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## SADEV Architectural Glass Systems

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### Report:

Deflection testing of the Barrier  
SABCO modular balustrade  
system.

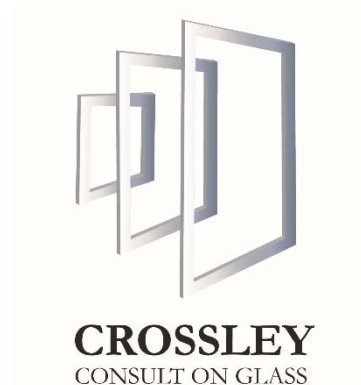
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Crossley Consult

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## 2 INTRODUCTION

- 2.1 SADEV has designed and manufactured a modular balustrade system, which comprises of an aluminium base channel called Barrier SABCO (SADEV Balustrade Concept) for which they require witnessed line load testing. The Barrier SABCO aluminium base channels have previously been subjected to testing according to the French standards (CSTB).

In a number of other European countries including the United Kingdom, a code of practice; BS EN 6180:2011, Barriers in and about buildings- defines the requirements of a balustrade system that is used for the protection and guidance of persons. BS EN 6180:2011 defines the appropriate imposed loads and the performance limits loads such as a deflection limit of 25mm at the design level.

The Barrier SABCO system is available in 2 mount configurations, a floor mount and a side mount. Both configurations are to be subjected to line load testing.

- 2.2 The Barrier SABCO system is suitable for both monolithic and laminated glass ranging between 15 mm and 25.52mm.
- 2.3 The deflection tests were conducted at the premises of Kite Glass on 22<sup>nd</sup> and 23<sup>rd</sup> April 2015 under the supervision of Crossley Consult Ltd.

In attendance:

Daniel Edwards	Crossley Consult Ltd.
Suzanne Arnold	Crossley Consult Ltd.
Cyril Dagand	SADEV Architectural Glass System.
Graham Walker	Barrier Components Ltd.

## 3 METHOD

### 3.1 Glass Compositions

3.1.1 Eight glass panes of various sizes were tested.

1. 15mm monolithic clear toughened, 1000mm wide x 1200mm high
2. 16.9mm laminated toughened comprising two plies of 8mm toughened glass with a 0.89mm SentryGlas® interlayer, 1000mm wide x 1200mm high
3. 19mm monolithic clear toughened, 990mm wide x 1200mm high
4. 20.76mm laminated toughened comprising two plies 10mm toughened glass with a 0.76mm Solutia DG41 interlayer, 1000mm wide x 1200mm high

5. 20.9mm laminated toughened comprising two plies of 10mm toughened glass with a 0.89mm SentryGlas® interlayer, 1000mm wide x 1200mm high
6. 21.52mm laminated toughened comprising two plies of 10mm toughened glass with a 1.5mm polyvinyl butyral (PVB) interlayer, 1000mm wide x 1200mm high
7. 21.52mm laminated toughened comprising two plies of 10mm toughened glass with a 1.5mm EVA interlayer, 1200mm wide x 1360mm high
8. 24.9mm laminated toughened comprising two plies 12mm toughened glass with a 0.89mm SentryGlas® interlayer, 1000mm wide x 1200mm high

## 3.2 Apparatus

3.2.1 The Barrier SABCO floor mounting base channel and side mounting base channel were bolted onto a strong back test rig designed specifically for testing barriers under load using M10 G8.8 hex head bolts at 400mm centres (unless otherwise stated). The base channel is also capable of being bolted at 200mm centres if required. The strong back set up is shown in Figure 1 below, and a typical bolt fixing detail for the channels in Figure 2 below.

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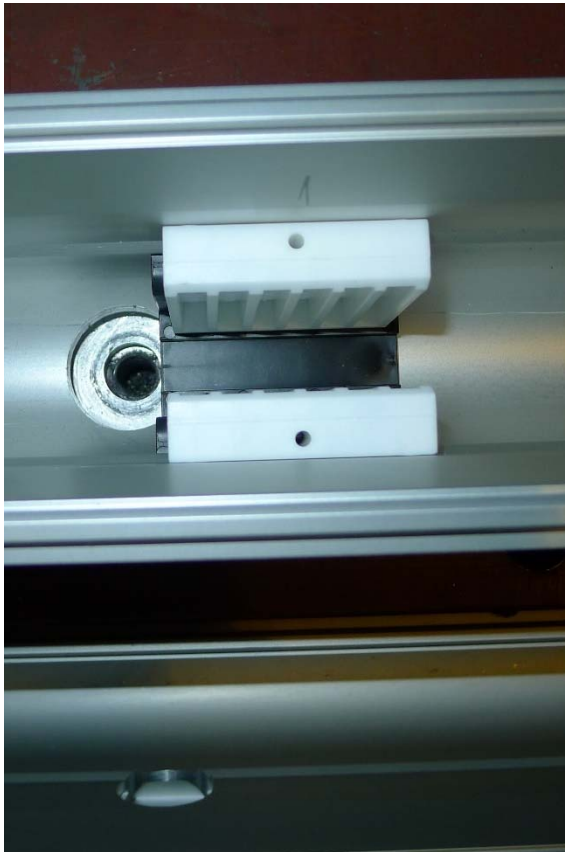


**Figure 1 Strongback prior to glass installation**



**Figure 2 typical bolt fixtures at 400mm centres.**

3.2.2. Each glass sample was installed within the Barrier SABCO base channel with the appropriate number of clamps at 250 mm centres (4 for 990mm and 1000mm width, and 5 for 1200mm width) and fully secured (Figure 3). For the monolithic panes polypropylene shims were installed between the clamp and the glass as illustrated in Figure 4.



**Figure 3** Typical lower section of clamp, an upper section is attached post glass installation to allow line and level to be set and the glass to be held firmly in place.



**Figure 4** Shim for monolithic panels in situ, prior to fixing in position with the top section of the clamp.

3.2.3 The line load was applied using a small hydraulic piston attached to a spreader bar, and measured using a calibrated Mecmesin load cell with a digital read out. The height of the spreader bar was adjusted to 1100mm above finished floor level, and the load applied directly to the glass. The deflection of the glass was measured by individually mounted deflection gauges, a 50mm travel dial gauge reading in increments of 0.01mm at the design level (1100mm from FFL) and a 25mm travel dial gauge reading in increments of 0.01mm at the top of the base channel.

3.2.4 The upper travel gauge measured the overall deflection of the glass at design level, and the lower the deflection at the top of the base channel situated between clamps as shown in Figure 5 and Figure 6 below.



Figure 5 Upper dial gauge in situ



Figure 6 Lower dial gauge

### 3.3 Procedure

3.3.1 Three test loads were assessed, a line load of 0.74 kN/m run, a line load of 1.5 kN/m run and a line load of 3.0 kN/m run. In each case the load applied was appropriate to the requirements of BS EN 6180:2011.

3.3.2 BS 6180:2011 section 6.4.1 states that “for serviceability considerations, the limiting condition for deflection appropriate for a barrier for the protection of people is that the total horizontal displacement of the barrier at any point from its original unloaded position should not exceed the deflection limits determined from the relevant structural design code (where applicable) for the material used, or 25 mm, whichever is the smaller.” Whilst BS 6180:2011 section 8.5.1 states that for free-standing glass protective barriers “the glass should be designed to satisfy the appropriate design

criteria given in Clause 6. The deflection of the glass should be no greater than 25 mm at any point.”

3.3.3 For each load case and glass type, the following procedure was used:

- Install glass into the channel
- Manually pump the hydraulic jack until the load indicator shows the correct preload (equivalent to the correct load) and hold it for 60 seconds
- Remove the load
- Zero the load indicator
- Record a zero load deflection reading
- Manually pump the hydraulic jack until the load indicator shows the correct load (adjusted if necessary for the panel width).
- Immediately record the two deflection gauge readings.
- Record further deflection readings every 30 seconds after the first reading for a period of 5 minutes. Manually adjust the jack to maintain the correct load during this period.
- Remove the load.

3.3.4 Table 1 below shows the combinations of load and glass composition tested. For the 3.0 kN/m line load additional fixings were added to secure the base channel at 200mm centres.

**Table 1 - Glass types and load combinations tested**

	Floor Mount			Side Mount		
	0.74 kN/m	1.5 kN/m	3.0 kN/m	0.74 kN/m	1.5 kN/m	3.0 kN/m
15mm Monolithic	X			X		
16.9mm Laminated (SGP)	X	X		X		
19mm Monolithic		X		X	X	
20.76mm Laminated (DG41)		X			X	
20.9mm Laminated (SGP)		X			X	
21.52mm Laminated (PVB)	X	X		X		
21.52mm Laminated (EVA)	X	X		X	X	
24.9mm Laminated (SGP)			X			



## 4 RESULTS

- 4.1 Instantaneous deflection results were recorded, along with the creep over 5 minutes. Table 2 below indicates the instantaneous deflection results for the load and glass combinations tested. The values in yellow exceeded the permissible deflection limits. For the panels with an instantaneous deflection  $\leq 25.00\text{mm}$  graphs illustrating the creep over 5 minutes can be found in Appendix 7.

