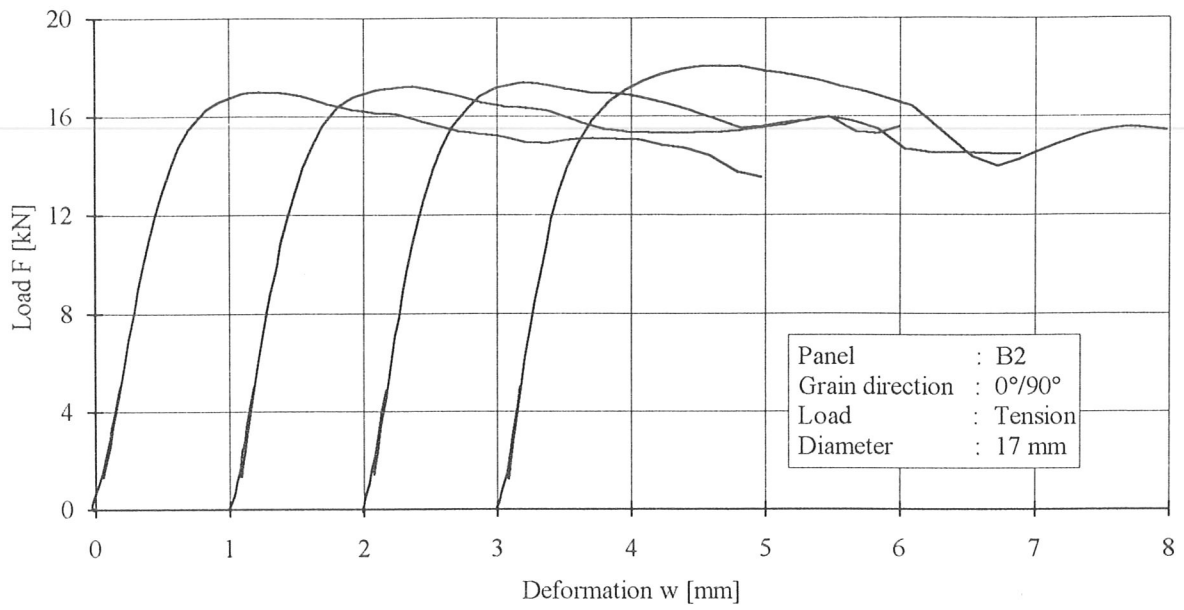
The embedding strength under an angle of 45° between load direction and grain direction of the face ply is about 5 % higher than under an angle of 0°/90°. This effect should, however, not be taken into account for structural use of densified veneer wood.

- *Influence of density*

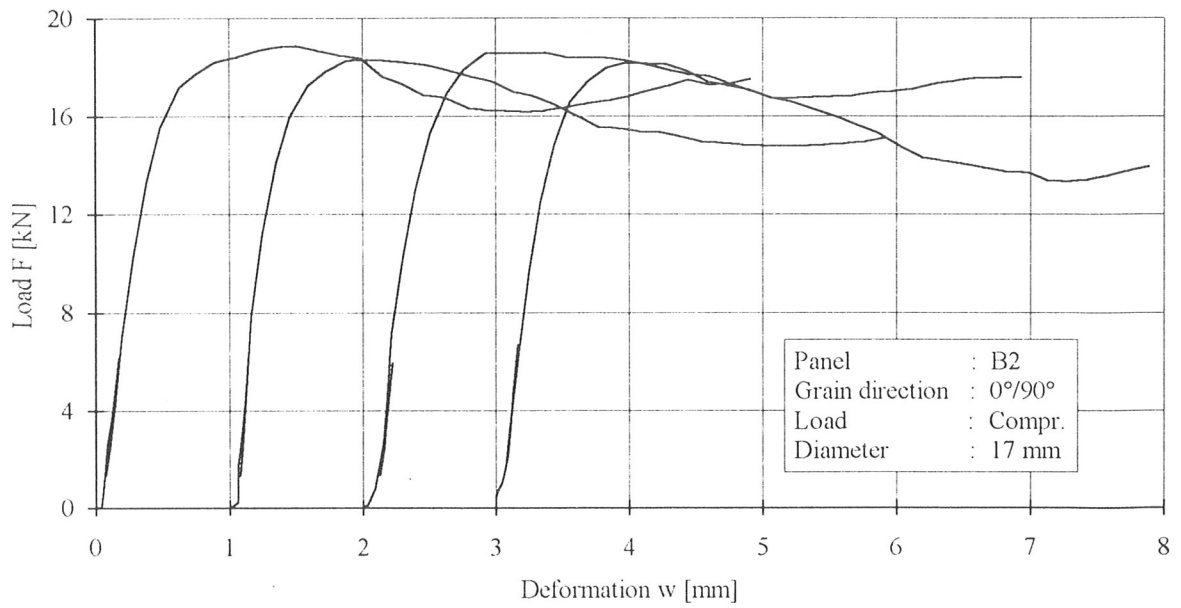
The embedding strength may be assumed to increase linearly with increasing density of the dw independent of the wood species. **Table 4** shows the mean values and the coefficient of variation of the ratios of f_h/ρ for the different dw.

Table 4: Ratio f_h/ρ of the embedding tests with densified veneer wood for dowel-type fasteners with $d = 17$ mm

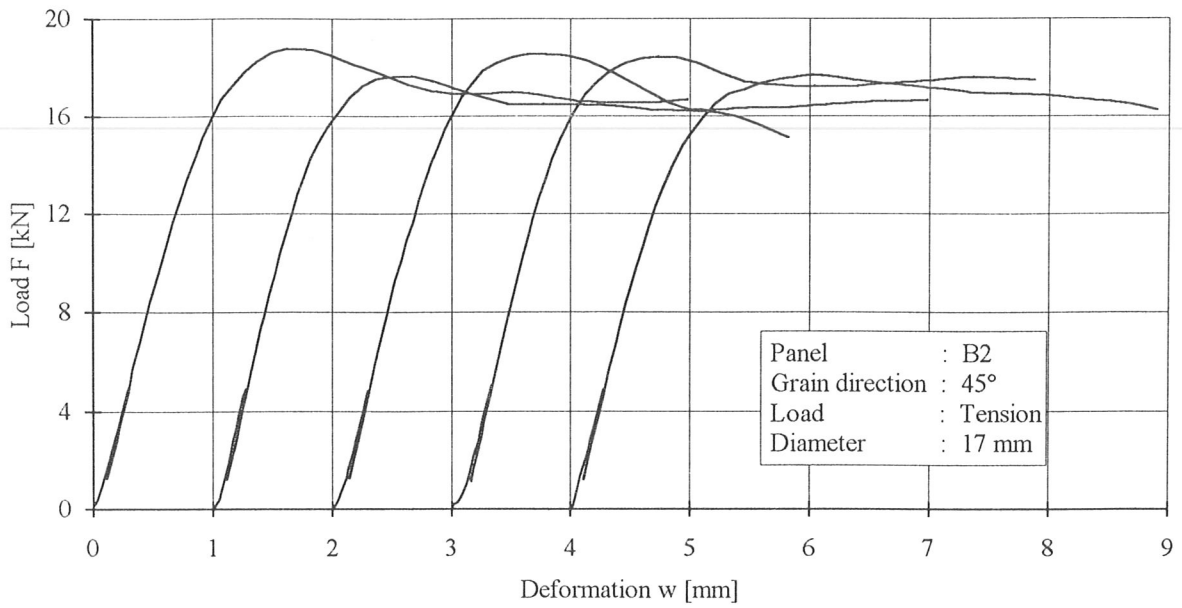
Panel material	Number of tests	Load-grain angle α (°)	Mean density ρ (kg/m ³)	Coefficient of variation (density) (%)	Mean ratio $\frac{f_h}{\rho}$ ($\frac{N m^3}{mm^2 kg}$)	Coefficient of variation ($\frac{f_h}{\rho}$) (%)
Beech	32	0°/90°	1246	8,65	0,101	10,2
	40	45°	1241	6,79	0,106	9,06
Poplar	32	0°/90°	1228	3,95	0,096	6,19
	40	45°	1234	2,28	0,101	4,32
Maritime pine	32	0°/90°	1240	5,83	0,093	7,20
	40	45°	1235	6,30	0,097	6,81



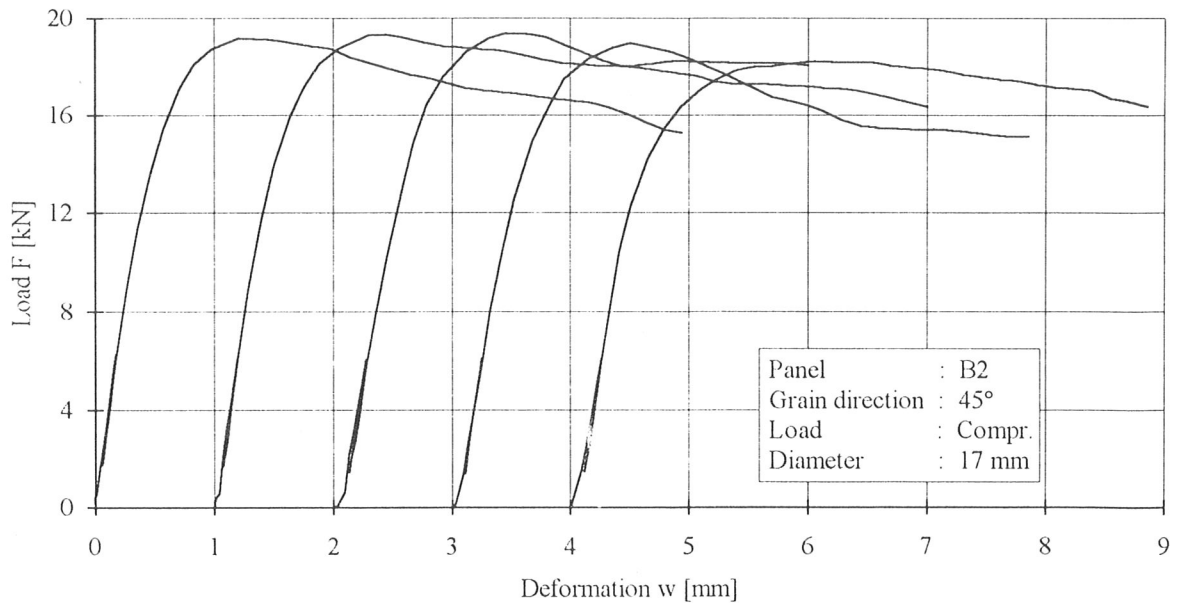
Load-deformation curves (B2/T0°)



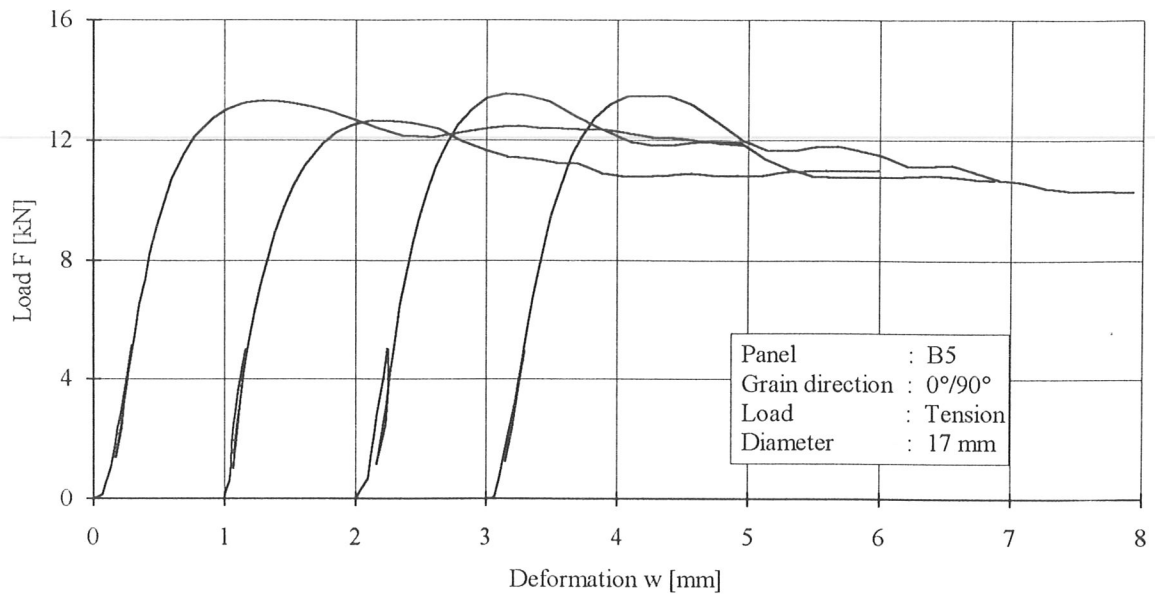
Load-deformation curves (B2/C0°)



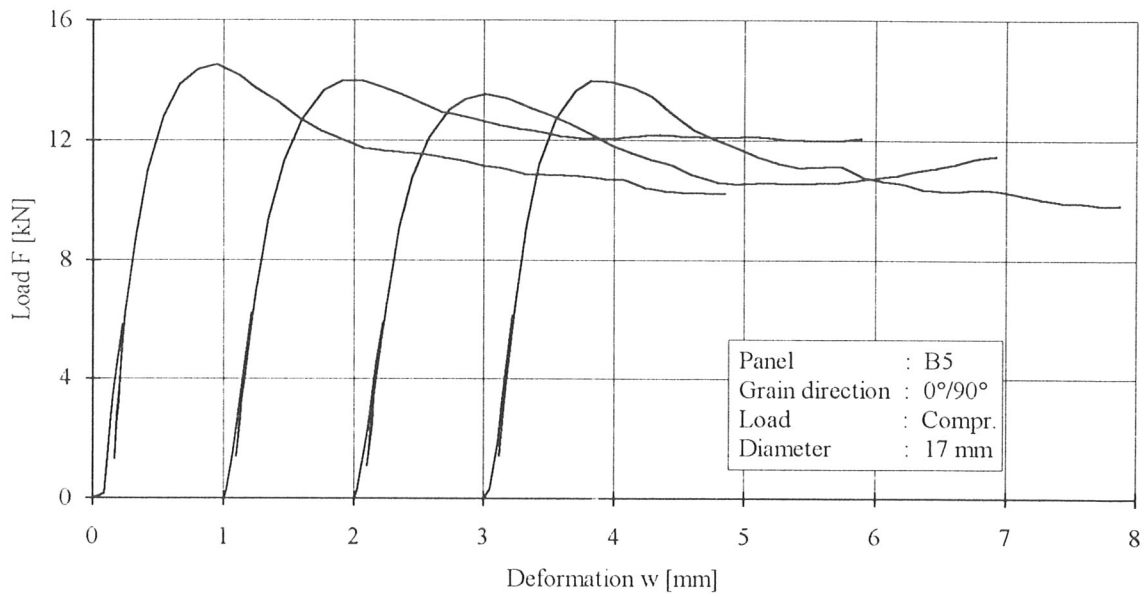
Load-deformation curves (B2/T45°)



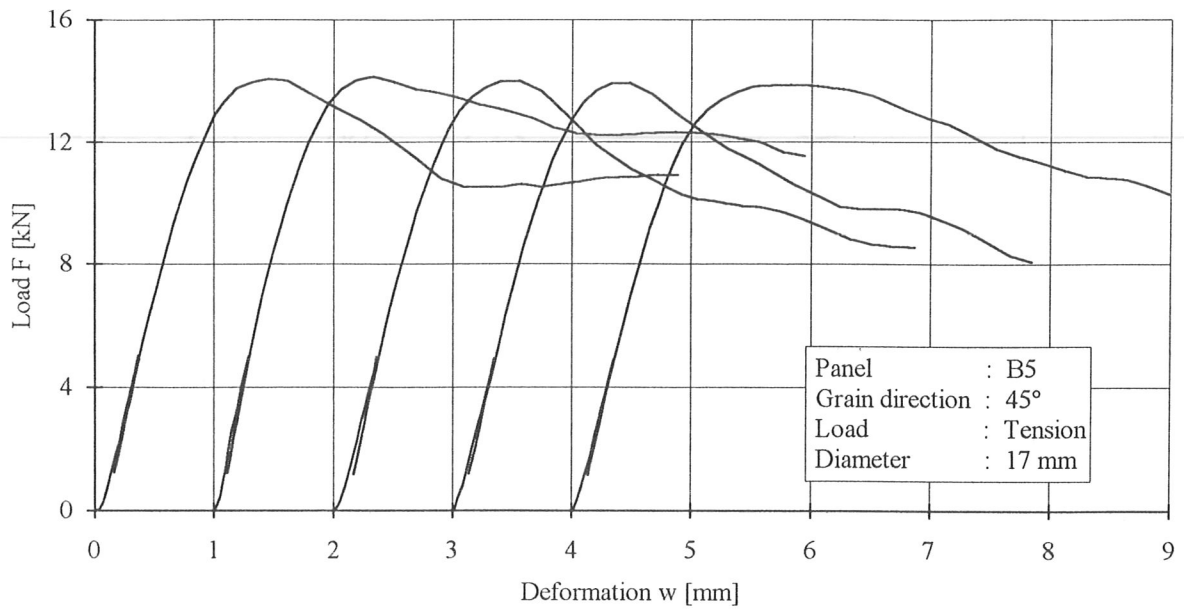
Load-deformation curves (B2/C45°)



