MONARCH Z CLIP
Load Testing Summary

MONARCH
METAL FABRICATION

INTRODUCTION

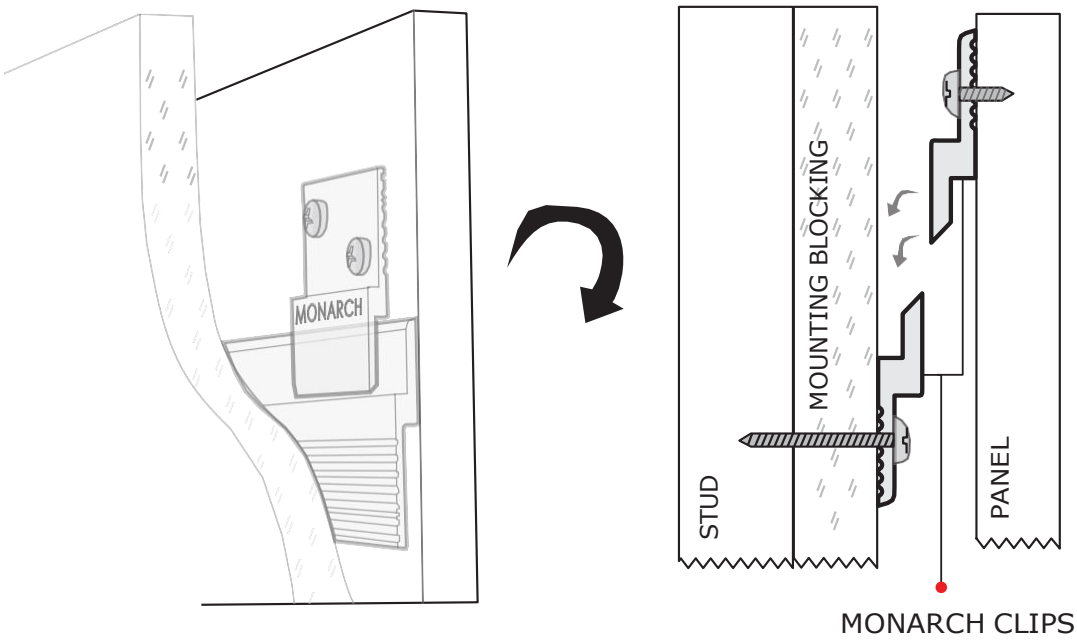
One of the most frequent requests at Monarch Metal is for the load-bearing information of our Monarch Z Clip Systems for installing panels, signs, and artwork. In all of the internal tests Monarch has done, it has been the screws holding the Monarch Clips that fail and not the Monarch Clip itself. However, the question has come up frequently enough that we engaged Qualtim, Inc., a third-party independent laboratory, to perform testing on the clips.

TESTING DESIGN

As part of the test design, we set out to understand the mode of failure and relative strength for the most common installations. To understand the mode of failure, one has to start with the elements that are important to determining the strength of the system. The 5 elements to consider are:

1) The mounting surface for the continuous lengths.
   For example, will they be mounted to wood studs or metal studs?
   Will there be blocking? Drywall?
2) What screw is being used to mount the continuous length?
   Is it a sheet metal screw, a wood screw, or a specialty
   screw? How long is the screw? What is the diameter?
3) Which Monarch Clip is being used? Stainless Steel or Aluminum?
4) What is the material, thickness, and size of the item being hung?
5) What screw is being used to mount the shorter panel clips to the back of the panel?

Figure 1. Monarch Z Clip Cut Through Drawing



We only give all of these questions to illustrate the number of variables to control for when testing and show the difficulty of designing an appropriate test. These variables do not even include the typical variables to consider such as the environment of the installation as well as the direction of the force (assumed to be entirely in shear in this testing.)

To try to address the widest cross-section of applications, we designed three different tests.

1) The first test was designed to test the load at which the Monarch Z Clips pull out from the backside of the panel.
2) The second test was designed to test the load at which the system would fail in a standard installation of a 19,05 mm thick MDF veneered panel onto steel studs with 19.05 mm OSB blocking.
3) The third test was designed to test the load at which the system would fail in a standard installation of a 19.05 mm thick MDF veneered panel onto wood studs with 12,7 mm gypsum sheathing.