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Table 2 - Instantaneous deflections

	Floor Mount			Side Mount		
	0.74 kN/m	1.5 kN/ m	3.0 kN/m	0.74 kN/m	1.5 kN/m	3.0 kN/m
15mm Monolithic	17.1			19.4		
16.9mm Laminated (SGP)	15.0	27.9		15.0		
19mm Monolithic		22.6		12.3	26.55	
20.76mm Laminated (DG41)		19.1			21.5	
20.9mm Laminated (SGP)		16.7			21.0	
21.52mm Laminated (PVB)	12.9	29.6		13.0		
21.52mm Laminated (EVA)	12.5	25.0		12.5	28.6	
24.9mm Laminated (SGP) (200mm centres)			28.3			

## 5 DISCUSSION

- 5.1 For each base configuration tested with a horizontal uniformly distributed load of up to 1.5 kN/m, applied at 1100mm from FFL, there are multiple glazing types which will fulfil the BS 6180:2011 instantaneous deflection performance requirement of under 25 mm.
- 5.2 None of the glazing types tested offered an instantaneous deflection of under 25 mm when subjected to a 3.0 kN/m horizontal line load.
- 5.3 Table 3, below summarises the tested solutions that achieved an instantaneous deflection below 25 mm in accordance with the BS 6180:2011 requirements.

Table 3 – Glass and load combinations with an instantaneous deflection within the BS6180:2011 standard of 25mm

	Floor Mount			Side Mount		
	0.74 kN/m	1.5 kN/m	3.0 kN/m	0.74 kN/m	1.5 kN/m	3.0 kN/m
15mm Monolithic	X			X		
16.9mm Laminated (SGP)	X			X		
19mm Monolithic		X		X		
20.76mm Laminated (DG41)		X			X	
20.9mm Laminated (SGP)		X			X	
21.52mm Laminated (PVB)	X			X		
21.52mm Laminated (EVA)	X	X		X		
24.9mm Laminated (SGP)						

## 6 REMARKS

- 6.1 The polypropylene shims installed with the monolithic panes exhibited mild distortion post-test, indicating that the polypropylene material is compressing and is not rigid enough to fully support the glass and that the deflection will continue to creep upwards for the duration of the applied load Figure 7. It is understood that these polypropylene shims are to be replaced by a different material.

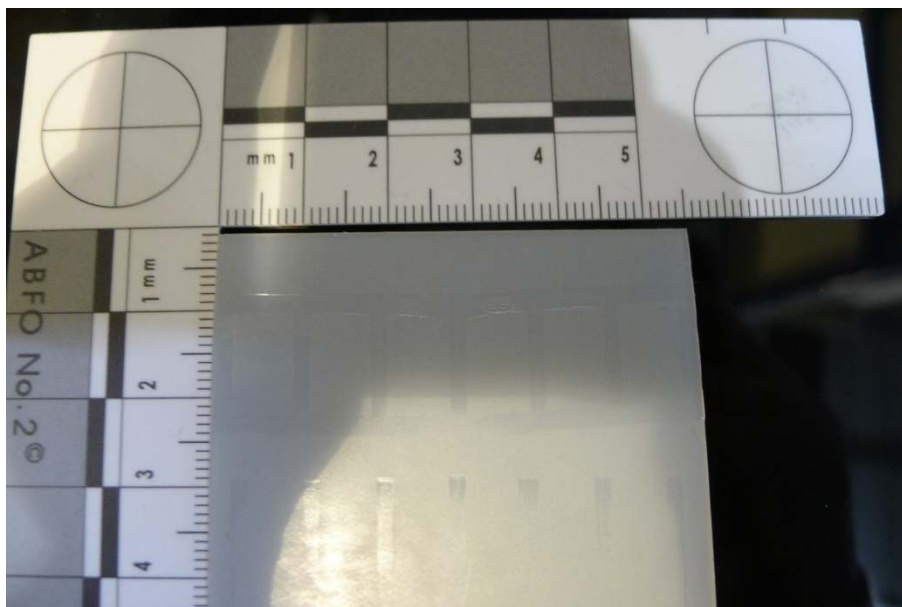


Figure 7 shim for monolithic post-test, showing mild distortion

- 6.2 The lower deflection measurements show a high level of consistency across the different glass and applied load combinations and minimal increase during the duration

of the applied load. The channel may deflect further in line with the base clamps where the load is being transmitted onto the channel structure; however this point was unable to be measured during testing.

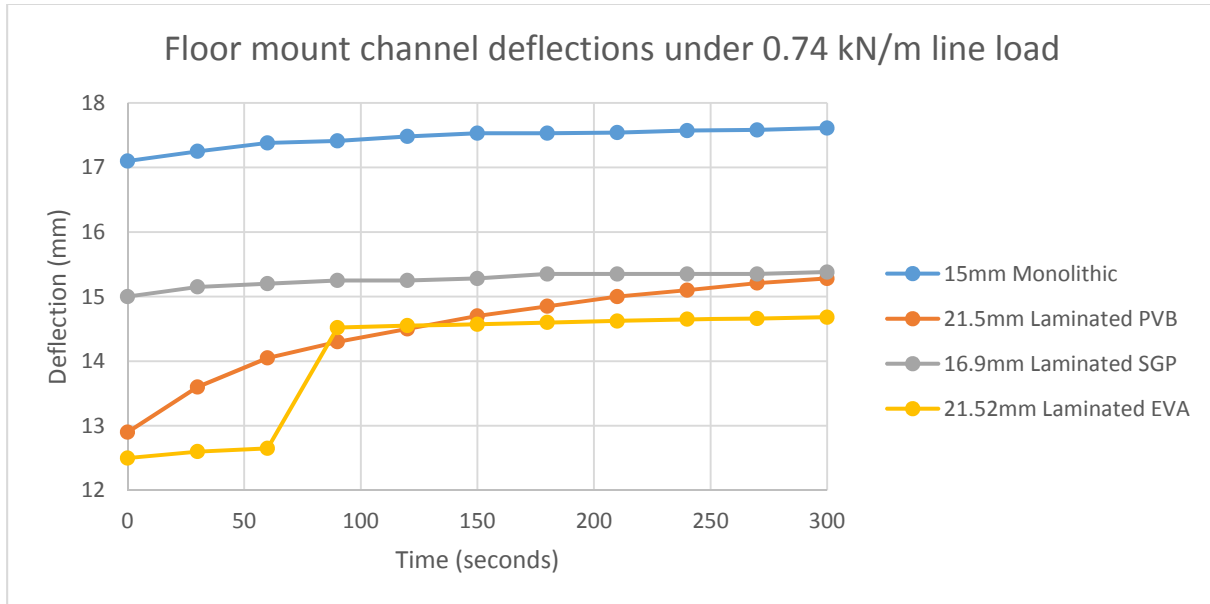
- 6.3 Under the 0.74 kN/m line load the top mounted 21.52mm EVA exhibited a significant jump in deflection between 60 seconds and 90 seconds. This jump corresponded with a drop in the applied load during the same time duration. This is believed to have been caused by the clamps settling into a new position and is not expected to occur should the combination be retested.