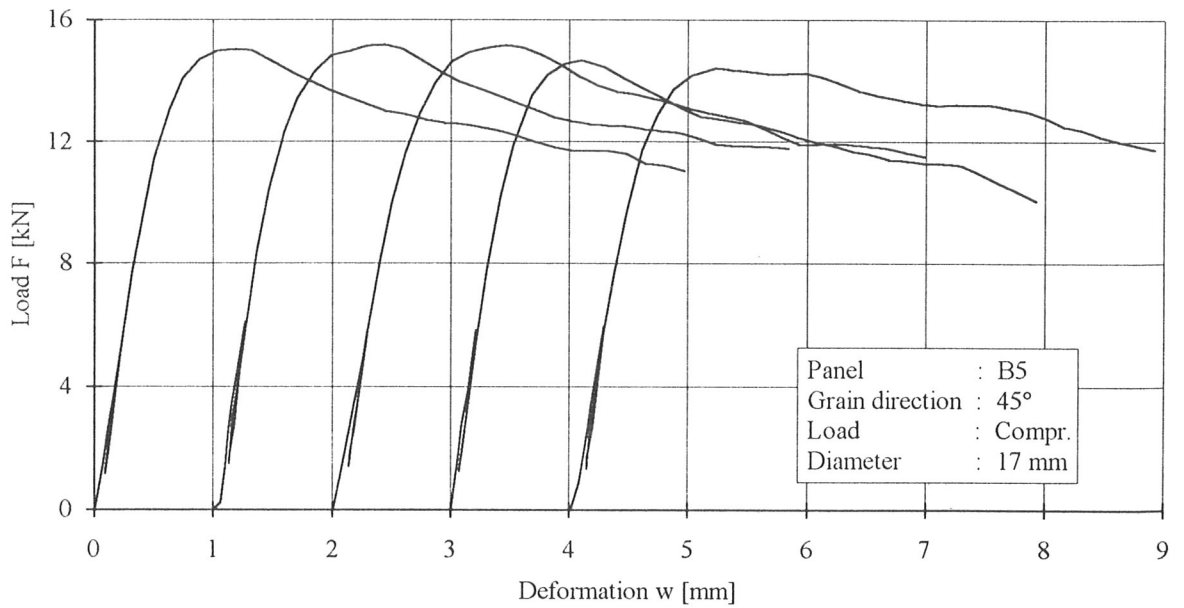
Load-deformation curves (B5/T0°)



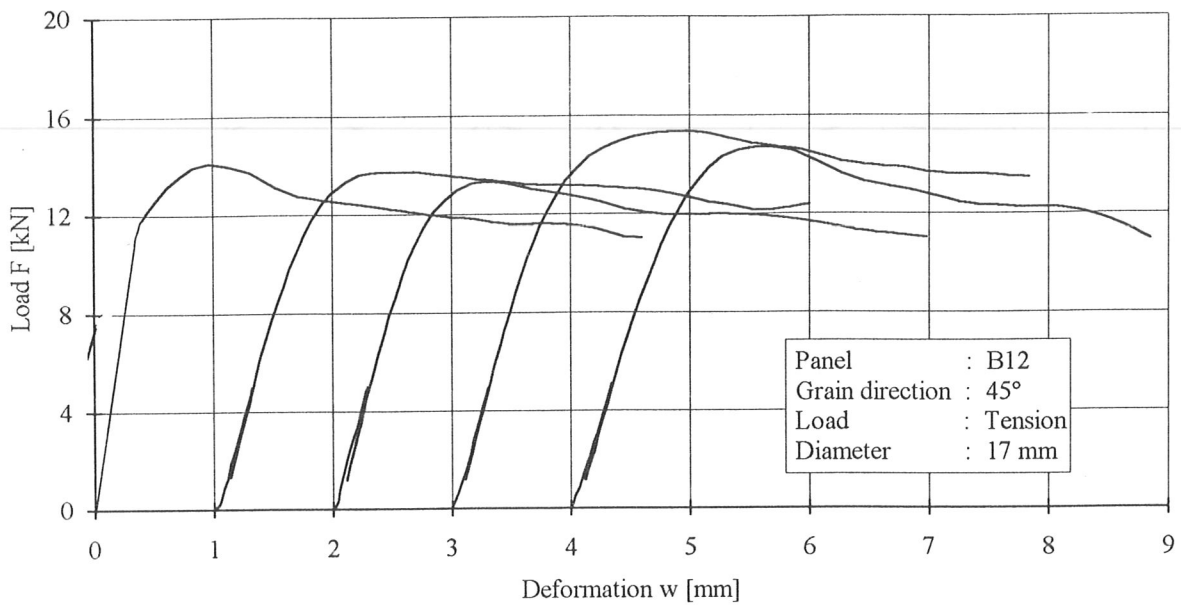
Load-deformation curves (B5/C0°)



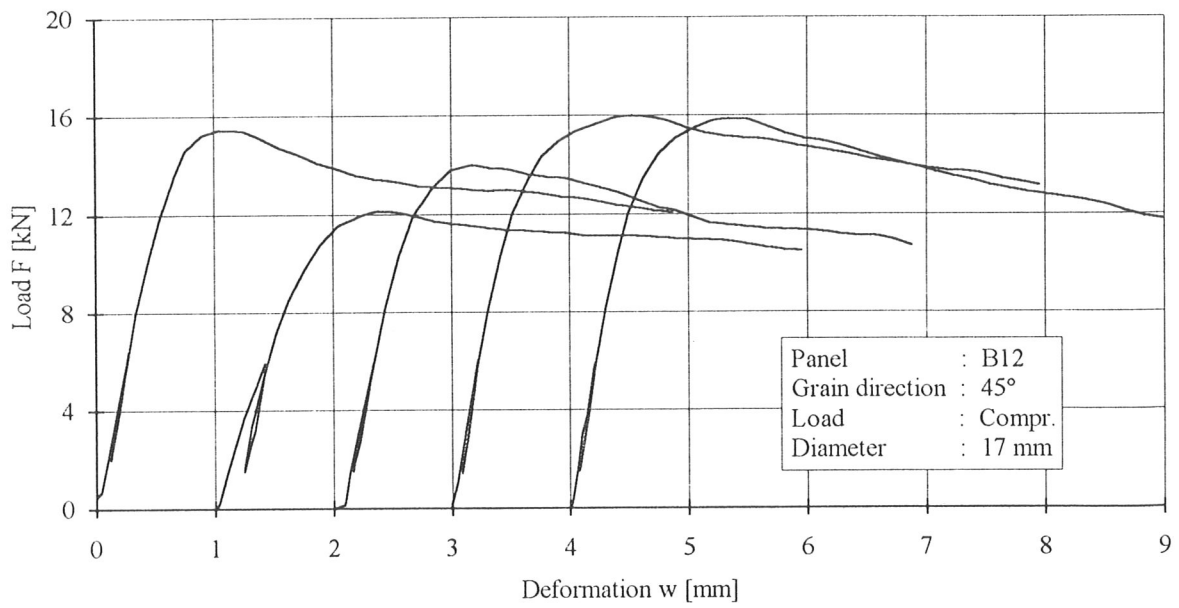
Load-deformation curves (B5/T45°)



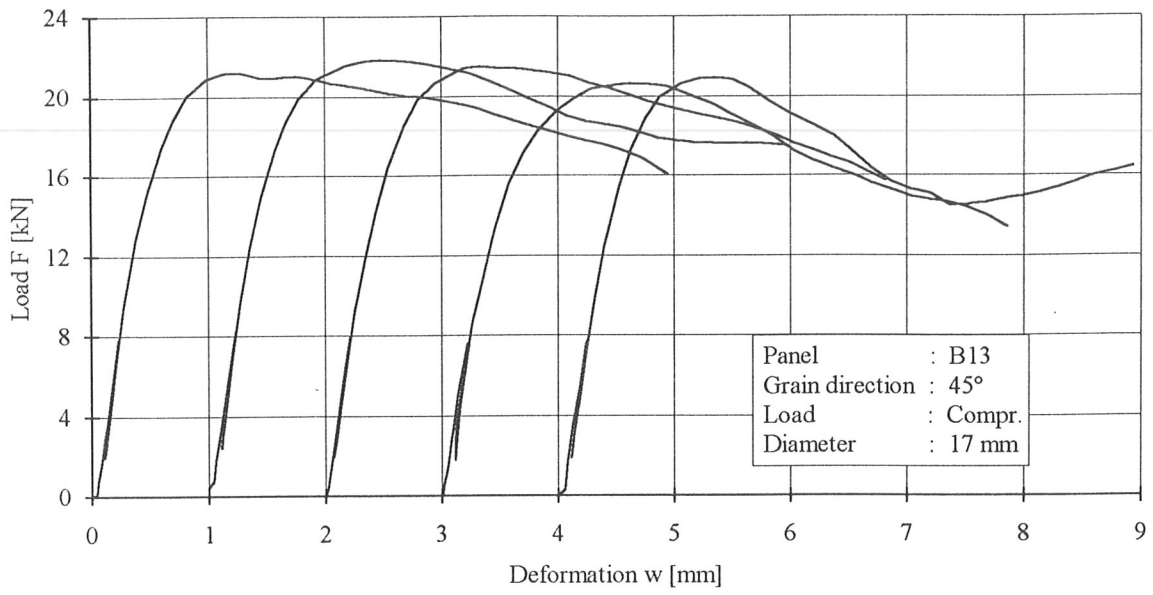
Load-deformation curves (B5/C45°)



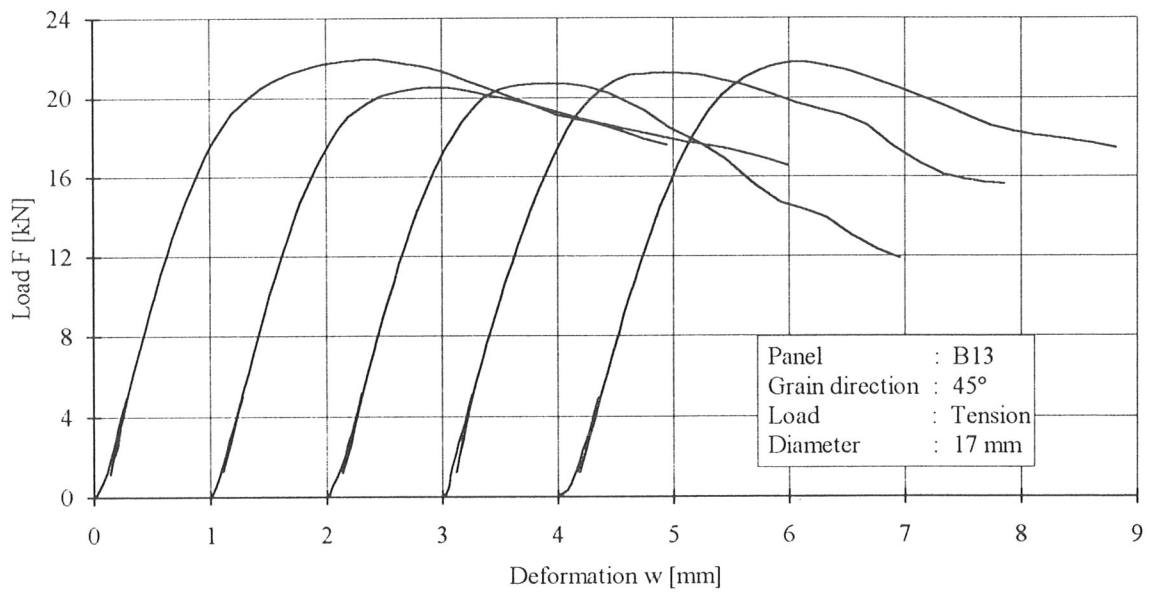
Load-deformation curves (B12/T45°)



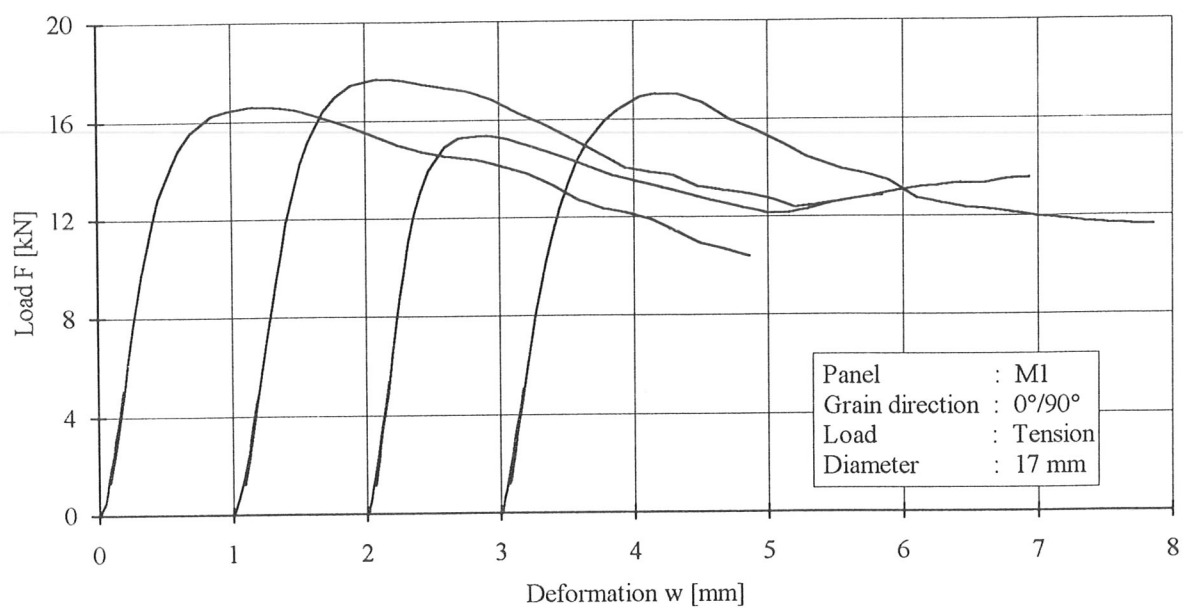
Load-deformation curves (B12/C45°)



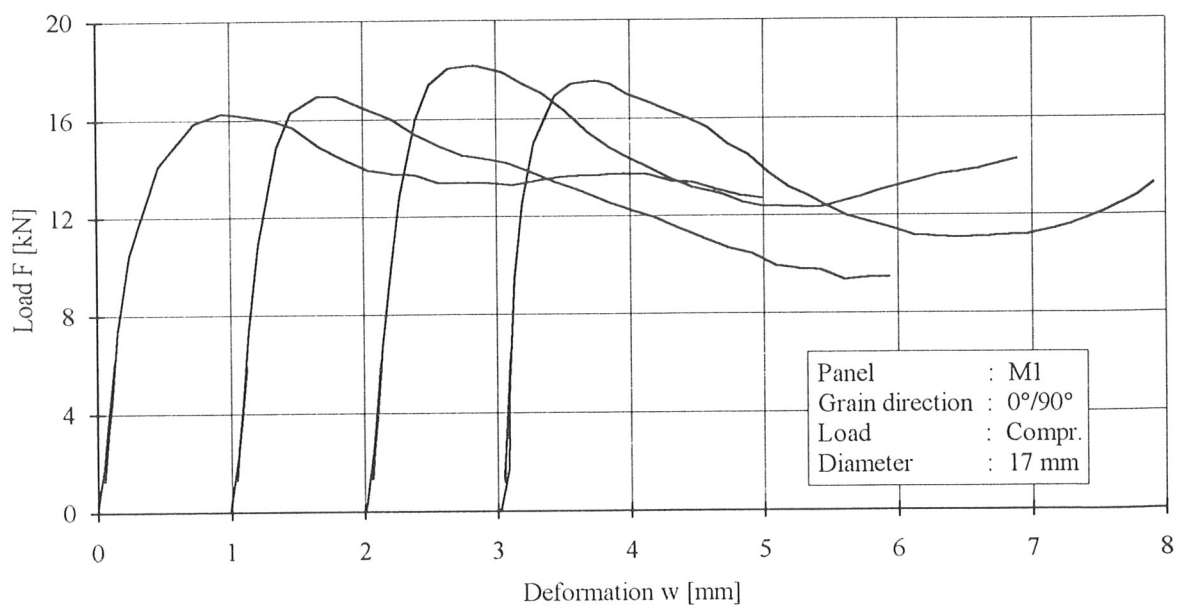
Load-deformation curves (B13/T45°)



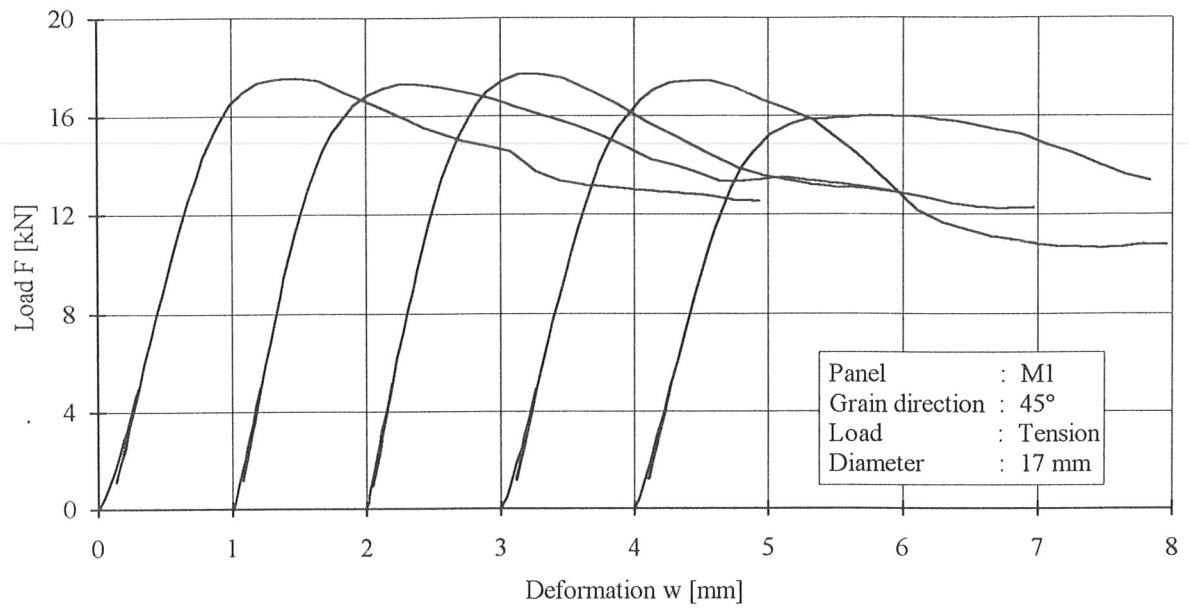
Load-deformation curves (B13/C45°)



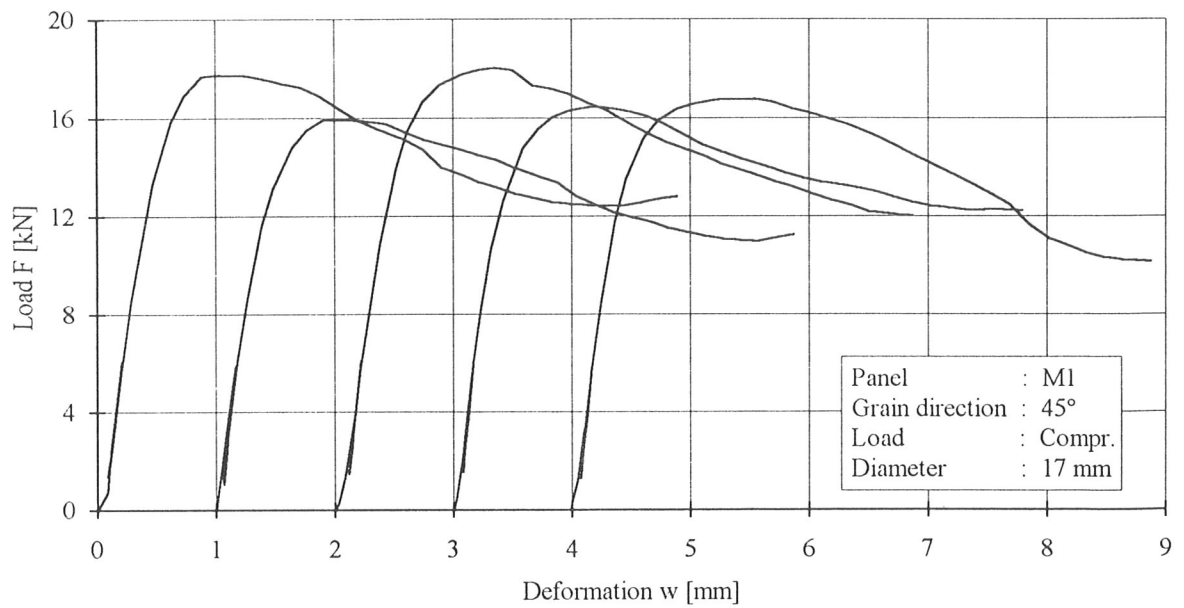
Load-deformation curves (M1/T0°)



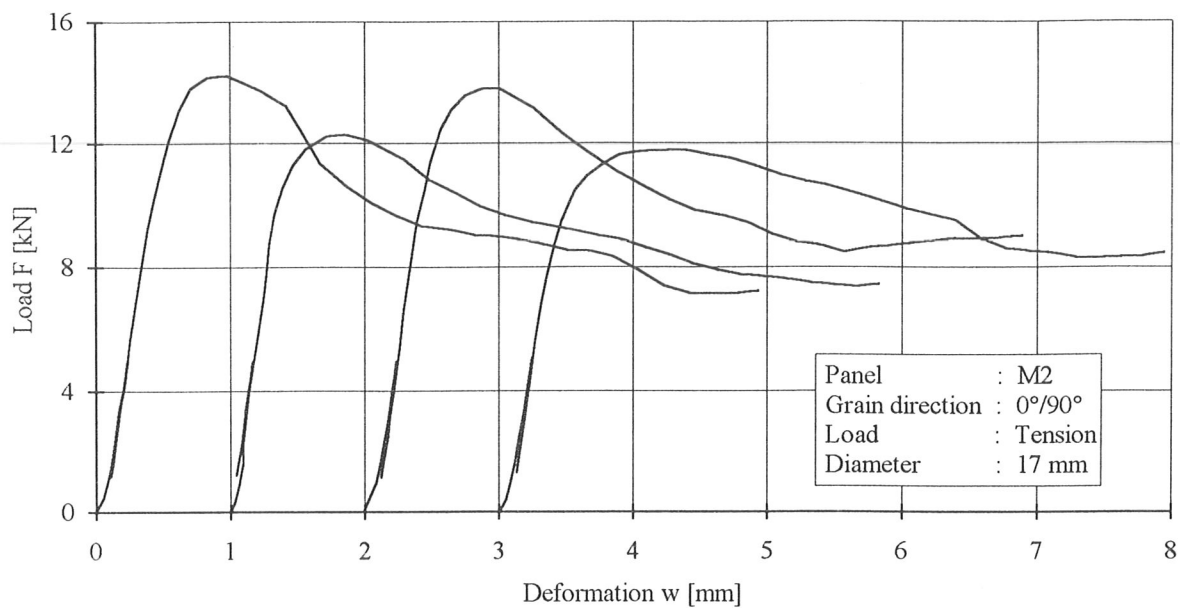
Load-deformation curves (M1/C0°)



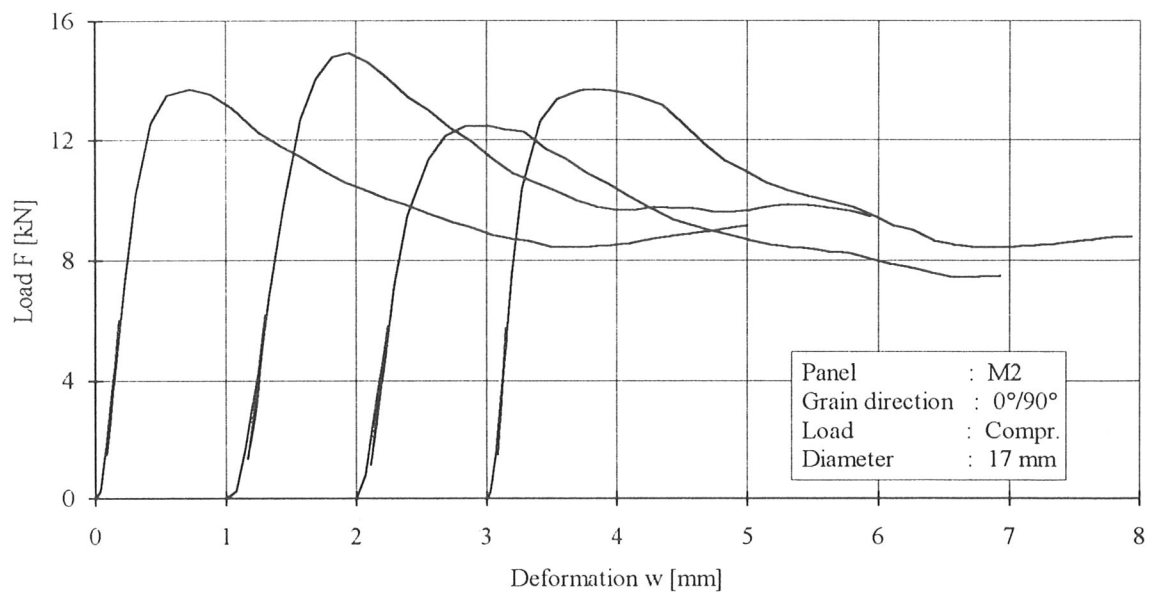
Load-deformation curves (M1/T45°)



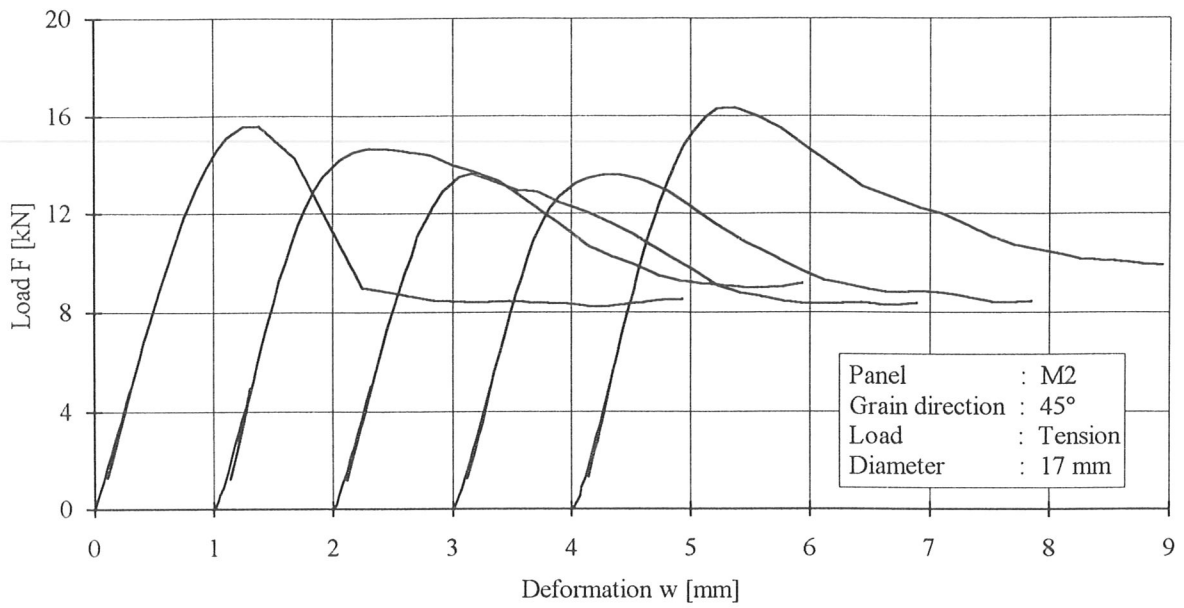
Load-deformation curves (M1/C45°)



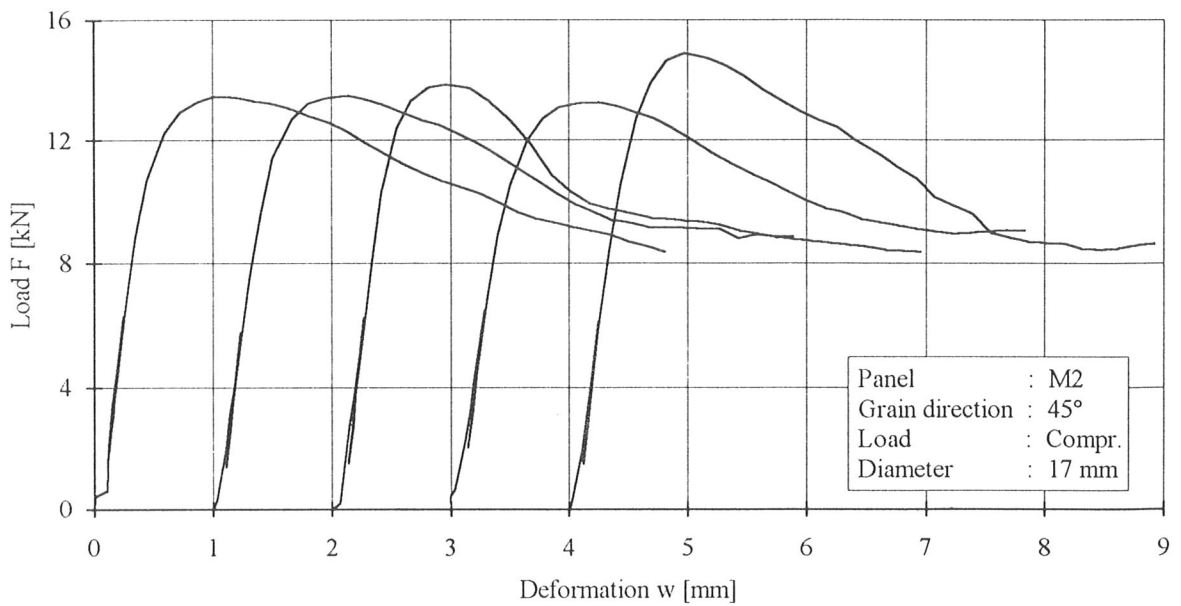
Load-deformation curves (M2/T0°)



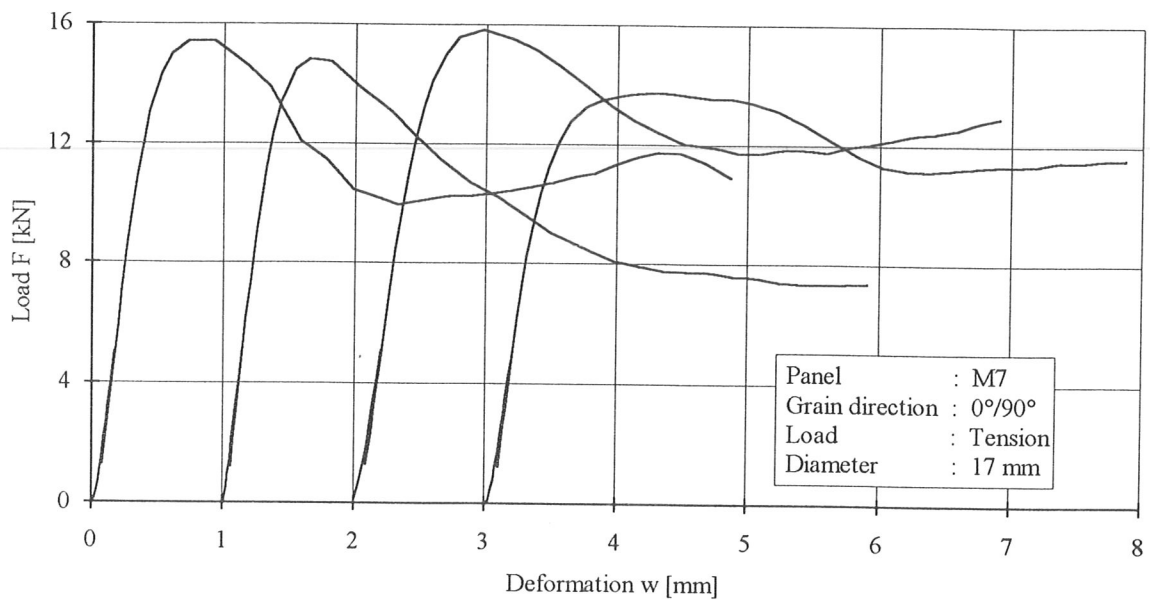
Load-deformation curves (M2/C0°)



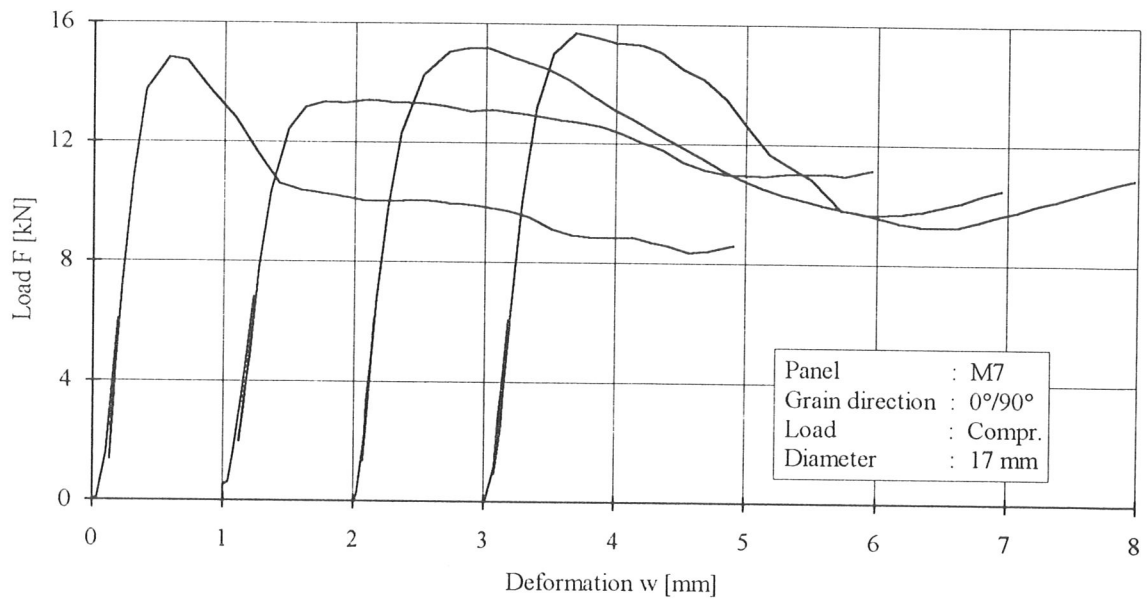
Load-deformation curves (M2/T45°)



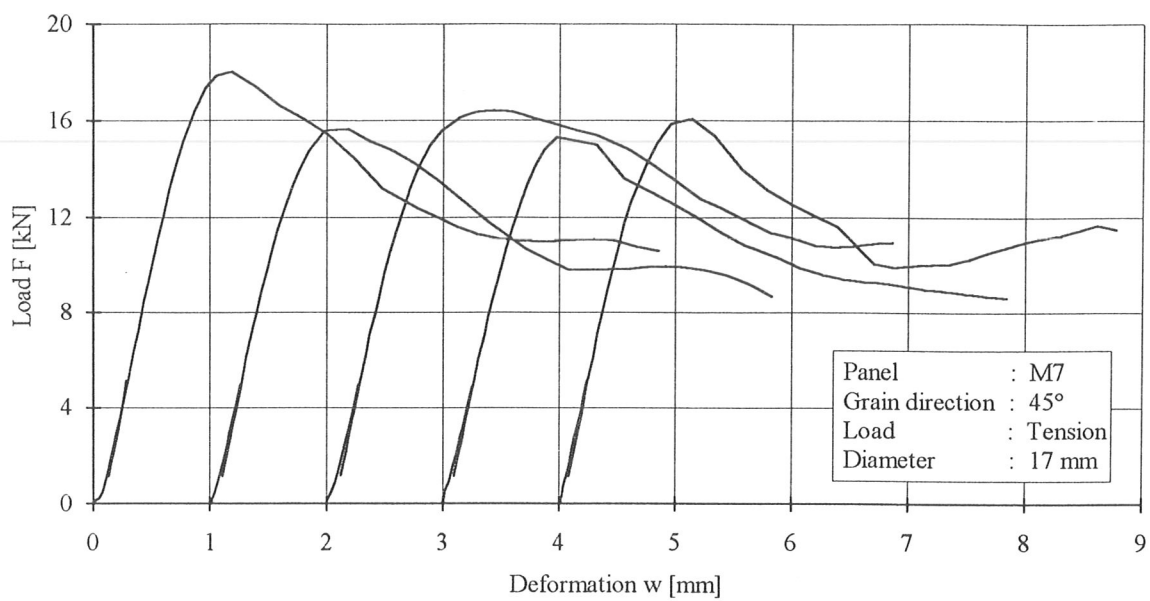
Load-deformation curves (M2/C45°)