Crossley Consult Ltd

April 2015

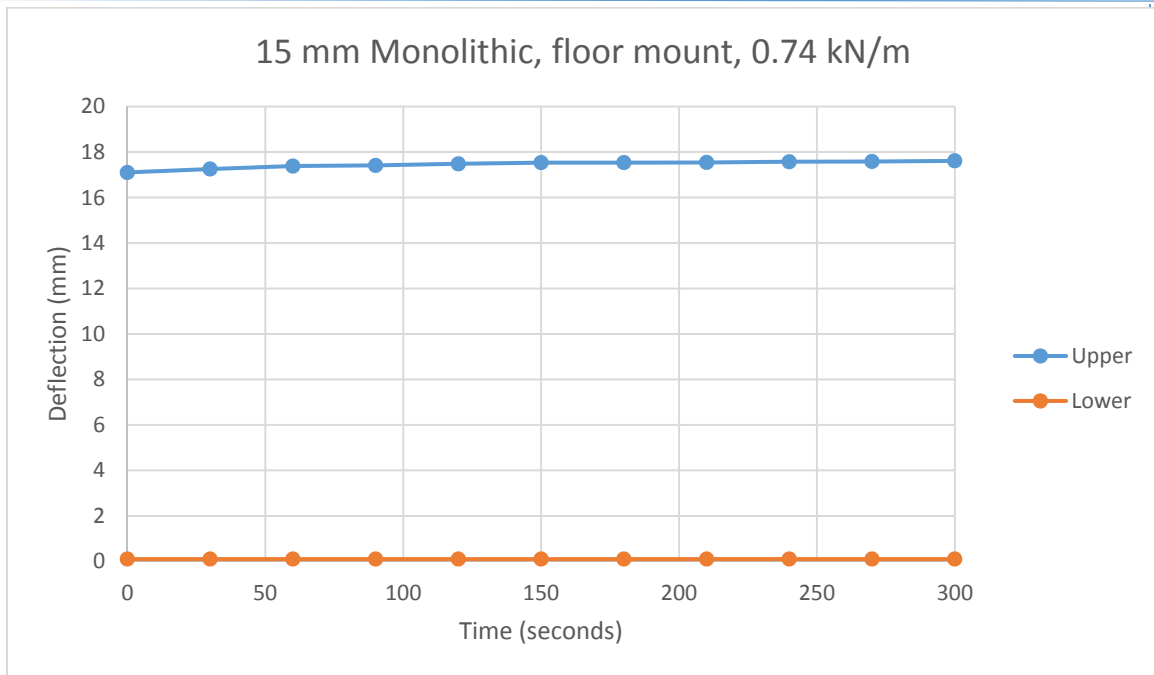
## 7 APPENDICES

### 7.1 0.74 kN/m run floor mount



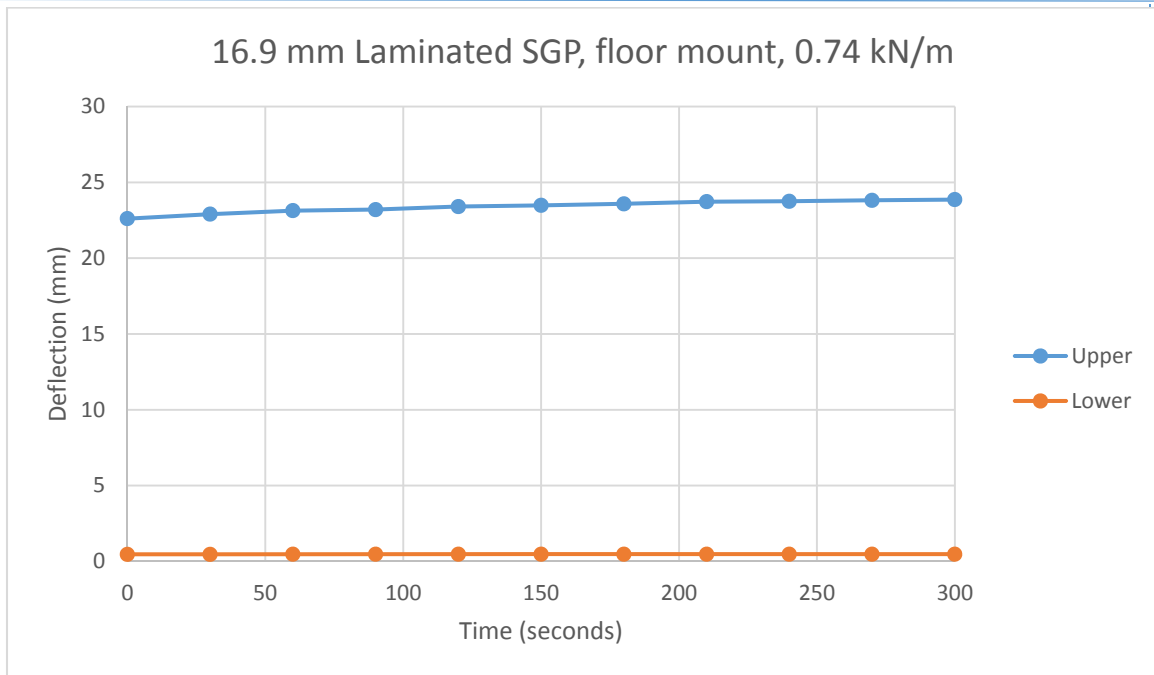
#### 7.1.1 15mm Monolithic, floor mount, 0.74 kN/m line load

Time	Deflection gauge reading		Deflection (mm)	
	Upper	Lower	Upper	Lower
Zero reading	1000	600		
0 seconds	2710	610	17.10	0.10
30 seconds	2725	610	17.25	0.10
60 seconds	2738	610	17.38	0.10
90 seconds	2741	610	17.41	0.10
120 seconds	2748	610	17.48	0.10
150 seconds	2753	610	17.53	0.10
180 seconds	2753	610	17.53	0.10
210 seconds	2754	610	17.54	0.10
240 seconds	2757	610	17.57	0.10
270 seconds	2758	610	17.58	0.10
300 seconds	2761	610	17.61	0.10



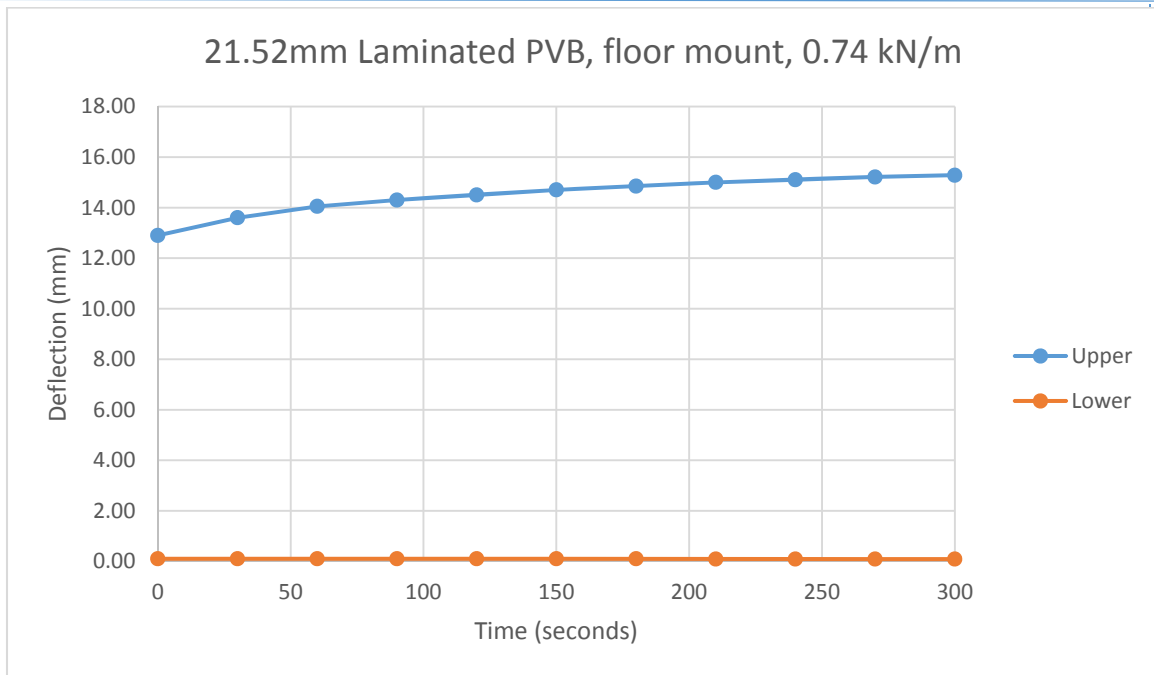
**7.1.2 16.9mm Laminated SGP, floor mount, 0.74 kN/m line load**

Time	Deflection gauge reading		Deflection (mm)	
	Upper	Lower	Upper	Lower
Zero reading	1000	200		
0 seconds	3260	246	22.60	0.46
30 seconds	3290	246	22.90	0.46
60 seconds	3313	247	23.13	0.47
90 seconds	3320	247	23.20	0.47
120 seconds	3340	247	23.40	0.47
150 seconds	3348	247	23.48	0.47
180 seconds	3358	247	23.58	0.47
210 seconds	3372	247	23.72	0.47
240 seconds	3375	247	23.75	0.47
270 seconds	3381	247	23.81	0.47
300 seconds	3386	247	23.86	0.47



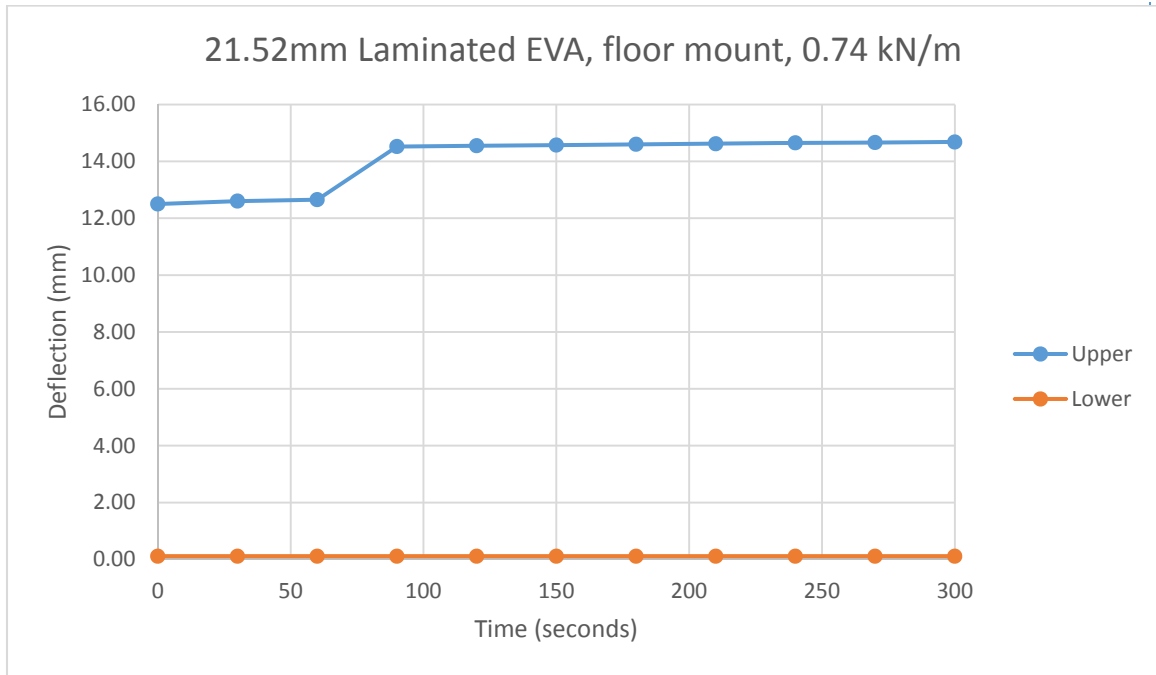
**7.1.3 21.52mm Laminated PVB, floor mount, 0.74 kN/m line load**