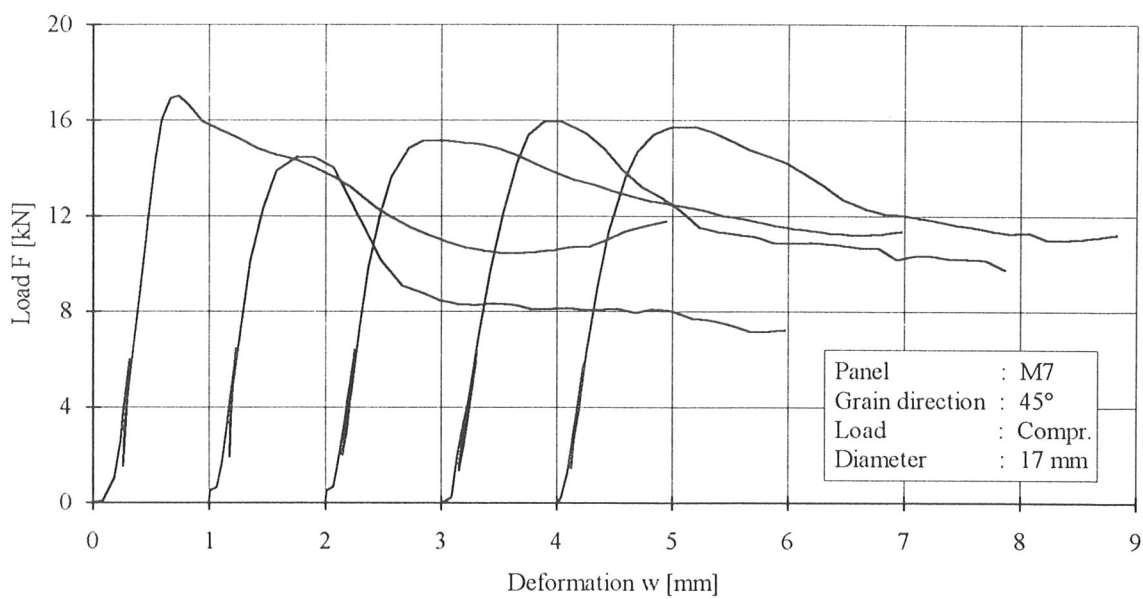
Load-deformation curves (M7/T0°)



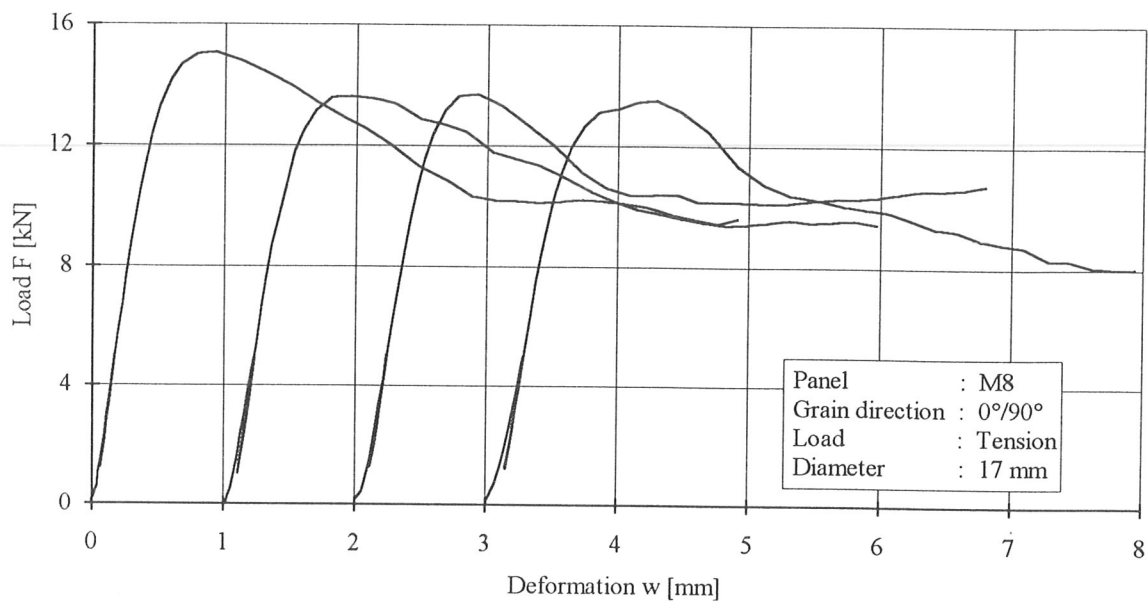
Load-deformation curves (M7/C0°)



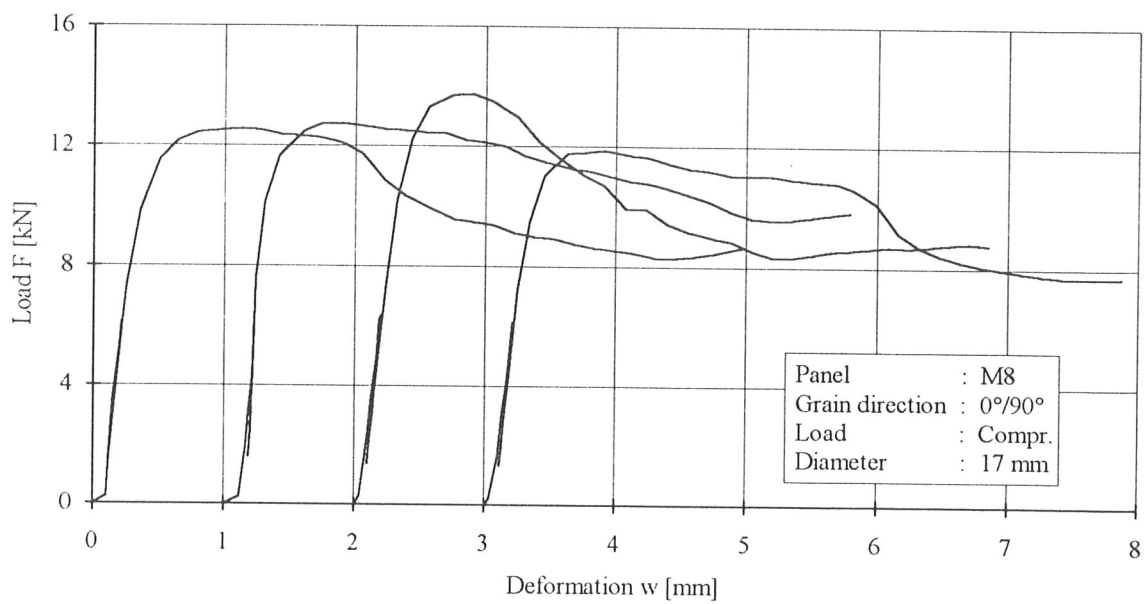
Load-deformation curves (M7/T45°)



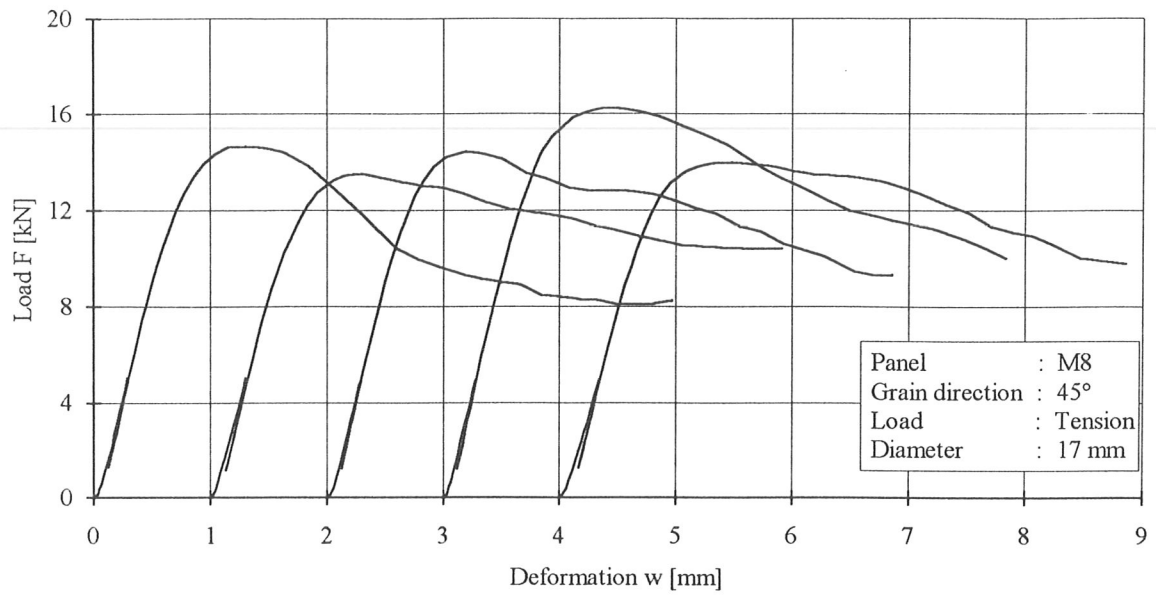
Load-deformation curves (M7/C45°)



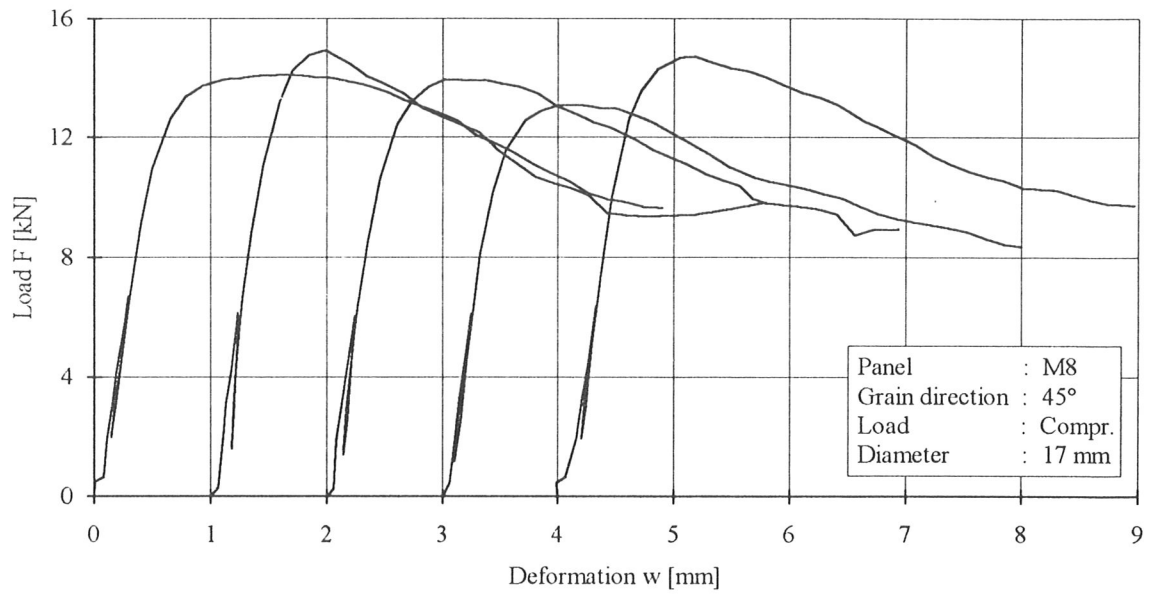
Load-deformation curves (M8/T0°)



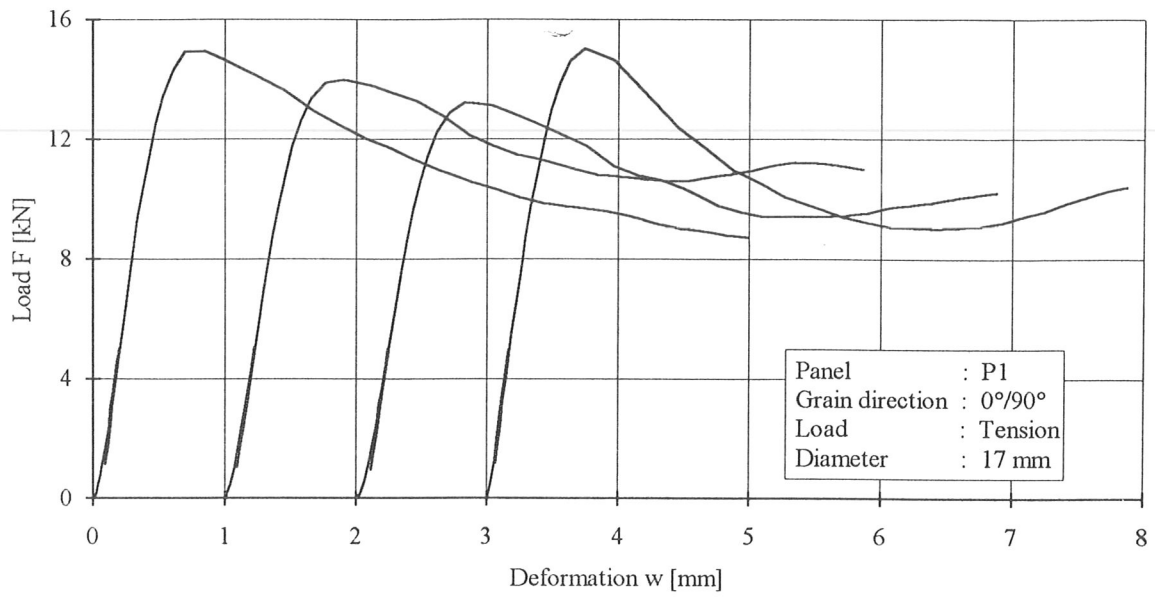
Load-deformation curves (M8/C0°)



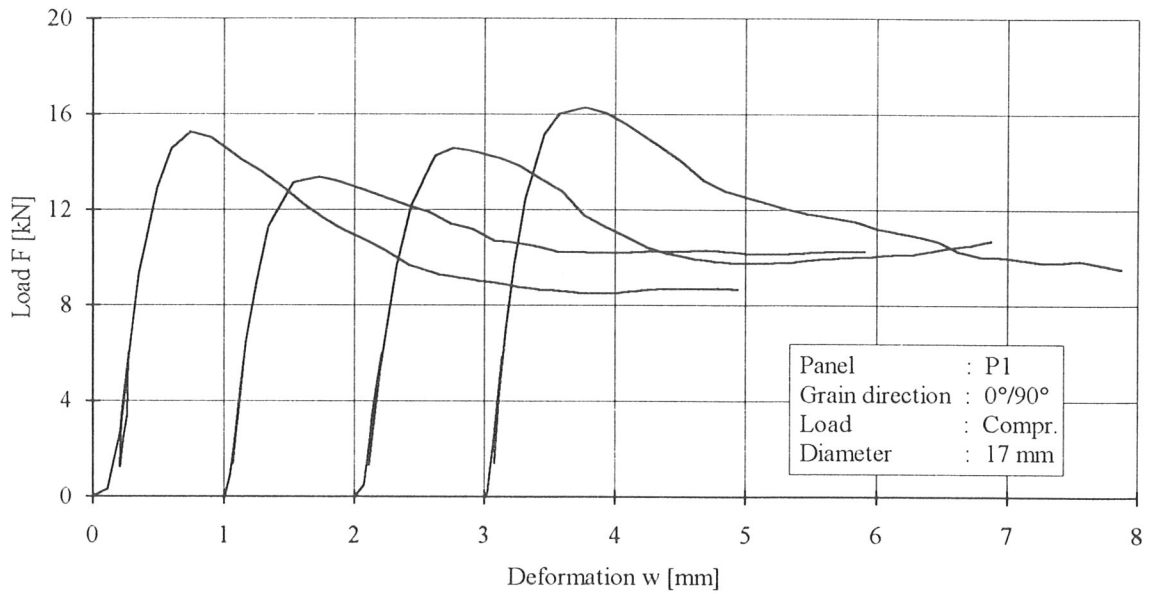
Load-deformation curves (M8/T45°)



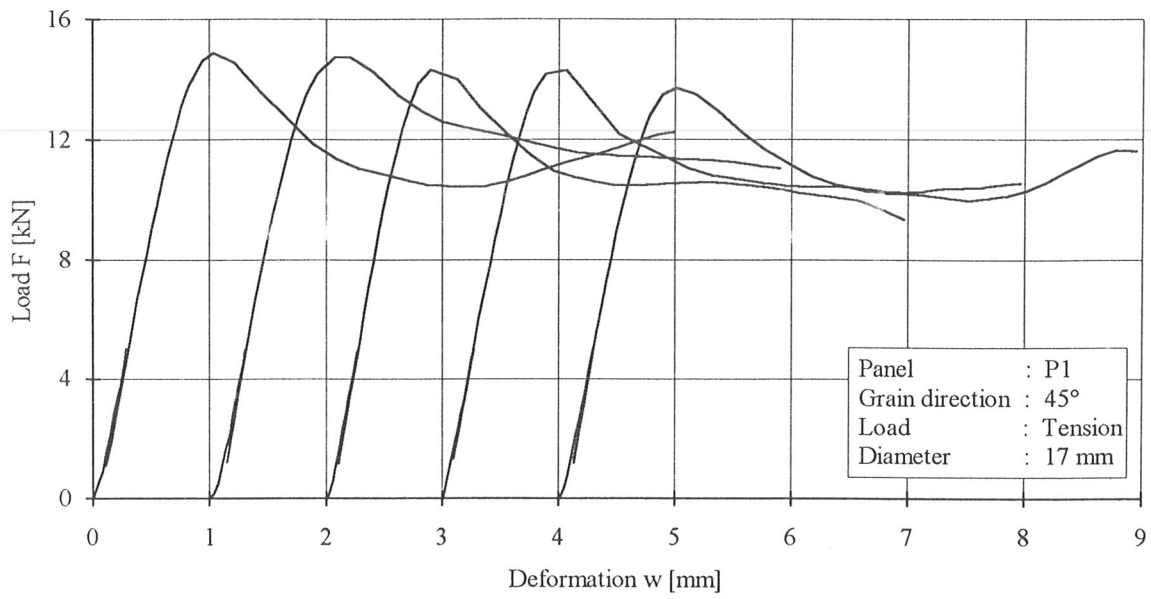
Load-deformation curves (M8/C45°)



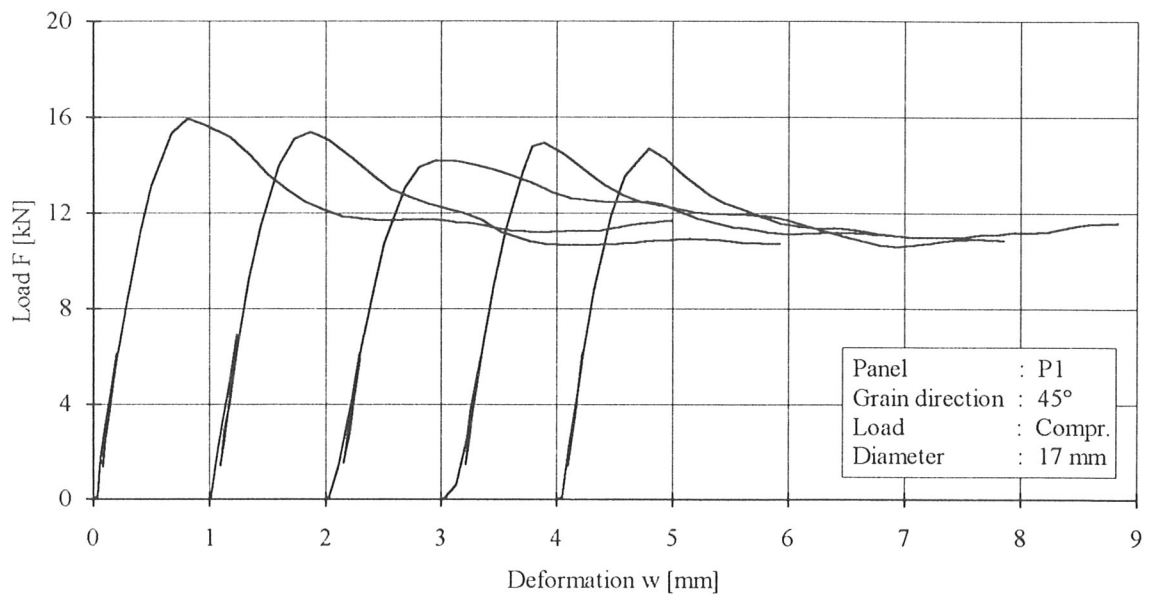
Load-deformation curves (P1/T0°)



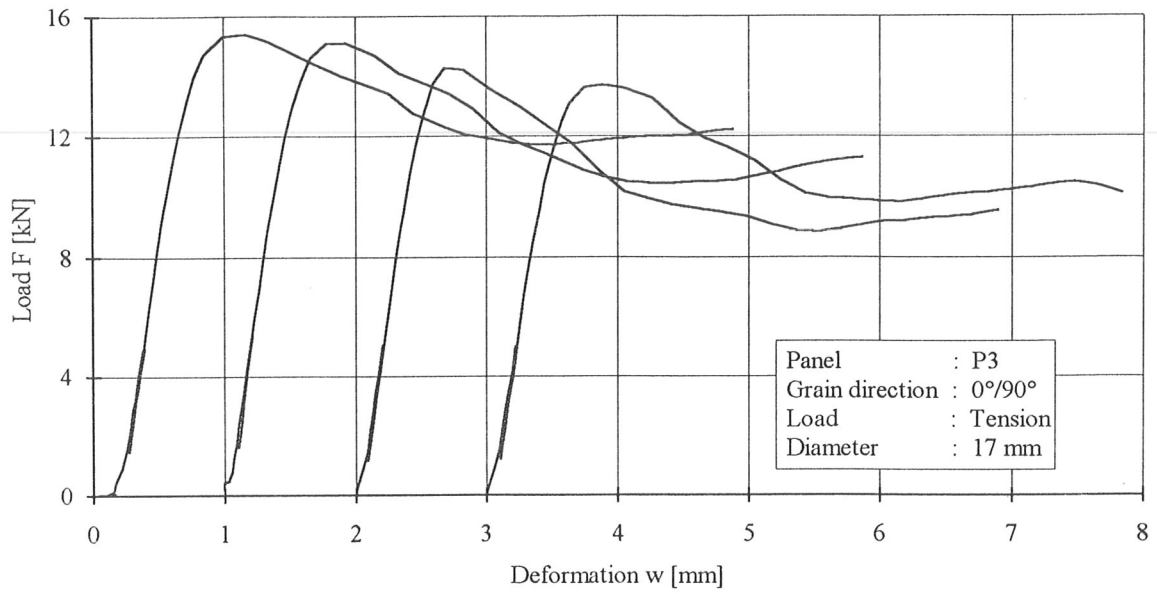
Load-deformation curves (P1/C0°)



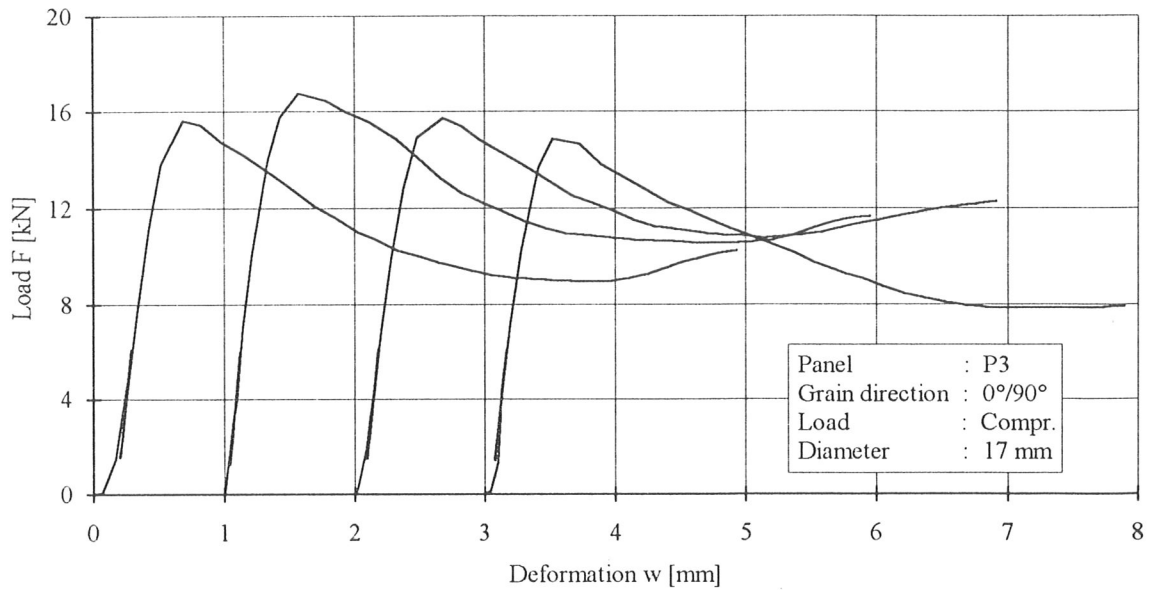
Load-deformation curves (P1/T45°)



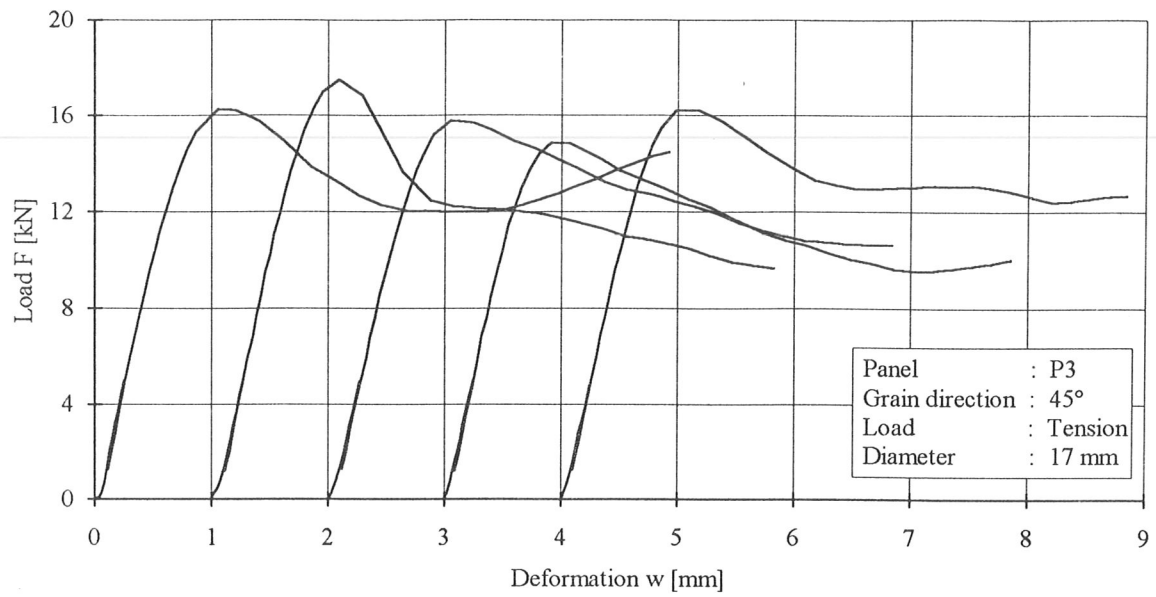
Load-deformation curves (P1/C45°)



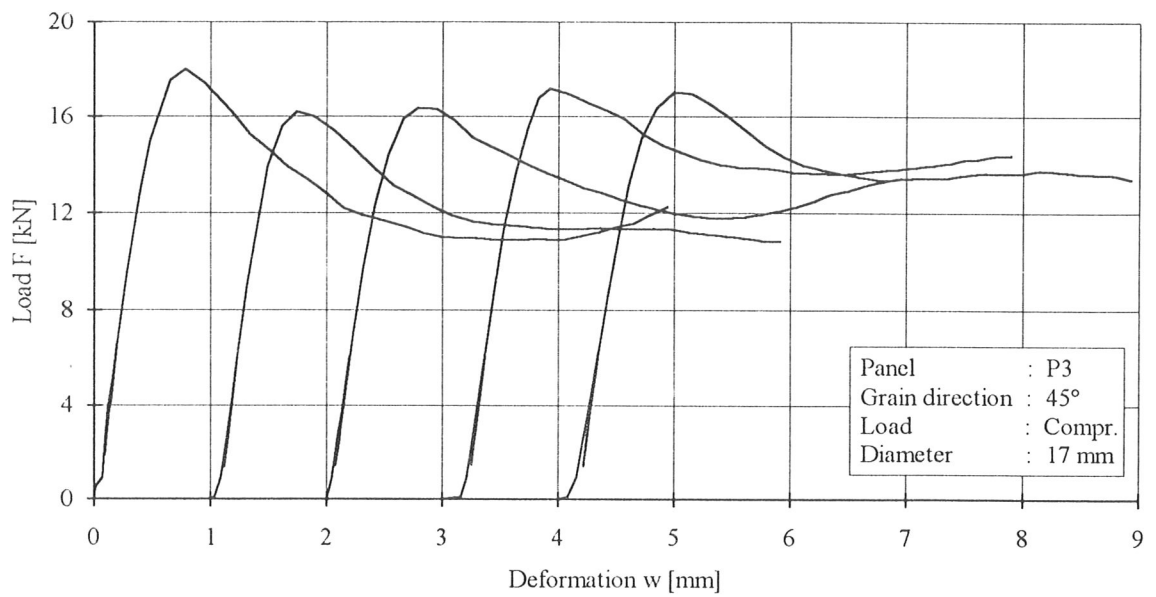
Load-deformation curves (P3/T0°)



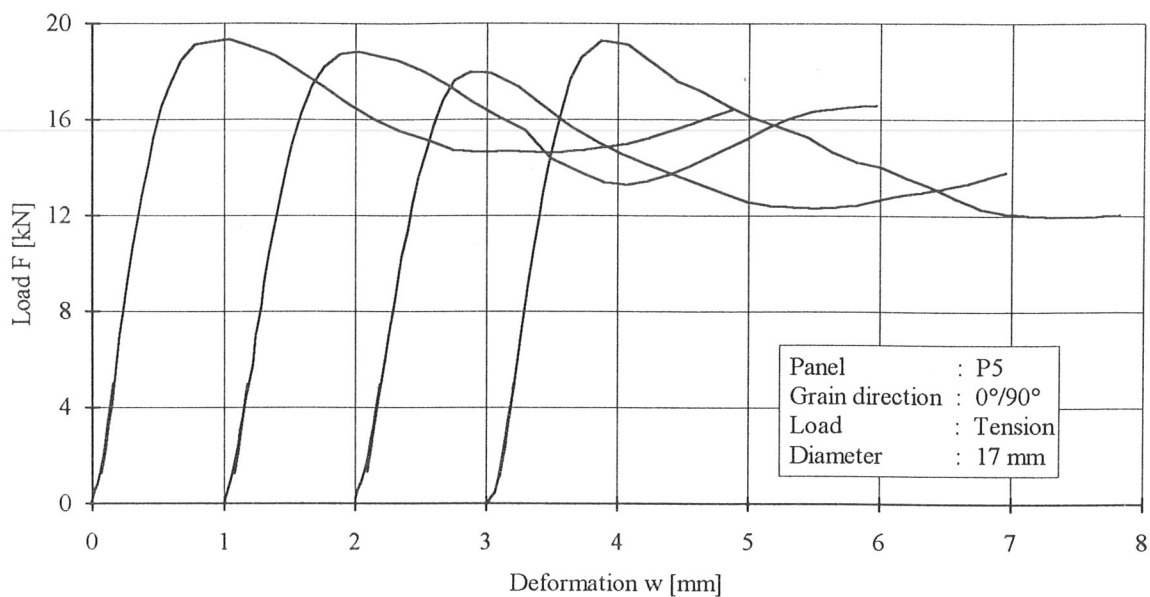
Load-deformation curves (P3/C0°)



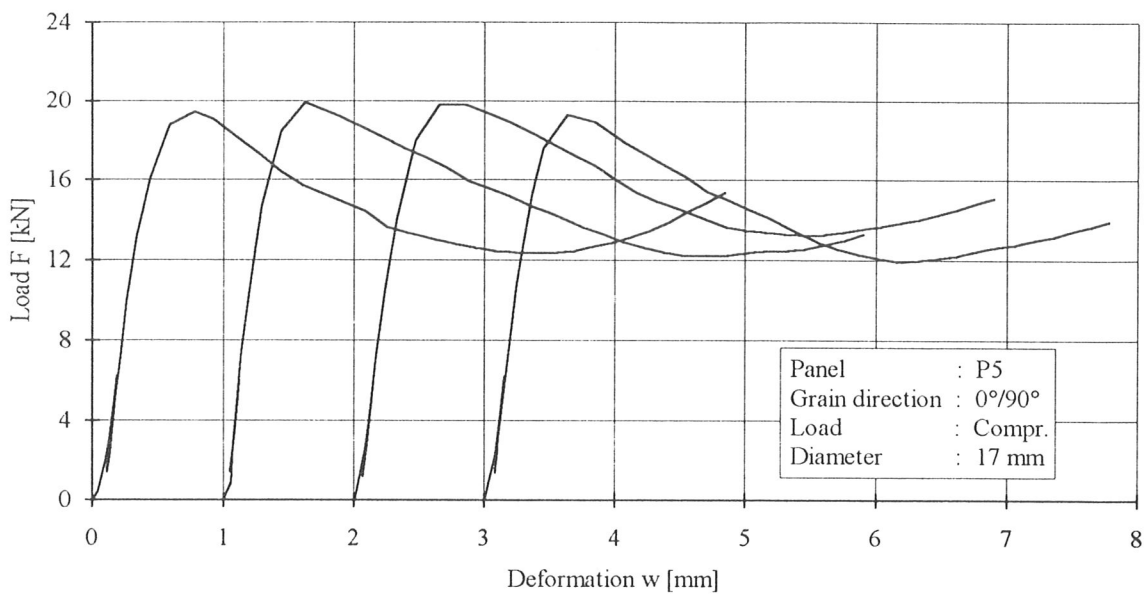
Load-deformation curves (P3/T45°)



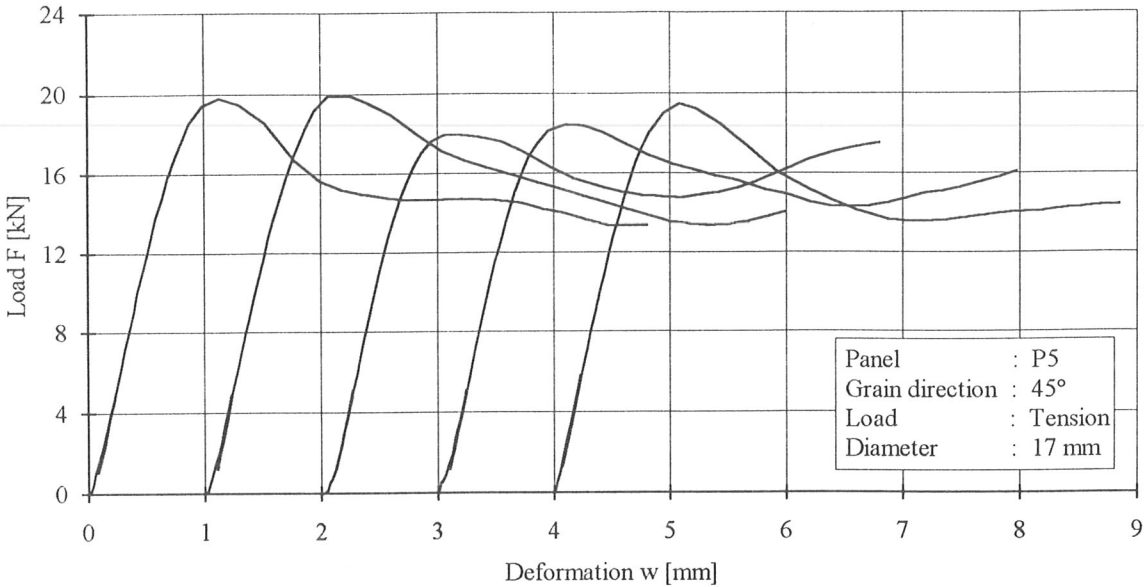
Load-deformation curves (P3/C45°)