Time	Deflection gauge reading		Deflection (mm)	
	Upper	Lower	Upper	Lower
Zero reading	1000	800		
0 seconds	2290	810	12.90	0.10
30 seconds	2360	810	13.60	0.10
60 seconds	2405	810	14.05	0.10
90 seconds	2430	810	14.30	0.10
120 seconds	2450	810	14.50	0.10
150 seconds	2470	810	14.70	0.10
180 seconds	2485	810	14.85	0.10
210 seconds	2500	809	15.00	0.09
240 seconds	2510	809	15.10	0.09
270 seconds	2521	809	15.21	0.09
300 seconds	2528	809	15.28	0.09

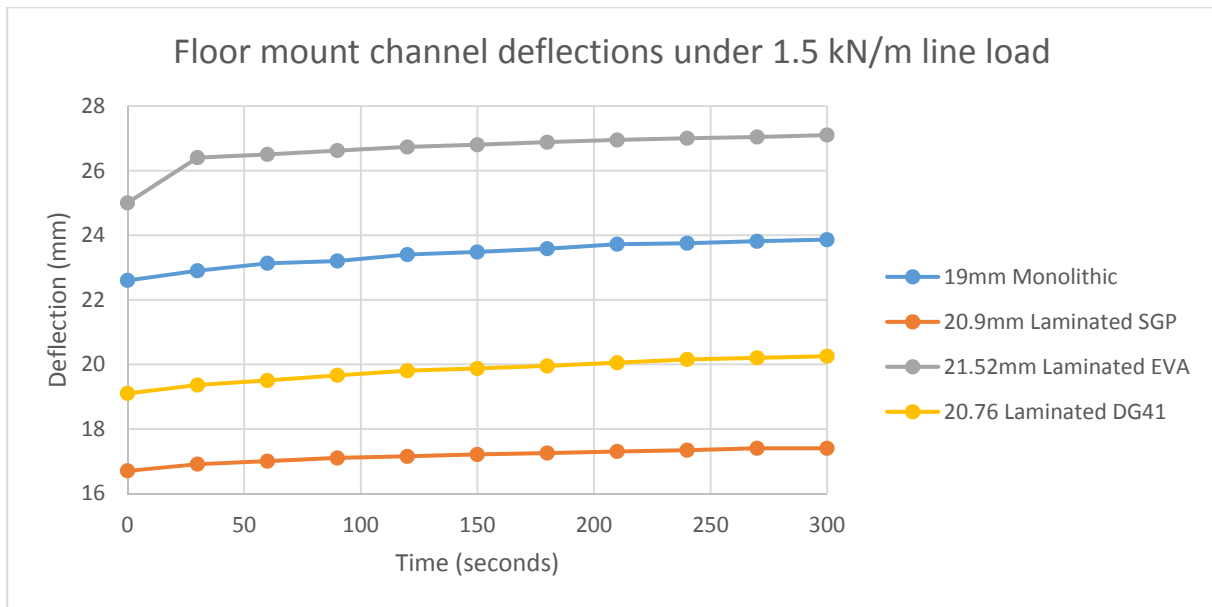


**7.1.4 21.52 Laminated EVA, floor mount, 0.74 kN/m line load**

Time	Deflection gauge reading		Deflection (mm)	
	Upper	Lower	Upper	Lower
Zero reading	500	500		
0 seconds	1750	511	12.50	0.11
30 seconds	1760	511	12.60	0.11
60 seconds	1765	511	12.65	0.11
90 seconds	1952	210	14.52	0.11
120 seconds	1955	210	14.55	0.11
150 seconds	1957	210	14.57	0.11
180 seconds	1960	210	14.60	0.11
210 seconds	1962	210	14.62	0.11
240 seconds	1965	210	14.65	0.11
270 seconds	1966	210	14.66	0.11
300 seconds	1968	210	14.68	0.11



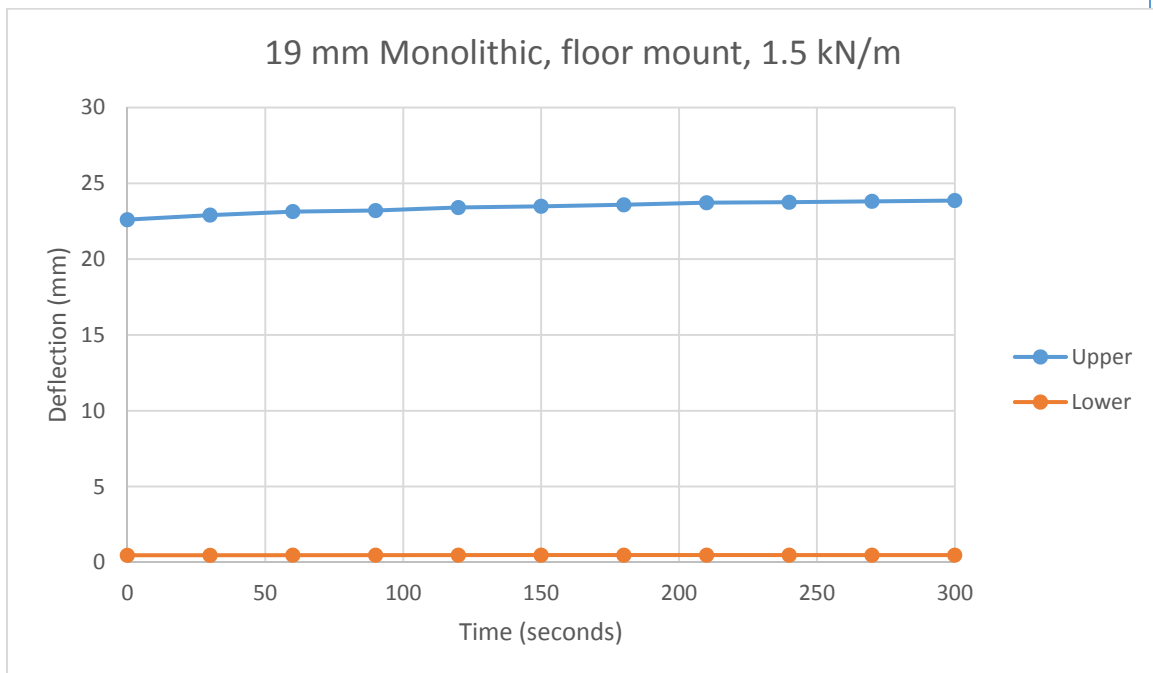
7.2 1.5 kN/m run floor mount





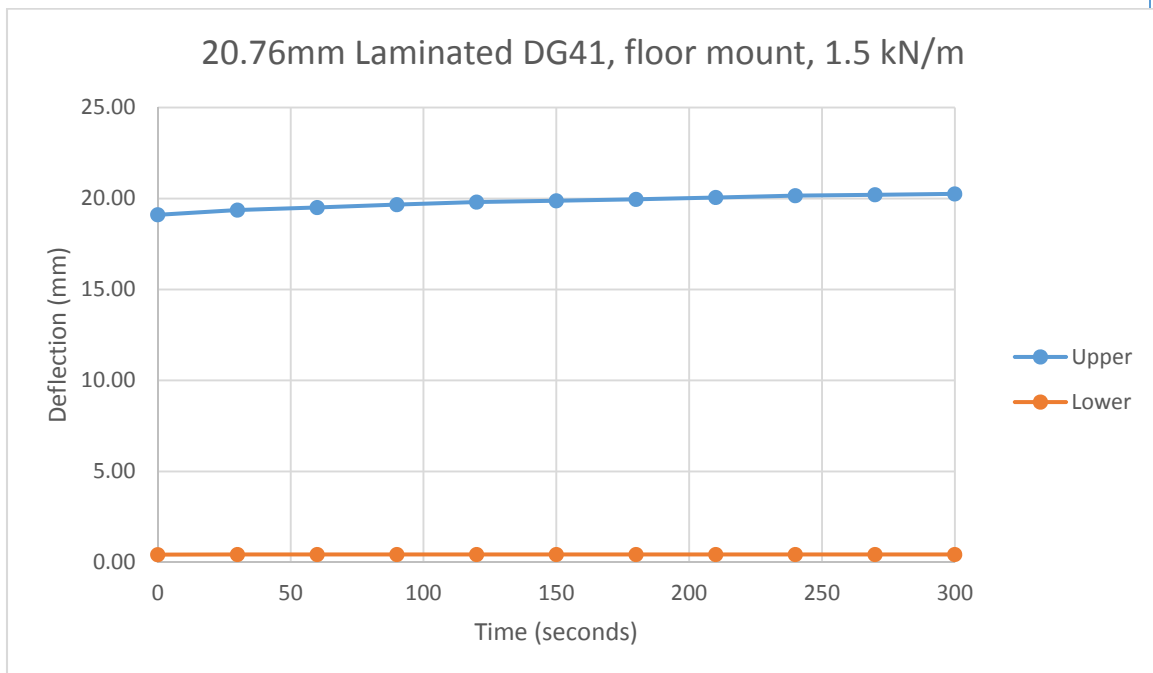
7.2.1 19mm Monolithic, floor mount, 1.5 kN/m line load