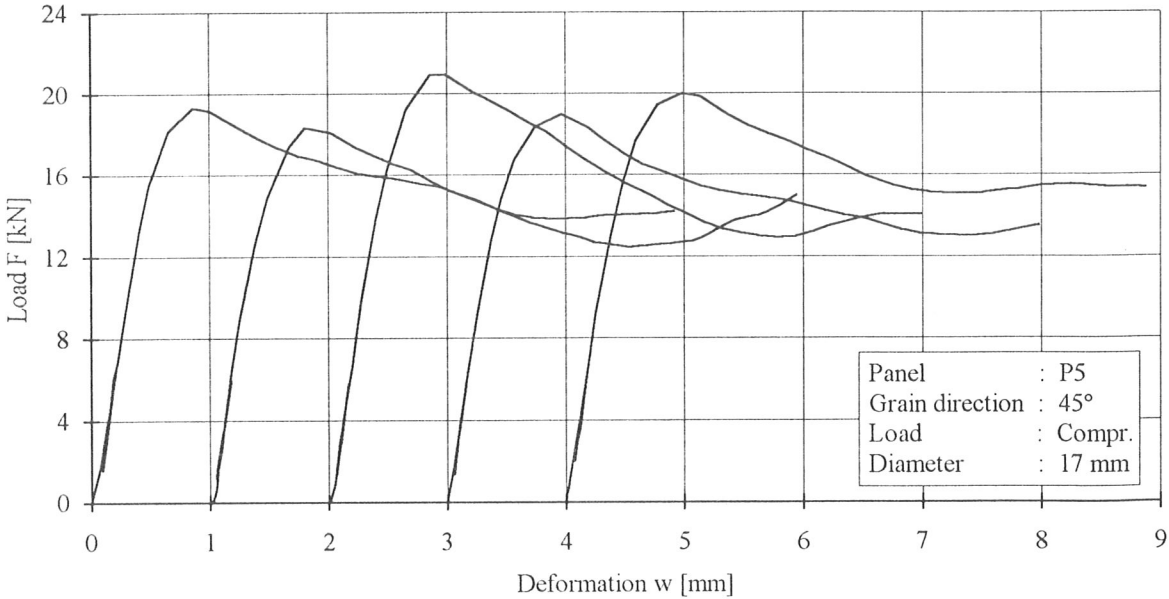
Load-deformation curves (P5/T0°)



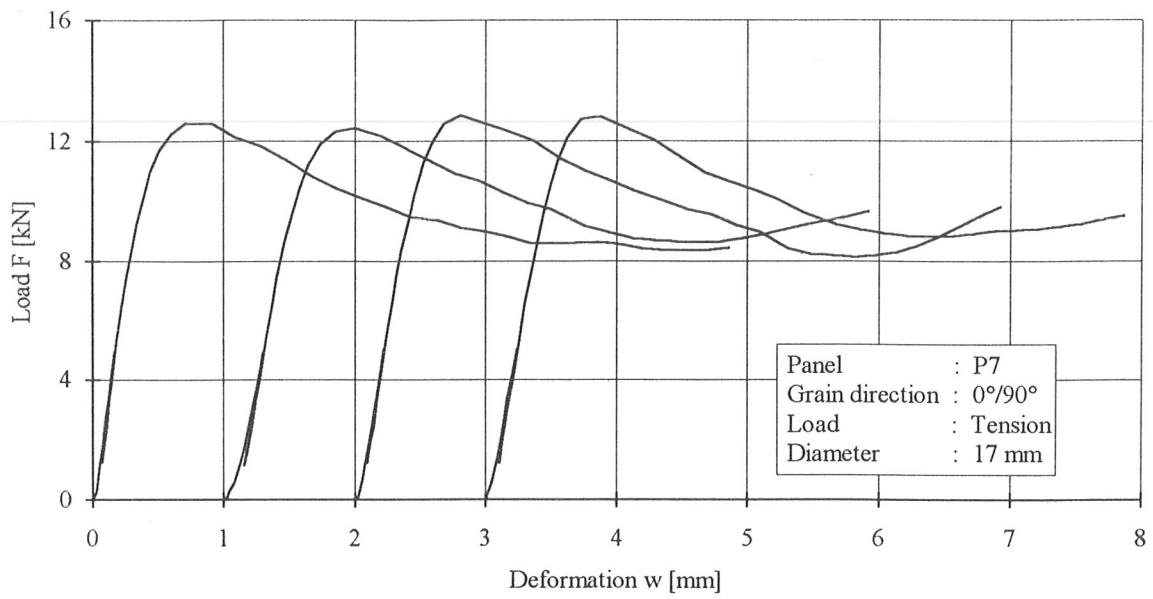
Load-deformation curves (P5/C0°)



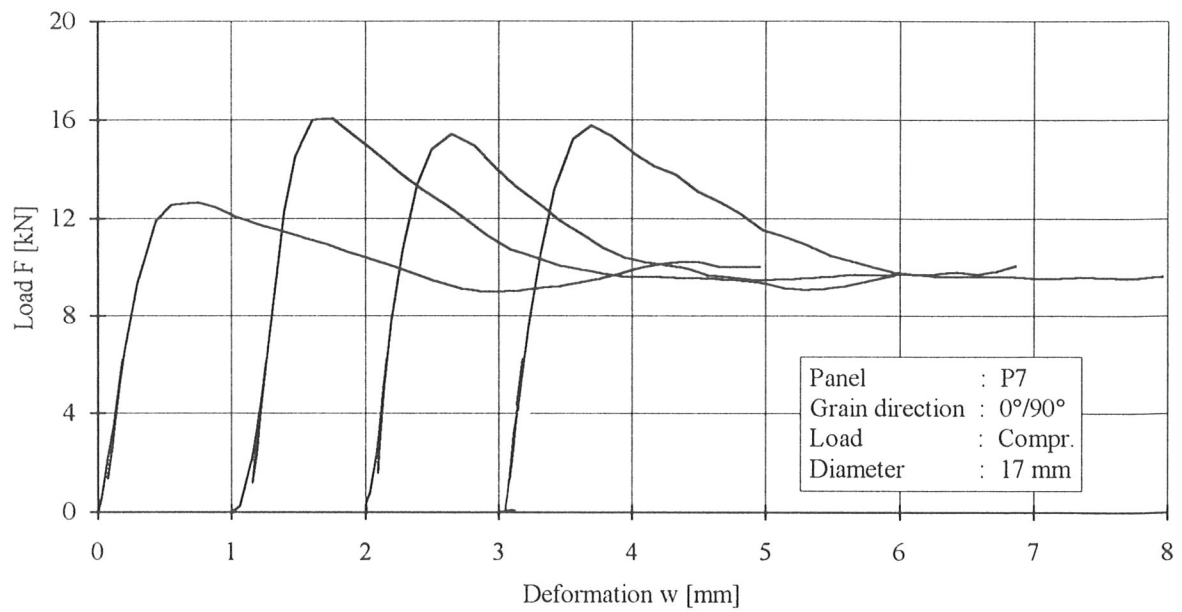
Load-deformation curves (P5/T45°)



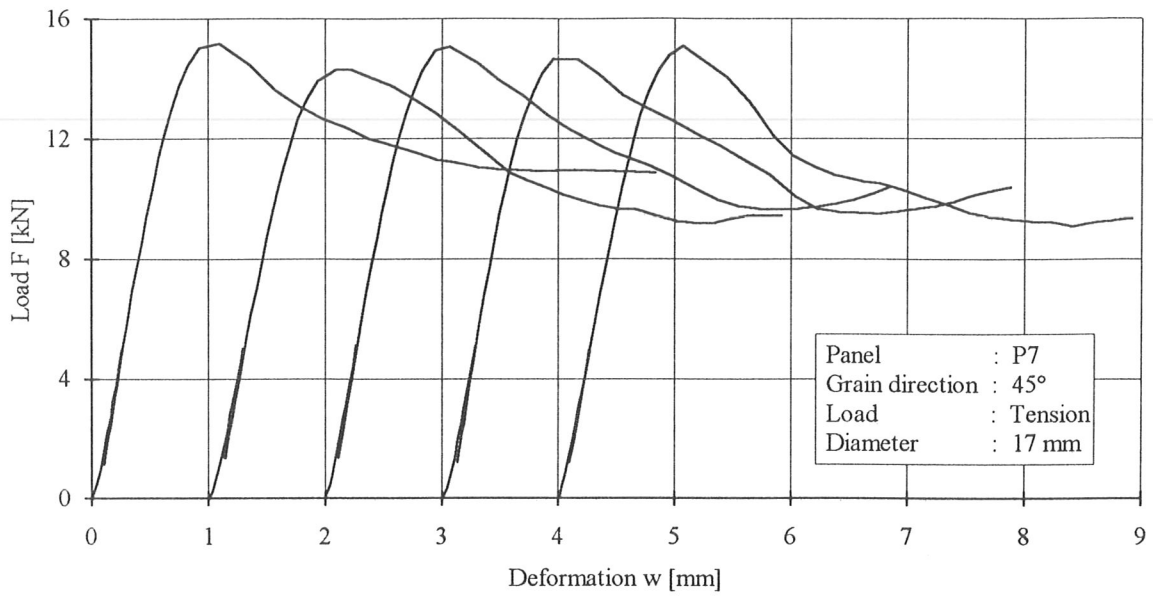
Load-deformation curves (P5/C45°)



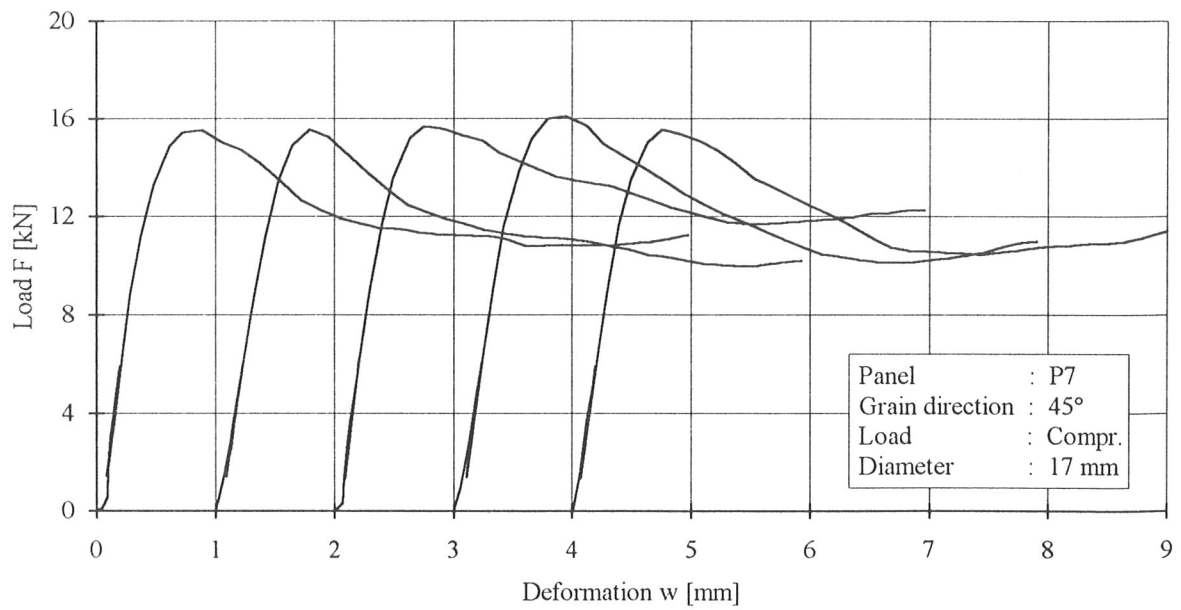
Load-deformation curves (P7/T0°)



Load-deformation curves (P7/C0°)



Load-deformation curves (P7/T45°)



Load-deformation curves (P7/C45°)

Results of the embedding tests

Dowel-type fastener: d = 17 mm

Panel: B2 (Beech)

Test	Panel thickness t (mm)	Density ρ (kg/m ³)	Maximum load F_{\max} (kN)	Embedding strength f_h (N/mm ²)	Mean embedding strength $f_{h,\text{mean}}$ (N/mm ²)
B2/T0°-10	8,5	1200	17,0	117	120
B2/T0°-20	8,5	1204	17,2	119	
B2/T0°-30	8,5	1205	17,4	120	
B2/T0°-40	8,6	1096	18,1	123	
B2/T45°-80	8,3	1348	18,8	133	124
B2/T45°-81	8,8	1173	17,7	117	
B2/T45°-90	8,7	1183	18,6	125	
B2/T45°-100	8,6	1192	18,5	126	
B2/T45°-110	8,7	1184	17,7	119	
B2/C0°-11	8,2	1266	18,9	135	124
B2/C0°-50	9,1	1142	18,3	118	
B2/C0°-60	9,2	1129	18,6	118	
B2/C0°-70	8,6	1207	18,2	124	
B2/C45°-91	8,5	1222	19,2	132	129
B2/C45°-101	8,8	1178	19,3	129	
B2/C45°-120	8,8	1191	19,4	129	
B2/C45°-121	8,6	1199	19,0	129	
B2/C45°-130	8,6	1200	18,2	124	

Results of the embedding tests

Dowel-type fastener: d = 17 mm

Panel: B5 (Beech)

Test	Panel thickness t (mm)	Density ρ (kg/m ³)	Maximum load F_{\max} (kN)	Embedding strength f_h (N/mm ²)	Mean embedding strength $f_{h,\text{mean}}$ (N/mm ²)
B5/T0°-10	7,1	1169	13,3	110	111
B5/T0°-20	7,1	1169	12,7	104	
B5/T0°-30	7,0	1179	13,6	114	
B5/T0°-40	6,8	1223	13,5	116	
B5/T45°-80	6,6	1268	14,1	125	121
B5/T45°-81	7,0	1190	14,1	118	
B5/T45°-90	6,7	1242	14,0	123	
B5/T45°-100	6,7	1245	14,0	122	
B5/T45°-110	7,0	1194	13,9	116	
B5/C0°-11	7,2	1166	14,5	118	118
B5/C0°-50	6,8	1222	14,0	121	
B5/C0°-60	7,1	1183	13,5	112	
B5/C0°-70	6,8	1214	14,0	120	
B5/C45°-91	6,7	1260	15,1	132	130
B5/C45°-101	6,7	1243	15,2	133	
B5/C45°-120	6,9	1207	15,2	129	
B5/C45°-121	6,6	1245	14,7	130	
B5/C45°-130	6,6	1232	14,4	128	

Results of the embedding tests

Dowel-type fastener: $d = 17 \text{ mm}$
 Panel: **B12 (Beech)**

Test	Panel thickness t (mm)	Density ρ (kg/m ³)	Maximum load F_{\max} (kN)	Embedding strength f_h (N/mm ²)	Mean embedding strength $f_{h,\text{mean}}$ (N/mm ²)
B12/T0°-10	7,2	1172	13,5	109	111
B12/T0°-20	7,1	1182	13,4	110	
B12/T0°-30	7,0	1184	13,2	110	
B12/T0°-40	7,0	1516	13,9	116	
B12/T45°-80	7,3	1162	14,1	113	112
B12/T45°-81	7,5	1139	13,8	107	
B12/T45°-90	7,5	1142	13,4	104	
B12/T45°-100	7,5	1153	15,4	120	
B12/T45°-110	7,3	1173	14,7	118	
B12/C0°-11	7,5	1120	13,2	103	113
B12/C0°-50	7,0	1202	13,9	117	
B12/C0°-60	7,0	1202	13,7	114	
B12/C0°-70	7,1	1195	14,5	119	
B12/C45°-91	7,1	1197	15,5	128	117
B12/C45°-101	7,1	1203	12,2	100	
B12/C45°-120	7,4	1147	14,0	111	
B12/C45°-121	7,7	1124	16,0	122	
B12/C45°-130	7,5	1159	15,9	124	

Results of the embedding tests

Dowel-type fastener: $d = 17 \text{ mm}$
 Panel: **B13 (Beech)**

Test	Panel thickness t (mm)	Density ρ (kg/m ³)	Maximum load F_{\max} (kN)	Embedding strength f_h (N/mm ²)	Mean embedding strength $f_{h,\text{mean}}$ (N/mm ²)
B13/T0°-10	7,6	1389	18,4	142	148
B13/T0°-20	7,7	1378	18,7	142	
B13/T0°-30	7,5	1413	19,1	149	
B13/T0°-40	7,7	1369	20,7	157	
B13/T45°-80	7,7	1384	22,0	167	163
B13/T45°-81	7,4	1393	20,6	163	
B13/T45°-90	7,9	1339	20,7	154	
B13/T45°-100	7,8	1337	21,3	160	
B13/T45°-110	7,5	1376	21,8	170	
B13/C0°-11	7,4	1363	22,1	175	168
B13/C0°-50	7,5	1416	22,2	173	
B13/C0°-60	7,5	1404	20,9	163	
B13/C0°-70	7,5	1385	20,6	161	
B13/C45°-91	7,3	1406	21,2	170	165
B13/C45°-101	7,6	1364	21,9	169	
B13/C45°-120	7,8	1311	21,5	162	
B13/C45°-121	7,5	1371	20,7	162	
B13/C45°-130	7,5	1377	20,9	164	