Time	Deflection gauge reading		Deflection (mm)	
	Upper	Lower	Upper	Lower
Zero reading	1000	200		
0 seconds	3260	246	22.60	0.46
30 seconds	3290	246	22.90	0.46
60 seconds	3313	247	23.13	0.47
90 seconds	3320	247	23.20	0.47
120 seconds	3340	247	23.40	0.47
150 seconds	3348	247	23.48	0.47
180 seconds	3358	247	23.58	0.47
210 seconds	3372	247	23.72	0.47
240 seconds	3375	247	23.75	0.47
270 seconds	3381	247	23.81	0.47
300 seconds	3386	247	23.86	0.47



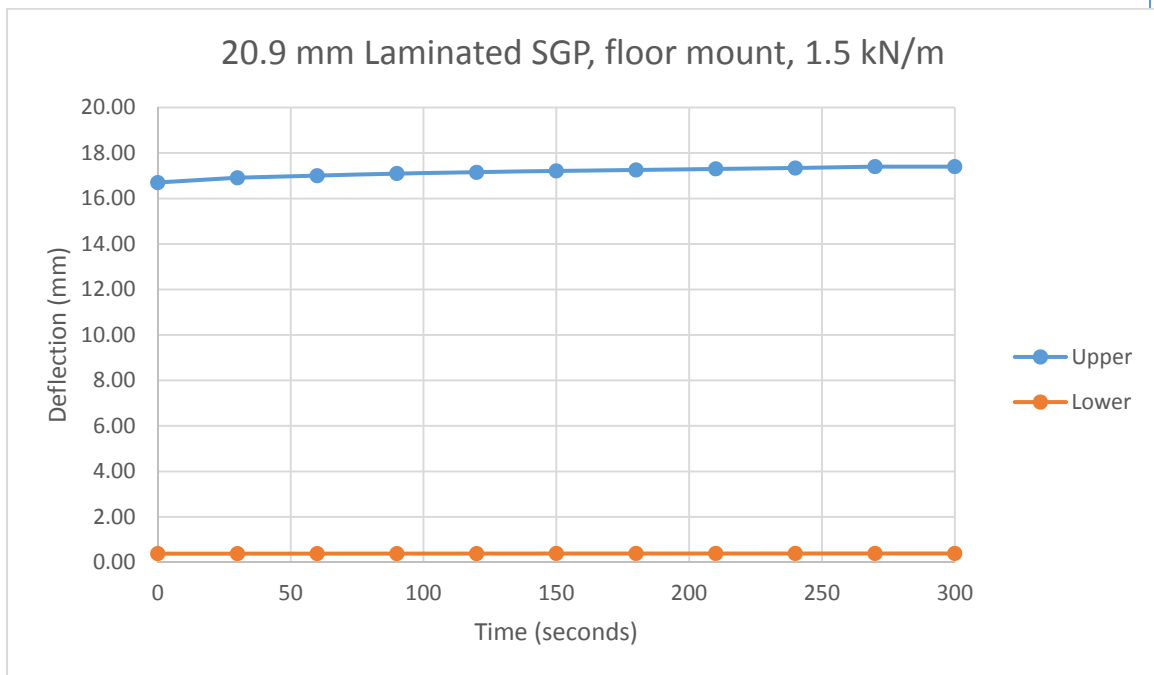
7.2.2 20.76mm Laminated DG41, floor mount, 1.5 kN/m line load

Time	Deflection gauge reading		Deflection (mm)	
	Upper	Lower	Upper	Lower
Zero reading	1000	300		
0 seconds	2910	342	19.10	0.42
30 seconds	2936	343	19.36	0.43
60 seconds	2950	343	19.50	0.43
90 seconds	2966	343	19.66	0.43
120 seconds	2980	343	19.80	0.43
150 seconds	2987	343	19.87	0.43
180 seconds	2995	343	19.95	0.43
210 seconds	3005	343	20.05	0.43
240 seconds	3015	343	20.15	0.43
270 seconds	3020	343	20.20	0.43
300 seconds	3025	343	20.25	0.43



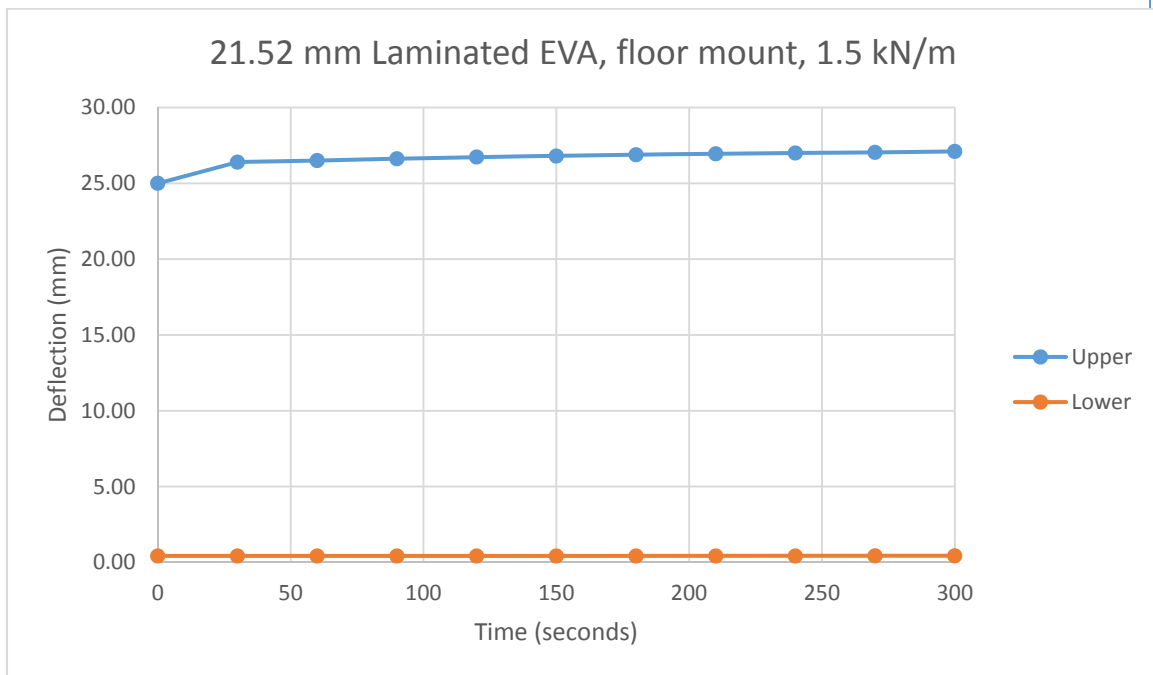
7.2.3 20.9mm Laminated SGP, floor mount, 1.5 kN/m line load

Time	Deflection gauge reading		Deflection (mm)	
	Upper	Lower	Upper	Lower
Zero reading	600	500		
0 seconds	2270	538	16.70	0.38
30 seconds	2291	538	16.91	0.38
60 seconds	2300	538	17.00	0.38
90 seconds	2310	538	17.10	0.38
120 seconds	2315	538	17.15	0.38
150 seconds	2321	539	17.21	0.39
180 seconds	2325	539	17.25	0.39
210 seconds	2330	539	17.30	0.39
240 seconds	2334	539	17.34	0.39
270 seconds	2340	539	17.40	0.39
300 seconds	2340	539	17.40	0.39

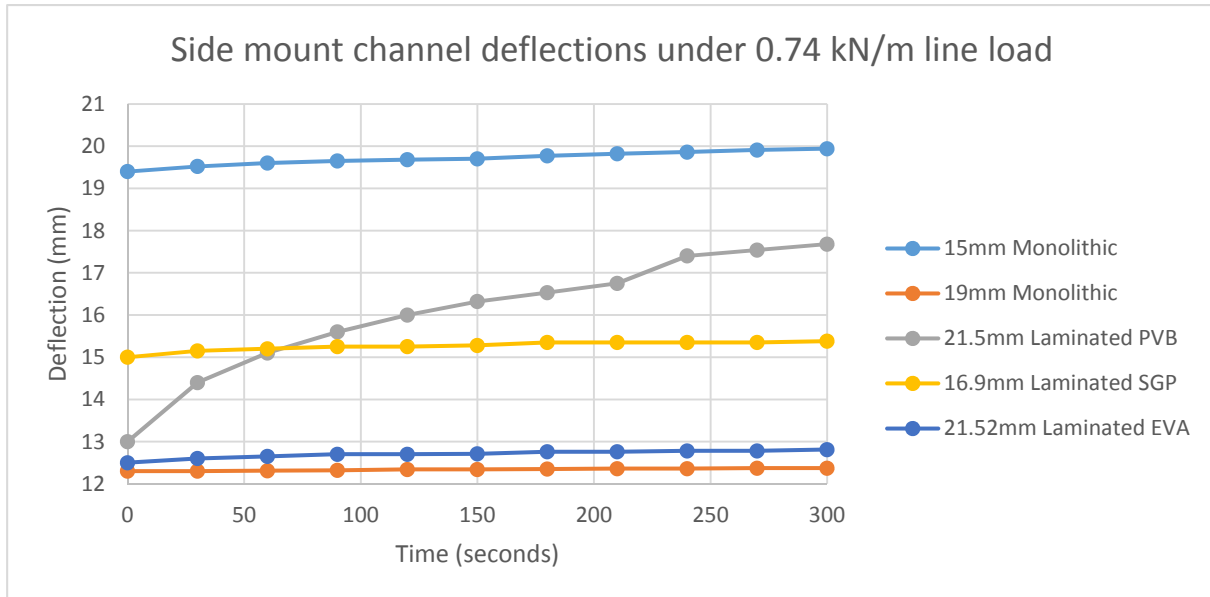


7.2.4 21.52mm Laminated EVA, floor mount, 1.5 kN/m line load

Time	Deflection gauge reading		Deflection (mm)	
	Upper	Lower	Upper	Lower
Zero reading	900	200		
0 seconds	3400	242	25.00	0.42
30 seconds	3540	242	26.40	0.42
60 seconds	3550	242	26.50	0.42
90 seconds	3562	242	26.62	0.42
120 seconds	3573	242	26.73	0.42
150 seconds	3580	242	26.80	0.42
180 seconds	3588	242	26.88	0.42
210 seconds	3595	242	26.95	0.42
240 seconds	3600	242	27.00	0.42
270 seconds	3604	243	27.04	0.43
300 seconds	3610	243	27.10	0.43

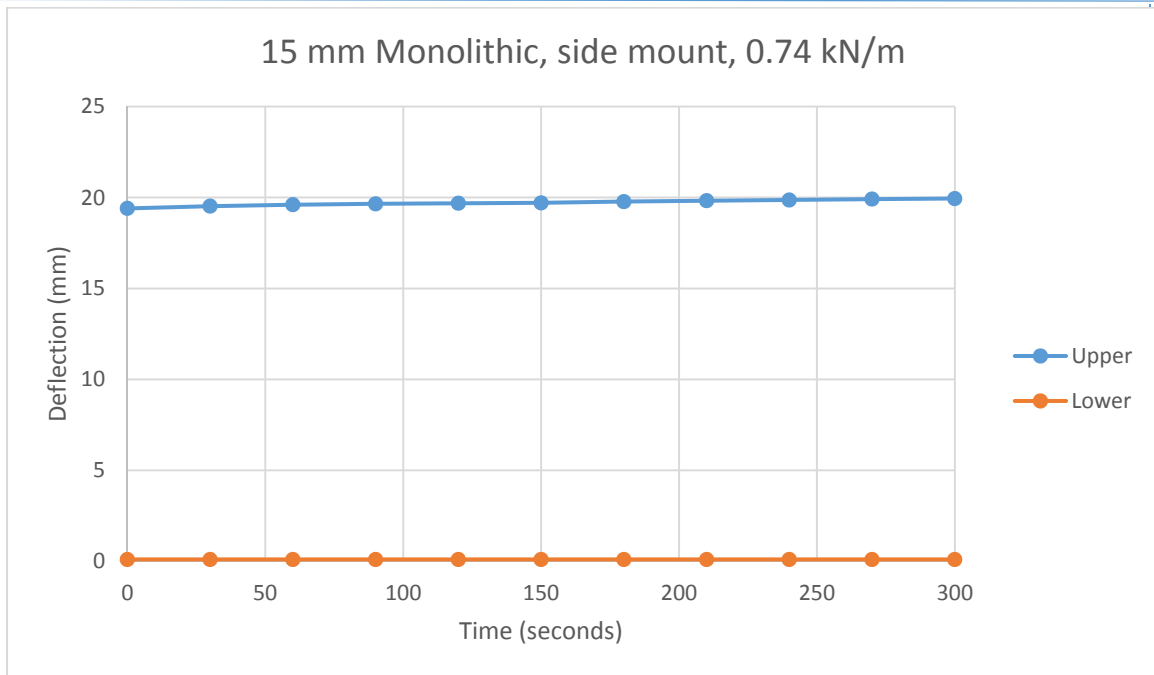


### 7.3 0.74 kN/m run side mount



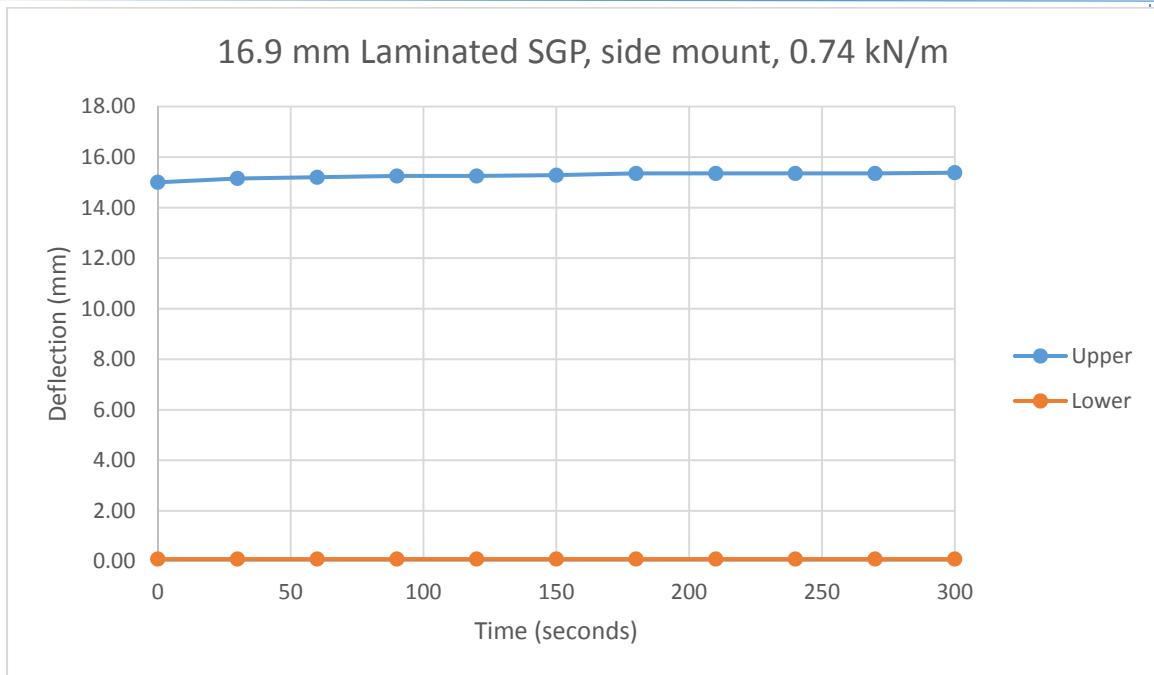
#### 7.3.1 15mm Monolithic, side mount, 0.74 kN/m line load

Time	Deflection gauge reading		Deflection (mm)	
	Upper	Lower	Upper	Lower
Zero reading	600	500		
0 seconds	2540	510	19.40	0.10
30 seconds	2552	510	19.52	0.10
60 seconds	2560	510	19.6	0.10
90 seconds	2565	510	19.65	0.10
120 seconds	2568	510	19.68	0.10
150 seconds	2570	510	19.70	0.10
180 seconds	2577	510	19.77	0.10
210 seconds	2582	510	19.82	0.10
240 seconds	2586	510	19.86	0.10
270 seconds	2591	510	19.91	0.10
300 seconds	2594	510	19.94	0.10



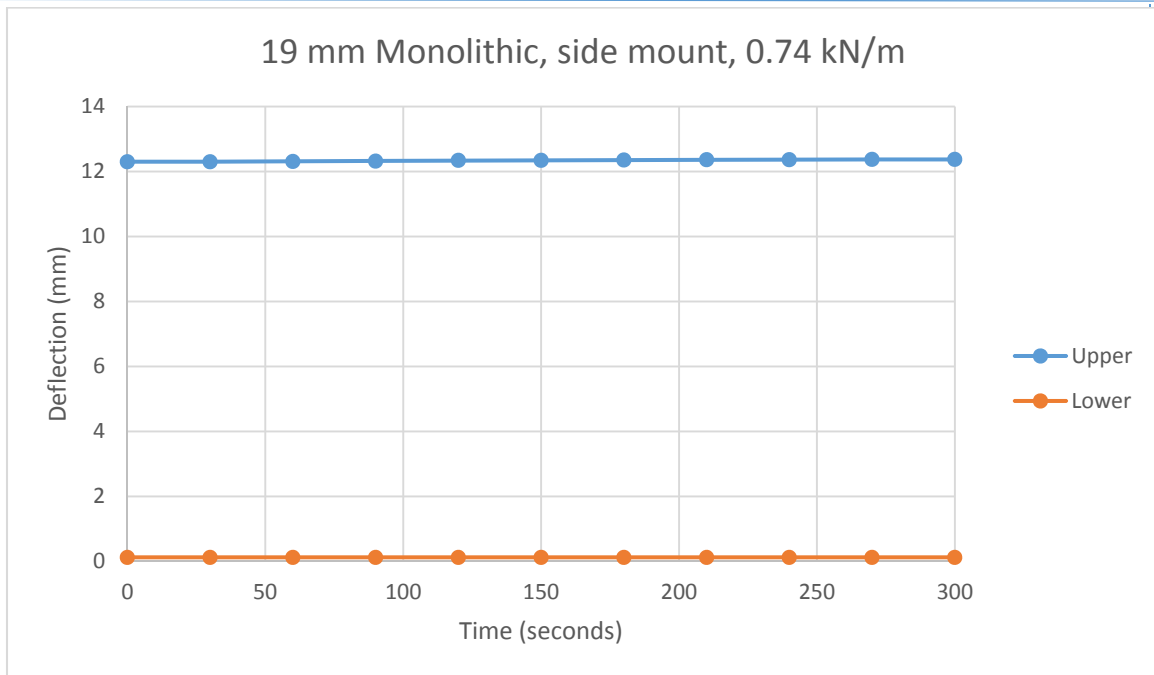
**7.3.2 16.9mm Laminated SGP, side mount, 0.74 kN/m line load**