Results of the embedding tests

Dowel-type fastener: $d = 17 \text{ mm}$
 Panel: **M1 (Maritime pine)**

Test	Panel thickness t (mm)	Density ρ (kg/m ³)	Maximum load F_{\max} (kN)	Embedding strength f_h (N/mm ²)	Mean embedding strength $f_{h,\text{mean}}$ (N/mm ²)
M1/T0°-10	8,6	1192	16,6	113	116
M1/T0°-20	8,5	1184	17,7	122	
M1/T0°-30	8,4	1180	15,4	107	
M1/T0°-40	8,3	1202	17,1	120	
M1/T45°-80	8,1	1249	17,6	127	121
M1/T45°-81	8,5	1181	17,3	119	
M1/T45°-90	8,5	1197	17,7	122	
M1/T45°-100	8,4	1221	17,4	122	
M1/T45°-110	8,3	1201	16,0	113	
M1/C0°-11	8,8	1140	16,3	108	126
M1/C0°-50	7,8	1307	17,0	127	
M1/C0°-60	7,8	1323	18,2	136	
M1/C0°-70	7,8	1314	17,5	131	
M1/C45°-91	8,2	1243	17,7	127	120
M1/C45°-101	8,3	1206	15,9	112	
M1/C45°-120	8,4	1200	18,0	126	
M1/C45°-121	8,2	1235	16,4	117	
M1/C45°-130	8,3	1217	16,8	118	

Results of the embedding tests

Dowel-type fastener: $d = 17 \text{ mm}$
 Panel: **M2 (Maritime pine)**

Test	Panel thickness t (mm)	Density ρ (kg/m ³)	Maximum load F_{\max} (kN)	Embedding strength f_h (N/mm ²)	Mean embedding strength $f_{h,\text{mean}}$ (N/mm ²)
M2/T0°-10	6,6	1261	14,2	126	111
M2/T0°-20	6,7	1241	12,3	107	
M2/T0°-30	7,1	1169	13,8	114	
M2/T0°-40	7,1	1159	11,8	97	
M2/T45°-80	7,0	1174	15,6	130	120
M2/T45°-81	7,3	1118	14,7	118	
M2/T45°-90	7,4	1102	13,6	108	
M2/T45°-100	7,2	1139	13,6	110	
M2/T45°-110	7,1	1180	16,4	135	
M2/C0°-11	6,6	1272	13,7	122	116
M2/C0°-50	7,0	1189	14,9	125	
M2/C0°-60	7,0	1171	12,5	105	
M2/C0°-70	7,2	1175	13,7	111	
M2/C45°-91	7,2	1182	13,5	109	112
M2/C45°-101	7,4	1127	13,5	107	
M2/C45°-120	7,2	1181	13,9	113	
M2/C45°-121	7,3	1161	13,3	106	
M2/C45°-130	7,1	1206	14,9	123	

Results of the embedding tests

Dowel-type fastener: d = 17 mm
 Panel: M7 (Maritime pine)

Test	Panel thickness t (mm)	Density ρ (kg/m ³)	Maximum load F _{max} (kN)	Embedding strength f _h (N/mm ²)	Mean embedding strength f _{h,mean} (N/mm ²)
M7/T0°-10	7,4	1364	15,4	122	117
M7/T0°-20	7,5	1357	14,9	116	
M7/T0°-30	7,5	1352	15,8	124	
M7/T0°-40	7,6	1323	13,8	106	
M7/T45°-80	7,6	1366	18,0	139	126
M7/T45°-81	7,6	1356	15,7	121	
M7/T45°-90	7,6	1348	16,4	127	
M7/T45°-100	7,8	1307	15,3	115	
M7/T45°-110	7,4	1366	16,1	127	
M7/C0°-11	7,5	1317	14,8	116	115
M7/C0°-50	7,4	1296	13,4	106	
M7/C0°-60	7,7	1282	15,2	116	
M7/C0°-70	7,5	1329	15,7	123	
M7/C45°-91	7,6	1390	17,0	131	122
M7/C45°-101	7,6	1388	14,5	112	
M7/C45°-120	7,5	1322	15,2	119	
M7/C45°-121	7,4	1338	16,0	126	
M7/C45°-130	7,6	1353	15,7	121	

Results of the embedding tests

Dowel-type fastener: $d = 17 \text{ mm}$
 Panel: **M8 (Maritime pine)**

Test	Panel thickness t (mm)	Density ρ (kg/m ³)	Maximum load F_{\max} (kN)	Embedding strength f_h (N/mm ²)	Mean embedding strength $f_{h,\text{mean}}$ (N/mm ²)
M8/T0°-10	7,2	1177	15,1	123	117
M8/T0°-20	7,0	1244	13,6	114	
M8/T0°-30	6,8	1290	13,7	118	
M8/T0°-40	7,1	1225	13,5	111	
M8/T45°-80	7,0	1222	14,7	123	121
M8/T45°-81	6,9	1228	13,5	115	
M8/T45°-90	7,0	1220	14,4	121	
M8/T45°-100	7,3	1187	16,3	130	
M8/T45°-110	7,0	1227	14,0	117	
M8/C0°-11	7,6	1126	12,6	97	104
M8/C0°-50	7,0	1175	12,8	107	
M8/C0°-60	7,2	1159	13,7	112	
M8/C0°-70	7,0	1193	11,9	99	
M8/C45°-91	7,2	1163	14,1	115	118
M8/C45°-101	7,0	1210	14,9	125	
M8/C45°-120	7,0	1249	13,9	117	
M8/C45°-121	7,0	1203	13,1	109	
M8/C45°-130	7,0	1228	14,7	123	

Results of the embedding tests

Dowel-type fastener: $d = 17 \text{ mm}$
 Panel: **P1 (Poplar)**

Test	Panel thickness t (mm)	Density ρ (kg/m ³)	Maximum load F_{\max} (kN)	Embedding strength f_h (N/mm ²)	Mean embedding strength $f_{h,\text{mean}}$ (N/mm ²)
P1/T0°-10	7,6	1171	15,0	115	115
P1/T0°-20	7,4	1223	14,0	111	
P1/T0°-30	7,2	1246	13,2	108	
P1/T0°-40	7,1	1291	15,0	124	
P1/T45°-80	7,0	1265	14,9	125	121
P1/T45°-81	7,0	1291	14,7	123	
P1/T45°-90	6,9	1288	14,3	122	
P1/T45°-100	7,0	1253	14,3	120	
P1/T45°-110	7,0	1252	13,7	115	
P1/C0°-11	7,7	1129	15,3	116	113
P1/C0°-50	7,7	1147	13,4	102	
P1/C0°-60	7,7	1136	14,6	111	
P1/C0°-70	7,7	1168	16,3	124	
P1/C45°-91	7,1	1241	15,9	132	126
P1/C45°-101	7,1	1237	15,4	127	
P1/C45°-120	7,0	1224	14,2	119	
P1/C45°-121	6,9	1262	14,9	127	
P1/C45°-130	7,0	1218	14,7	123	

Results of the embedding tests

Dowel-type fastener: $d = 17 \text{ mm}$
 Panel: **P3 (Poplar)**

Test	Panel thickness t (mm)	Density ρ (kg/m ³)	Maximum load F_{\max} (kN)	Embedding strength f_h (N/mm ²)	Mean embedding strength $f_{h,\text{mean}}$ (N/mm ²)
P3/T0°-10	8,0	1213	15,4	113	111
P3/T0°-20	7,7	1224	15,7	112	
P3/T0°-30	7,5	1234	14,3	112	
P3/T0°-40	7,6	1217	13,7	106	
P3/T45°-80	7,8	1206	16,3	122	125
P3/T45°-81	7,4	1261	17,5	139	
P3/T45°-90	7,6	1226	15,8	122	
P3/T45°-100	7,6	1242	14,9	115	
P3/T45°-110	7,6	1249	16,2	125	
P3/C0°-11	8,0	1179	15,6	115	117
P3/C0°-50	7,8	1241	16,8	126	
P3/C0°-60	7,9	1218	15,8	117	
P3/C0°-70	7,9	1201	14,9	110	
P3/C45°-91	7,5	1276	18,0	141	130
P3/C45°-101	7,5	1260	16,2	127	
P3/C45°-120	7,7	1214	16,4	124	
P3/C45°-121	7,7	1232	17,2	131	
P3/C45°-130	7,9	1199	17,0	126	

Results of the embedding tests

Dowel-type fastener: $d = 17 \text{ mm}$
 Panel: **P5 (Poplar)**

Test	Panel thickness t (mm)	Density ρ (kg/m ³)	Maximum load F_{\max} (kN)	Embedding strength f_h (N/mm ²)	Mean embedding strength $f_{h,\text{mean}}$ (N/mm ²)
P5/T0°-10	9,0	1270	19,3	126	
P5/T0°-20	8,9	1245	18,8	124	
P5/T0°-30	8,9	1226	18,0	119	
P5/T0°-40	8,9	1285	19,3	127	124
P5/T45°-80	9,2	1206	19,8	126	
P5/T45°-81	9,2	1210	19,9	127	
P5/T45°-90	9,3	1198	18,0	113	
P5/T45°-100	9,5	1179	18,5	114	
P5/T45°-110	9,2	1213	19,5	124	121
P5/C0°-11	8,9	1274	19,4	128	
P5/C0°-50	8,9	1317	19,9	131	
P5/C0°-60	9,0	1272	19,8	129	
P5/C0°-70	9,0	1259	19,3	126	129
P5/C45°-91	9,0	1214	19,4	126	
P5/C45°-101	8,9	1211	18,4	121	
P5/C45°-120	9,1	1244	21,0	135	
P5/C45°-121	9,5	1168	19,0	117	
P5/C45°-130	7,9	1199	17,0	126	125

Results of the embedding tests

Dowel-type fastener: $d = 17 \text{ mm}$
 Panel: **P7 (Poplar)**

Test	Panel thickness t (mm)	Density ρ (kg/m ³)	Maximum load F_{\max} (kN)	Embedding strength f_h (N/mm ²)	Mean embedding strength $f_{h,\text{mean}}$ (N/mm ²)
P7/T0°-10	7,0	1198	12,6	106	107
P7/T0°-20	6,9	1233	12,5	106	
P7/T0°-30	7,0	1206	12,9	108	
P7/T0°-40	7,0	1233	12,8	107	
P7/T45°-80	7,0	1257	15,2	127	123
P7/T45°-81	7,1	1212	14,3	118	
P7/T45°-90	7,0	1250	15,1	126	
P7/T45°-100	7,1	1245	14,7	121	
P7/T45°-110	7,2	1240	15,1	123	
P7/C0°-11	7,0	1177	12,7	106	126
P7/C0°-50	7,0	1275	16,1	134	
P7/C0°-60	6,9	1304	15,4	131	
P7/C0°-70	7,0	1281	15,8	132	
P7/C45°-91	7,0	1255	15,5	130	127
P7/C45°-101	7,2	1235	15,6	127	
P7/C45°-120	7,4	1207	15,7	124	
P7/C45°-121	7,2	1273	16,1	131	
P7/C45°-130	7,3	1234	15,5	125	

Deformation and foundation values of the embedding tests

Dowel-type fastener: d = 17 mm
 Panel: B2 (Beech)

Test	W_1 (mm)	$W_{i,mod}$ (mm)	W_s (mm)	W_e (mm)	W_{06} (mm)	W_{08} (mm)	K_1 (N/mm ³)	K_s (N/mm ³)	K_e (N/mm ³)
B2/T0°-10	0,19	0,20	-0,01	0,16	0,37	0,54	185	176	208
B2/T0°-20	0,18	0,16	0,02	0,09	0,36	0,54	188	213	307
B2/T0°-30	0,17	0,16	0,01	0,13	0,35	0,52	204	215	265
B2/T0°-40	0,17	0,14	0,02	0,12	0,37	3,96	207	240	274
B2/T45°-80	0,30	0,27	0,02	0,23	0,64	0,91	119	130	150
B2/T45°-81	0,28	0,25	0,03	0,22	0,57	0,81	118	135	151
B2/T45°-90	0,30	0,25	0,05	0,22	0,64	0,89	111	134	149
B2/T45°-100	0,33	0,25	0,07	0,23	0,64	0,89	104	134	151
B2/T45°-110	0,28	0,27	0,01	0,22	0,60	0,87	122	125	149
B2/C0°-11	0,17	0,13	0,04	0,13	0,32	0,47	250	325	333
B2/C0°-50	0,14	0,10	0,04	0,10	0,24	0,38	277	387	428
B2/C0°-60	0,22	0,15	0,08	0,11	0,33	0,48	171	259	350
B2/C0°-70	0,15	0,12	0,03	0,12	0,28	0,42	276	356	380
B2/C45°-91	0,17	0,17	-0,01	0,14	0,36	0,57	250	240	296
B2/C45°-101	0,19	0,18	0,01	0,14	0,39	0,61	211	228	293
B2/C45°-120	0,27	0,21	0,06	0,20	0,52	0,72	147	189	207
B2/C45°-121	0,24	0,19	0,05	0,18	0,47	0,70	169	214	226
B2/C45°-130	0,26	0,22	0,03	0,20	0,44	0,69	160	185	210

Deformation and foundation values of the embedding tests

Dowel-type fastener: $d = 17$ mm
 Panel: **B5 (Beech)**

Test	W_i (mm)	$W_{i,mod}$ (mm)	W_s (mm)	W_e (mm)	W_{06} (mm)	W_{08} (mm)	K_i (N/mm ³)	K_s (N/mm ³)	K_e (N/mm ³)
B5/T0°-10	0,28	0,19	0,09	0,17	0,41	0,59	147	215	246
B5/T0°-20	0,16	0,15	0,01	0,14	0,30	0,49	258	271	294
B5/T0°-30	0,23	0,17	0,06	0,15	0,41	0,58	179	246	284
B5/T0°-40	0,29	0,22	0,07	0,15	0,42	0,59	149	192	270
B5/T45°-80	0,36	0,30	0,06	0,29	0,60	0,83	123	148	157
B5/T45°-81	0,28	0,26	0,02	0,23	0,50	0,72	148	162	177
B5/T45°-90	0,36	0,31	0,05	0,28	0,60	0,83	121	142	157
B5/T45°-100	0,35	0,32	0,03	0,25	0,58	0,81	124	136	162
B5/T45°-110	0,36	0,33	0,03	0,30	0,59	0,83	118	129	139
B5/C0°-11	0,22	0,15	0,07	0,19	0,32	0,46	218	324	226
B5/C0°-50	0,20	0,18	0,02	0,17	0,30	0,46	254	284	322
B5/C0°-60	0,22	0,20	0,02	0,17	0,31	4,12	227	248	295
B5/C0°-70	0,21	0,16	0,05	0,15	0,30	0,42	245	323	355
B5/C45°-91	0,25	0,24	0,01	0,16	0,38	0,55	209	220	301
B5/C45°-101	0,26	0,21	0,05	0,18	0,40	0,58	201	247	290
B5/C45°-120	0,31	0,30	0,01	0,16	0,45	0,66	165	170	270
B5/C45°-121	0,22	0,22	0,00	0,20	0,35	0,52	248	247	255
B5/C45°-130	0,29	0,25	0,05	0,20	0,43	0,60	183	218	262

Deformation and foundation values of the embedding tests

Dowel-type fastener: $d = 17 \text{ mm}$
 Panel: **B12 (Beech)**

Test	w_i (mm)	$w_{i,mod}$ (mm)	w_s (mm)	w_e (mm)	w_{06} (mm)	w_{08} (mm)	K_i (N/mm ³)	K_s (N/mm ³)	K_e (N/mm ³)
B12/T0°-10	0,20	0,18	0,02	0,17	0,35	0,55	208	226	239
B12/T0°-20	0,56	0,59	-0,02	0,43	0,50	3,68	148	141	193
B12/T0°-30	0,26	0,24	0,02	0,31	0,42	0,62	161	173	131
B12/T0°-40	0,26	0,23	0,03	0,20	0,40	0,59	162	185	220
B12/T45°-80	0,15	0,31	0,07	0,29	0,49	0,64	164	158	167
B12/T45°-81	0,32	0,28	0,04	0,23	0,52	0,74	122	140	166
B12/T45°-90	0,29	0,29	0,01	0,24	0,48	0,68	134	137	159
B12/T45°-100	0,31	0,29	0,02	0,26	0,56	0,82	127	137	149
B12/T45°-110	0,33	0,32	0,01	0,31	0,60	0,86	120	125	133
B12/C0°-11	0,19	0,18	0,01	0,15	0,27	0,42	245	262	325
B12/C0°-50	0,23	0,20	0,03	0,16	0,32	4,79	223	257	323
B12/C0°-60	0,20	0,16	0,04	0,14	0,27	0,42	257	320	374
B12/C0°-70	0,20	0,17	0,03	0,13	0,29	0,44	245	287	362
B12/C45°-91	0,26	0,24	0,02	0,18	0,40	0,58	189	204	283
B12/C45°-101	0,43	0,57	-0,14	0,26	0,53	0,75	117	88	190
B12/C45°-120	0,34	0,27	0,07	0,23	0,45	0,62	139	176	204
B12/C45°-121	0,22	0,21	0,01	0,18	0,38	0,59	209	220	255
B12/C45°-130	0,21	0,20	0,01	0,16	0,36	0,55	225	234	273