Time	Deflection gauge reading		Deflection (mm)	
	Upper	Lower	Upper	Lower
Zero reading	400	700		
0 seconds	1900	709	15.00	0.09
30 seconds	1915	709	15.15	0.09
60 seconds	1920	709	15.20	0.09
90 seconds	1925	709	15.25	0.09
120 seconds	1925	709	15.25	0.09
150 seconds	1928	709	15.28	0.09
180 seconds	1935	709	15.35	0.09
210 seconds	1935	709	15.35	0.09
240 seconds	1935	709	15.35	0.09
270 seconds	1935	709	15.35	0.09
300 seconds	1938	709	15.38	0.09



**7.3.3 19mm Monolithic, side mount, 0.74 kN/m line load**

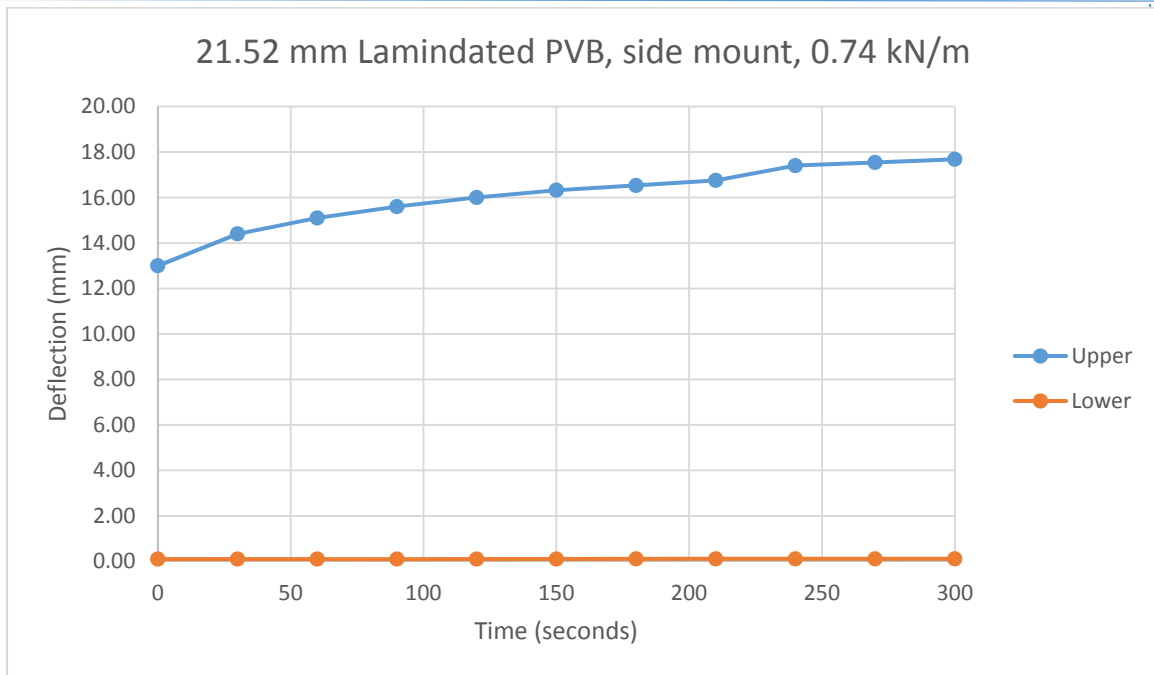
Time	Deflection gauge reading		Deflection (mm)	
	Upper	Lower	Upper	Lower
Zero reading	1300	400		
0 seconds	2530	412	12.3	0.12
30 seconds	2530	412	12.3	0.12
60 seconds	2531	412	12.31	0.12
90 seconds	2532	412	12.32	0.12
120 seconds	2534	412	12.34	0.12
150 seconds	2534	412	12.34	0.12
180 seconds	2535	412	12.35	0.12
210 seconds	2536	412	12.36	0.12
240 seconds	2536	412	12.36	0.12
270 seconds	2537	412	12.37	0.12
300 seconds	2537	412	12.37	0.12



**7.3.4 21.52mm Laminated PVB, side mount, 0.74 kN/m line load**

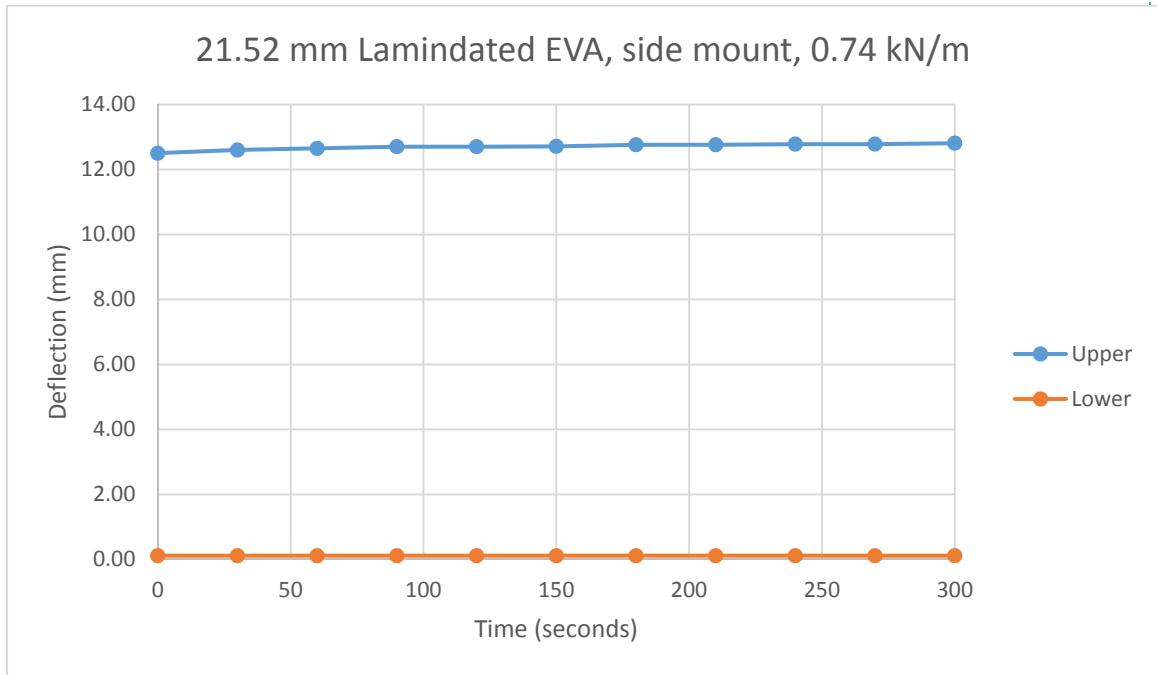
Time	Deflection gauge reading		Deflection (mm)	
	Upper	Lower	Upper	Lower
Zero reading	1000	1000		
0 seconds	2300	1010	13.00	0.10
30 seconds	2440	1010	14.40	0.10
60 seconds	2510	1010	15.10	0.10
90 seconds	2560	1010	15.60	0.10
120 seconds	2600	1010	16.00	0.10
150 seconds	2632	1010	16.32	0.10
180 seconds	2653	1011	16.53	0.11
210 seconds	2675	1011	16.75	0.11
240 seconds	2740	1011	17.40	0.11
270 seconds	2754	1011	17.54	0.11
300 seconds	2768	1011	17.68	0.11