Deformation and foundation values of the embedding tests

Dowel-type fastener: $d = 17 \text{ mm}$
 Panel: **B13 (Beech)**

Test	W_i (mm)	$W_{i,mod}$ (mm)	W_s (mm)	W_e (mm)	W_{06} (mm)	W_{08} (mm)	K_i (N/mm ³)	K_s (N/mm ³)	K_e (N/mm ³)
B13/T0°-10	0,17	0,19	-0,01	0,16	0,40	0,61	225	207	244
B13/T0°-20	0,18	0,22	-0,04	0,24	0,42	0,63	209	172	163
B13/T0°-30	0,22	0,26	-0,04	0,23	0,47	0,66	177	152	171
B13/T0°-40	0,25	0,20	0,05	0,15	0,52	0,74	152	194	260
B13/T45°-80	0,28	0,22	0,06	0,19	0,69	1,00	136	171	195
B13/T45°-81	0,27	0,24	0,02	0,22	0,64	0,91	149	164	180
B13/T45°-90	0,30	0,26	0,04	0,23	0,68	0,96	125	145	165
B13/T45°-100	0,25	0,24	0,02	0,19	0,67	0,97	148	159	206
B13/T45°-110	0,35	0,31	0,02	0,25	0,80	1,11	112	164	194
B13/C0°-11	0,12	0,10	0,02	0,12	0,30	0,48	392	493	482
B13/C0°-50	0,16	0,13	0,03	0,12	0,37	0,59	297	365	411
B13/C0°-60	0,16	0,14	0,02	0,13	0,28	0,46	386	449	490
B13/C0°-70	0,17	0,15	0,02	0,12	0,31	0,50	368	426	507
B13/C45°-91	0,24	0,20	0,04	0,16	0,37	0,58	271	326	390
B13/C45°-101	0,22	0,21	0,01	0,16	0,38	0,59	278	296	379
B13/C45°-120	0,22	0,21	0,01	0,18	0,39	0,60	279	293	343
B13/C45°-121	0,23	0,22	0,01	0,15	0,42	0,65	269	280	392
B13/C45°-130	0,25	0,21	0,04	0,18	0,40	5,12	250	292	325

Deformation and foundation values of the embedding tests

Dowel-type fastener: $d = 17 \text{ mm}$
 Panel: M1 (Beech)

Test	w_i (mm)	$w_{i,mod}$ (mm)	w_s (mm)	w_e (mm)	w_{06} (mm)	w_{08} (mm)	K_1 (N/mm ³)	K_s (N/mm ³)	K_e (N/mm ³)
M1/T0°-10	0,19	0,15	0,04	0,13	0,34	0,48	182	224	266
M1/T0°-20	0,19	0,16	0,03	0,12	0,37	0,51	181	218	272
M1/T0°-30	0,16	0,14	0,02	0,14	0,26	3,27	221	251	272
M1/T0°-40	0,17	0,15	0,01	0,13	0,34	0,53	210	229	271
M1/T45°-80	0,30	0,25	0,04	0,21	0,56	0,77	123	143	161
M1/T45°-81	0,21	0,20	0,01	0,18	0,43	0,62	164	174	190
M1/T45°-90	0,19	0,18	0,00	0,19	0,42	0,61	187	188	185
M1/T45°-100	0,26	0,24	0,03	0,20	0,52	0,73	133	148	177
M1/T45°-110	0,27	0,21	0,05	0,36	0,50	0,70	133	168	100
M1/C0°-11	0,13	0,11	0,01	0,09	0,22	0,40	316	349	405
M1/C0°-50	0,12	0,10	0,01	0,10	0,19	0,30	392	436	463
M1/C0°-60	0,13	0,11	0,02	0,09	0,23	0,34	362	419	510
M1/C0°-70	0,12	0,10	0,01	0,10	0,19	0,30	392	436	463
M1/C45°-91	0,21	0,14	0,07	0,14	0,37	0,52	208	308	277
M1/C45°-101	0,17	0,17	0,00	0,14	0,30	0,46	251	255	297
M1/C45°-120	0,22	0,17	0,05	0,15	0,38	0,55	193	245	286
M1/C45°-121	0,17	0,14	0,03	0,12	0,29	0,46	258	304	357
M1/C45°-130	0,17	0,16	0,01	0,12	0,30	0,45	251	274	348

Deformation and foundation values of the embedding tests

Dowel-type fastener: $d = 17 \text{ mm}$
 Panel: **M2 (Beech)**

Test	w_i (mm)	$w_{i,mod}$ (mm)	w_s (mm)	w_e (mm)	w_{06} (mm)	w_{08} (mm)	K_i (N/mm ³)	K_s (N/mm ³)	K_e (N/mm ³)
M2/T0°-10	0,23	0,18	0,06	0,15	0,36	0,50	190	249	306
M2/T0°-20	0,17	0,12	0,05	0,14	0,26	0,34	257	364	307
M2/T0°-30	0,24	0,19	0,05	0,15	0,35	0,47	172	219	266
M2/T0°-40	0,24	0,19	0,05	0,15	0,32	0,46	171	218	282
M2/T45°-80	0,30	0,29	0,01	0,24	0,58	0,81	139	144	168
M2/T45°-81	0,31	0,27	0,03	0,23	0,52	0,72	131	147	171
M2/T45°-90	0,31	0,29	0,02	0,27	0,50	0,70	126	135	146
M2/T45°-100	0,32	0,29	0,03	0,25	0,49	0,68	129	142	160
M2/T45°-110	0,31	0,27	0,04	0,24	0,57	0,79	133	154	174
M2/C0°-11	0,18	0,15	0,03	0,12	0,25	0,35	297	367	433
M2/C0°-50	0,29	0,21	0,08	0,19	0,41	0,54	171	239	278
M2/C0°-60	0,18	0,15	0,03	0,12	0,25	0,35	297	367	433
M2/C0°-70	0,17	0,14	0,03	0,17	0,21	0,31	290	355	359
M2/C45°-91	0,24	0,16	0,07	0,18	0,32	0,45	204	297	294
M2/C45°-101	0,24	0,21	0,03	0,17	0,33	0,47	201	232	264
M2/C45°-120	0,26	0,21	0,05	0,18	0,34	0,46	188	235	291
M2/C45°-121	0,27	0,25	0,02	0,20	0,36	0,51	181	194	265
M2/C45°-130	0,24	0,21	0,03	0,18	0,36	0,52	206	239	287

Deformation and foundation values of the embedding tests

Dowel-type fastener: $d = 17 \text{ mm}$
 Panel: **M7 (Beech)**

Test	W_i (mm)	$W_{i,mod}$ (mm)	W_s (mm)	W_e (mm)	W_{06} (mm)	W_{08} (mm)	K_i (N/mm ³)	K_s (N/mm ³)	K_e (N/mm ³)
M7/T0°-10	0,17	0,14	0,03	0,13	0,29	0,40	235	279	303
M7/T0°-20	0,14	0,13	0,01	0,12	0,25	0,35	276	295	332
M7/T0°-30	0,19	0,18	0,02	0,15	0,35	4,67	203	224	271
M7/T0°-40	0,21	0,17	0,03	0,14	0,31	0,46	187	222	277
M7/T45°-80	0,28	0,21	0,07	0,22	0,54	0,72	140	184	182
M7/T45°-81	0,26	0,24	0,02	0,23	0,47	0,65	148	163	209
M7/T45°-90	0,27	0,24	0,03	0,21	0,50	0,71	142	162	186
M7/T45°-100	0,25	0,25	0,01	0,21	0,46	0,64	150	154	173
M7/T45°-110	0,23	0,22	0,01	0,21	0,45	0,64	173	182	194
M7/C0°-11	0,19	0,13	0,06	0,09	0,26	0,34	249	375	544
M7/C0°-50	0,20	0,18	0,02	0,17	0,28	0,38	234	264	324
M7/C0°-60	0,15	0,12	0,03	0,12	0,23	0,34	309	377	391
M7/C0°-70	0,18	0,13	0,05	0,16	3,76	0,37	263	359	306
M7/C45°-91	0,31	0,15	0,16	0,09	0,43	0,52	150	305	514
M7/C45°-101	0,22	0,16	0,06	0,09	0,31	0,43	210	285	562
M7/C45°-120	0,24	0,19	0,05	0,15	0,35	0,47	194	245	333
M7/C45°-121	0,30	0,23	0,07	0,21	0,42	0,57	161	211	246
M7/C45°-130	0,23	0,18	0,06	0,15	0,37	0,53	198	259	295

Deformation and foundation values of the embedding tests

Dowel-type fastener:

d = 17 mm

Panel:

M8 (Beech)

Test	W_i (mm)	$W_{i,mod}$ (mm)	W_s (mm)	W_e (mm)	W_{06} (mm)	W_{08} (mm)	K_1 (N/mm ³)	K_s (N/mm ³)	K_e (N/mm ³)
M8/T0°-10	0,17	0,15	0,01	0,15	0,30	0,43	245	266	287
M8/T0°-20	0,23	0,19	0,03	0,17	0,34	0,48	186	219	252
M8/T0°-30	0,23	0,18	0,05	0,17	0,36	0,48	188	239	254
M8/T0°-40	0,28	0,23	0,04	0,16	0,40	0,54	150	178	238
M8/T45°-80	0,28	0,24	0,04	0,22	0,49	0,68	148	173	195
M8/T45°-81	0,30	0,27	0,03	0,23	0,49	0,68	143	157	191
M8/T45°-90	0,28	0,24	0,05	0,20	0,48	0,67	148	177	193
M8/T45°-100	0,28	0,24	0,03	0,21	0,52	0,00	146	166	191
M8/T45°-110	0,34	0,30	0,05	0,22	0,53	0,73	123	141	185
M8/C0°-11	0,21	0,12	0,09	0,14	0,26	0,37	223	384	338
M8/C0°-50	0,22	0,10	0,13	0,15	0,24	0,31	226	527	353
M8/C0°-60	0,19	0,16	0,03	0,14	0,26	0,36	255	305	374
M8/C0°-70	0,20	0,15	0,05	0,15	0,00	0,33	249	335	348
M8/C45°-91	0,27	0,22	0,04	0,20	0,37	0,53	185	222	267
M8/C45°-101	0,23	0,18	0,05	0,19	0,36	0,51	218	273	266
M8/C45°-120	0,24	0,22	0,02	0,14	0,35	0,50	207	230	354
M8/C45°-121	0,24	0,20	0,04	0,20	0,00	0,46	209	253	262
M8/C45°-130	0,32	0,25	0,07	0,18	0,42	0,56	159	201	302

Deformation and foundation values of the embedding tests

Dowel-type fastener: $d = 17 \text{ mm}$
 Panel: P1 (Beech)

Test	w_i (mm)	$w_{i,mod}$ (mm)	w_s (mm)	w_e (mm)	w_{06} (mm)	w_{08} (mm)	K_i (N/mm ³)	K_s (N/mm ³)	K_e (N/mm ³)
P1/T0°-10	0,20	0,17	0,03	0,14	0,32	0,45	194	226	269
P1/T0°-20	0,22	0,19	0,03	0,19	0,35	4,28	182	213	217
P1/T0°-30	0,23	0,19	0,05	0,18	0,36	0,49	174	219	227
P1/T0°-40	0,16	0,15	0,02	0,11	3,46	0,44	251	282	361
P1/T45°-80	0,28	0,25	0,04	0,24	0,50	4,64	147	170	177
P1/T45°-81	0,31	0,25	0,05	0,22	0,51	0,69	137	165	188
P1/T45°-90	0,27	0,24	0,03	0,21	0,44	0,59	158	179	190
P1/T45°-100	0,26	0,25	0,01	0,21	0,45	0,61	161	169	185
P1/T45°-110	0,29	0,26	0,04	0,23	0,46	4,36	143	163	186
P1/C0°-11	0,27	0,16	0,12	0,17	0,35	0,46	168	294	302
P1/C0°-50	0,16	0,13	0,02	0,11	0,22	0,31	293	341	383
P1/C0°-60	0,20	0,15	0,05	0,13	0,29	0,41	224	305	343
P1/C0°-70	0,14	0,12	0,02	0,10	0,23	0,34	332	383	416
P1/C45°-91	0,19	0,18	0,01	0,16	0,33	0,48	259	274	308
P1/C45°-101	0,20	0,20	0,00	0,22	0,34	0,49	243	246	265
P1/C45°-120	0,29	0,23	0,05	0,20	0,40	0,55	177	217	264
P1/C45°-121	0,35	0,23	0,12	0,15	0,46	0,60	147	223	305
P1/C45°-130	0,22	0,17	0,04	0,17	0,32	0,00	233	290	312

Deformation and foundation values of the embedding tests

Dowel-type fastener: $d = 17 \text{ mm}$
 Panel: **P3 (Beech)**

Test	w_1 (mm)	$w_{f,mod}$ (mm)	w_s (mm)	w_e (mm)	w_{06} (mm)	w_{08} (mm)	K_1 (N/mm ³)	K_s (N/mm ³)	K_e (N/mm ³)
P3/T0°-10	0,38	0,19	0,19	0,15	0,53	0,67	97	193	236
P3/T0°-20	0,38	0,19	0,19	0,15	0,53	0,67	97	193	236
P3/T0°-30	0,20	0,17	0,03	0,17	0,33	0,45	197	232	237
P3/T0°-40	0,22	0,18	0,03	0,16	0,34	0,47	180	211	241
P3/T45°-80	0,25	0,20	0,05	0,19	0,48	4,10	151	190	197
P3/T45°-81	0,27	0,22	0,04	0,20	0,51	0,70	149	177	196
P3/T45°-90	0,27	0,23	0,04	0,21	0,49	0,68	142	166	179
P3/T45°-100	0,24	0,23	0,01	0,19	0,41	0,58	160	170	188
P3/T45°-110	0,25	0,23	0,03	0,20	0,47	2,80	154	171	187
P3/C0°-11	0,28	0,15	0,13	0,13	4,31	0,47	156	294	335
P3/C0°-50	0,12	0,12	0,00	0,10	0,21	0,32	374	383	428
P3/C0°-60	0,18	0,15	0,03	0,12	0,27	0,37	246	299	372
P3/C0°-70	0,16	0,08	0,08	0,12	0,24	0,34	274	544	366
P3/C45°-91	0,18	0,13	0,04	0,14	0,32	0,45	264	349	370
P3/C45°-101	0,23	0,17	0,06	0,12	0,33	0,45	206	280	338
P3/C45°-120	0,20	0,18	0,02	0,14	0,32	4,61	230	250	293
P3/C45°-121	0,36	0,18	0,18	0,15	0,49	3,75	128	262	310
P3/C45°-130	0,34	0,21	0,12	0,17	0,49	3,59	132	210	268

Deformation and foundation values of the embedding tests

Dowel-type fastener: $d = 17 \text{ mm}$
 Panel: **P5 (Beech)**

Test	w_1 (mm)	$w_{i,mod}$ (mm)	w_s (mm)	w_e (mm)	w_{06} (mm)	w_{08} (mm)	K_1 (N/mm ³)	K_s (N/mm ³)	K_e (N/mm ³)
P5/T0°-10	0,16	0,14	0,02	0,12	0,33	4,37	211	238	258
P5/T0°-20	0,18	0,17	0,01	0,12	0,37	3,93	181	195	264
P5/T0°-30	0,19	0,17	0,02	0,12	0,37	0,52	174	191	276
P5/T0°-40	0,20	0,14	0,06	0,14	0,39	0,52	165	234	230
P5/T45°-80	0,23	0,21	0,02	0,21	0,50	0,68	142	154	154
P5/T45°-81	0,24	0,21	0,03	0,17	0,52	0,71	136	155	186
P5/T45°-90	0,27	0,19	0,08	0,21	0,49	0,66	119	167	156
P5/T45°-100	0,20	0,19	0,01	0,21	0,46	0,65	159	168	181
P5/T45°-110	0,24	0,20	0,03	0,19	0,48	4,05	130	152	165
P5/C0°-11	0,18	0,13	0,05	0,11	0,30	4,90	219	297	377
P5/C0°-50	0,11	0,07	0,04	0,09	0,23	0,34	346	543	473
P5/C0°-60	0,18	0,13	0,05	0,11	0,30	4,90	219	297	377
P5/C0°-70	0,15	0,13	0,02	0,10	0,26	0,37	260	302	396
P5/C45°-91	0,20	0,17	0,02	0,14	0,36	0,49	199	225	297
P5/C45°-101	0,17	0,14	0,03	0,16	0,33	4,86	229	285	245
P5/C45°-120	0,17	0,14	0,03	0,13	0,36	0,52	225	270	275
P5/C45°-121	0,16	0,15	0,01	0,14	0,33	0,48	229	245	259
P5/C45°-130	0,17	0,17	0,00	0,14	0,34	0,50	224	219	281

Deformation and foundation values of the embedding tests

Dowel-type fastener: $d = 17 \text{ mm}$
 Panel: **P7 (Beech)**

T _{test}	W_i (mm)	$W_{i,mod}$ (mm)	W_s (mm)	W_e (mm)	W_{06} (mm)	W_{08} (mm)	K_1 (N/mm ³)	K_s (N/mm ³)	K_e (N/mm ³)
P7/T0°-10	0,17	0,15	0,01	0,13	0,26	0,38	249	273	306
P7/T0°-20	0,31	0,24	0,07	0,18	0,40	0,54	139	178	219
P7/T0°-30	0,31	0,24	0,07	0,18	0,40	0,54	139	178	219
P7/T0°-40	0,23	0,21	0,03	0,18	0,35	0,48	180	202	229
P7/T45°-80	0,26	0,22	0,03	0,20	0,46	0,62	163	188	206
P7/T45°-81	0,30	0,26	0,04	0,23	0,49	0,67	140	161	181
P7/T45°-90	0,26	0,24	0,03	0,22	0,46	0,63	161	178	199
P7/T45°-100	0,28	0,24	0,04	0,21	0,46	0,63	147	175	199
P7/T45°-110	0,27	0,24	0,02	0,23	0,47	0,66	153	168	174
P7/C0°-11	0,18	0,17	0,01	0,15	0,23	4,21	279	300	341
P7/C0°-50	0,26	0,18	0,08	0,14	4,92	0,41	197	283	382
P7/C0°-60	0,15	0,13	0,02	0,12	0,24	0,35	330	388	405
P7/C0°-70	0,17	0,15	0,02	0,14	0,28	0,39	296	312	380
P7/C45°-91	0,20	0,13	0,07	0,14	0,30	0,43	256	384	349
P7/C45°-101	0,23	0,21	0,02	0,19	0,35	0,48	214	230	257
P7/C45°-120	0,20	0,15	0,04	0,16	0,31	0,44	243	313	316
P7/C45°-121	0,23	0,21	0,03	0,17	0,36	0,49	211	237	285
P7/C45°-130	0,21	0,19	0,01	0,15	0,31	0,44	236	251	301