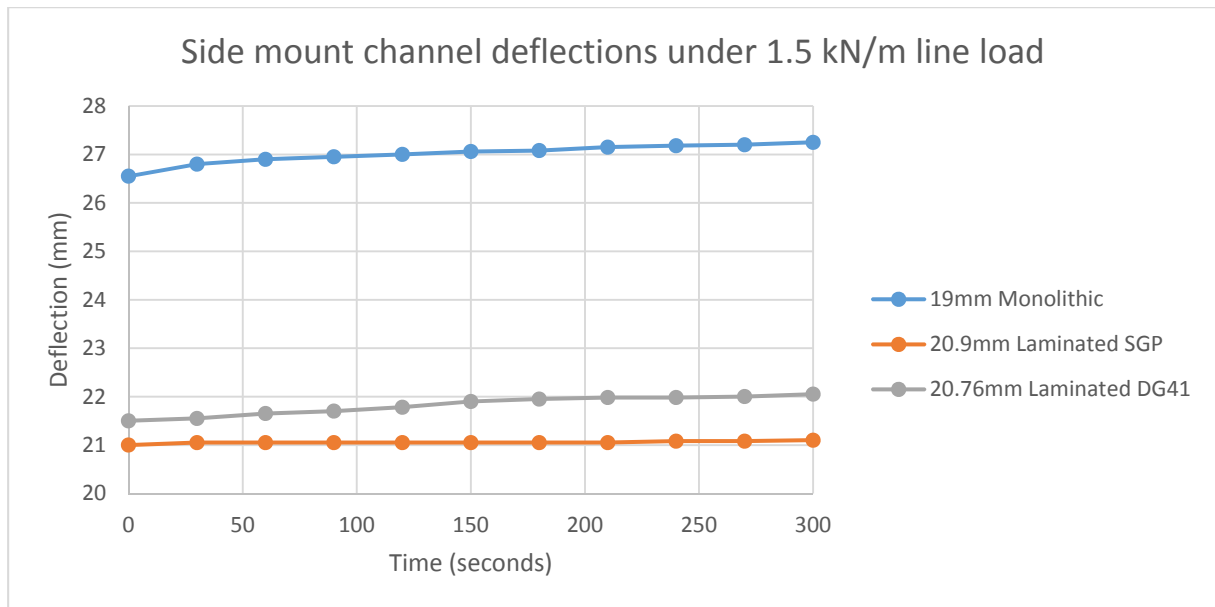


**7.3.5 21.52mm Laminated EVA, side mount, 0.74 kN/m line load**

Time	Deflection gauge reading		Deflection (mm)	
	Upper	Lower	Upper	Lower
Zero reading	500	500		
0 seconds	1750	511	12.50	0.11
30 seconds	1760	511	12.60	0.11
60 seconds	1765	511	12.65	0.11
90 seconds	1770	511	12.70	0.11
120 seconds	1770	511	12.70	0.11
150 seconds	1771	511	12.71	0.11
180 seconds	1776	511	12.76	0.11
210 seconds	1776	511	12.76	0.11
240 seconds	1778	511	12.78	0.11
270 seconds	1778	511	12.78	0.11
300 seconds	1781	511	12.81	0.11

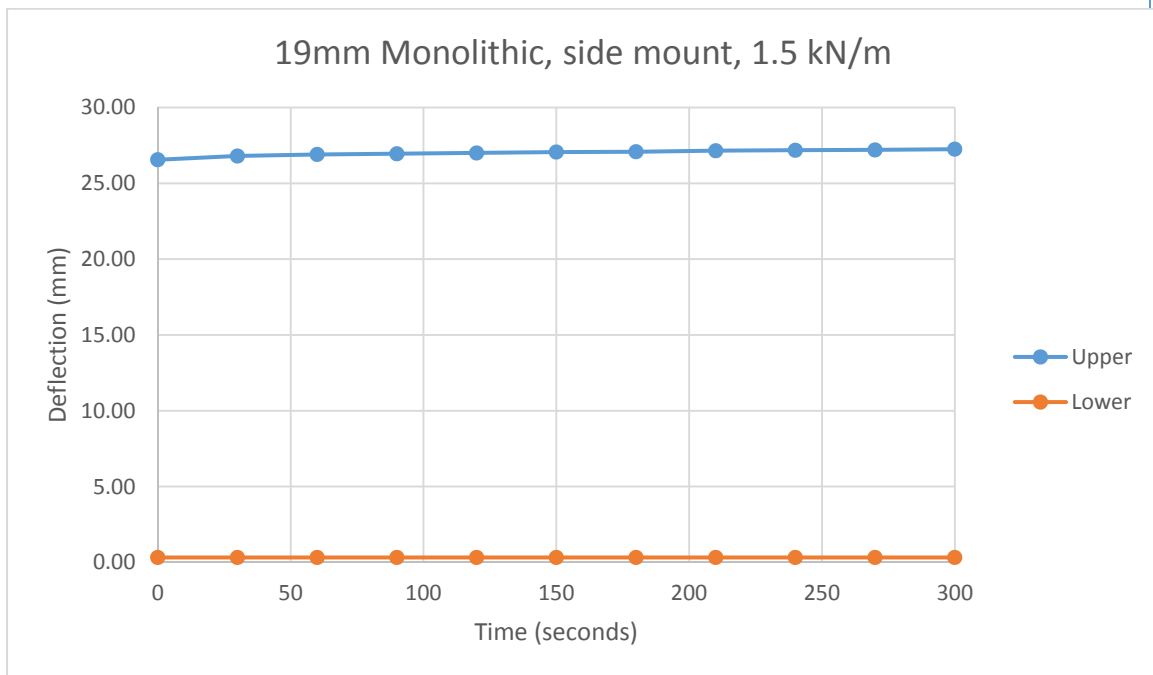


7.4 1.5 kN/m run side mount



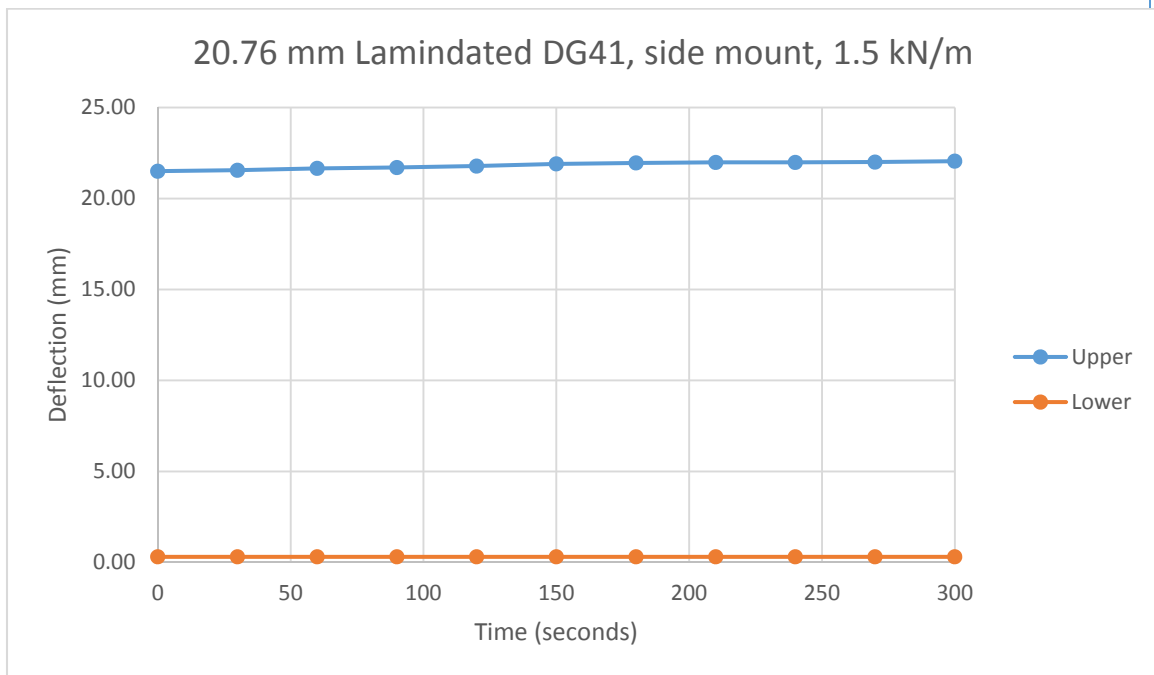
7.4.1 19mm Monolithic, side mount, 1.5 kN/m line load

Time	Deflection gauge reading		Deflection (mm)	
	Upper	Lower	Upper	Lower
Zero reading	1100	400		
0 seconds	3755	432	26.55	0.32
30 seconds	3780	432	26.80	0.32
60 seconds	3790	432	26.90	0.32
90 seconds	3795	432	26.95	0.32
120 seconds	3800	432	27.00	0.32
150 seconds	3806	432	27.06	0.32
180 seconds	3808	432	27.08	0.32
210 seconds	3815	432	27.15	0.32
240 seconds	3818	432	27.18	0.32
270 seconds	3820	432	27.20	0.32
300 seconds	3825	432	27.25	0.32



7.4.2 20.76mm Laminated DG41, side mount, 1.5 kN/m line load

Time	Deflection gauge reading		Deflection (mm)	
	Upper	Lower	Upper	Lower
Zero reading	600	1100		
0 seconds	2750	1130	21.50	0.30
30 seconds	2755	1130	21.55	0.30
60 seconds	2765	1130	21.65	0.30
90 seconds	2770	1130	21.70	0.30
120 seconds	2778	1130	21.78	0.30
150 seconds	2790	1130	21.90	0.30
180 seconds	2795	1130	21.95	0.30
210 seconds	2798	1130	21.98	0.30
240 seconds	2798	1130	21.98	0.30
270 seconds	2800	1130	22.00	0.30
300 seconds	2805	1130	22.05	0.30



7.4.3 20.9mm Laminated SGP, side mount, 1.5 kN/m line load

Time	Deflection gauge reading		Deflection (mm)	
	Upper	Lower	Upper	Lower
Zero reading	1000	600		
0 seconds	3100	631	21.00	0.31
30 seconds	3105	632	21.05	0.32
60 seconds	3105	632	21.05	0.32
90 seconds	3105	632	21.05	0.32
120 seconds	3105	631	21.05	0.31
150 seconds	3105	631	21.05	0.31
180 seconds	3105	631	21.05	0.31
210 seconds	3105	631	21.05	0.31
240 seconds	3108	631	21.08	0.31
270 seconds	3108	631	21.08	0.31
300 seconds	3110	631	21.10	0.31