STANDARD INSTALLATION

A standard installation of a 19,05 mm Thick, 1219,2 mm Wide x 2438,4 mm Tall MDF panel, involves mounting three different continuous lengths along the wall parallel to the floor. The continuous lengths would be spaced approximately 762 mm apart. The continuous lengths are fastened to studs at a minimum of every 406,4 mm on the center with the appropriate screw. Our testing was done with 22 Gauge Metal Studs and Wood Studs and the results would not apply to weaker substrates. Installers often use 19,05 mm blocking in front of the wall to allow for added fasteners every 203,2 mm on the center along the wall. Along the panel, installers would typically use 12 panel clips on the back of the panel; 4-panel clips at each height to interlock with each of the 3 continuous lengths. These clips would be spaced 304,8 to 381 mm apart and fastened to the back of the panel with (2) #8 x 19,05 mm Pan Head Deep Thread Screws for a total of 24 screws in a typical panel installation.

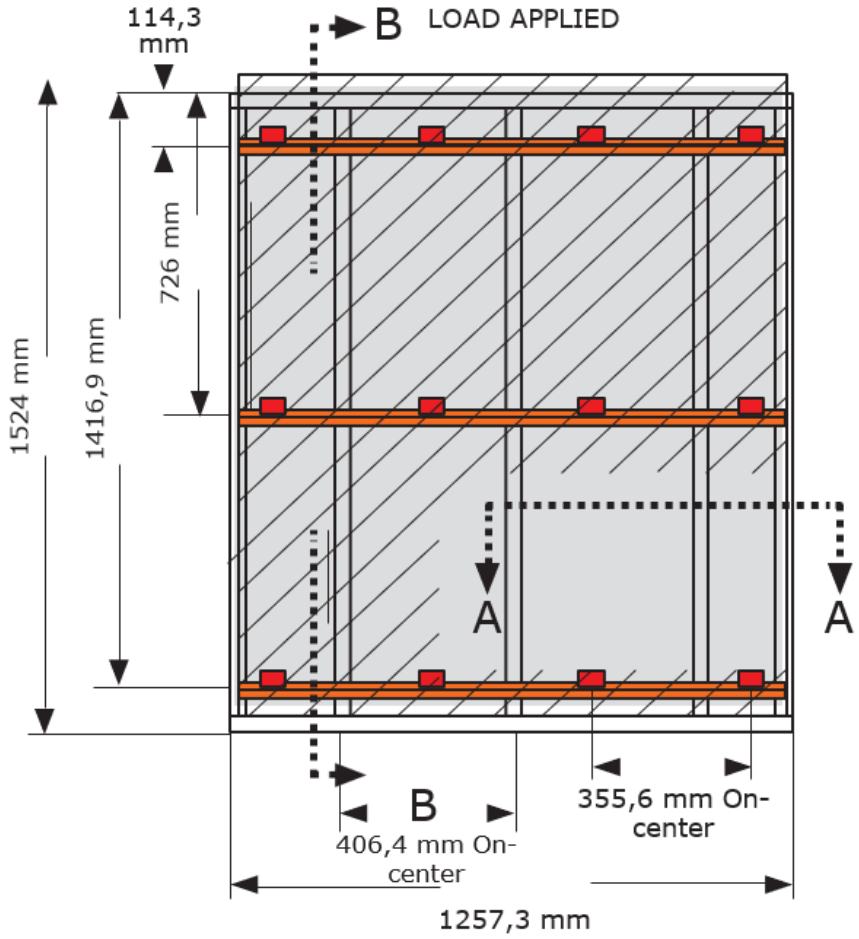
Test Set-up 1 – Shear Test of Panel Clips

The first test formation was designed to test the shear strength of the panel clips mounted to the rear side of the panel. The continuous lengths were prevented from failing by reinforcing the wood studs with SPF blocking and fastening the continuous length to the blocking every 101,6 mm.

Monarch Z-Clip Shear Test 1a-c

- Test Purpose: Ultimate load capacity of MF375 Z-Clip in ideal installation
- 406,4 mm On-Center SPF stud spacing with SPF intermediate blocking between studs
- 19,05 mm MDF Panel
- 50,8 mm x 101,6 mm SPF intermediate blocking
- (12) Monarch MF375 Z-Clip (3 Rows of 4 Clips) - Attached to MDF at 355,6 mm o.c. with #8 x 19,05 mm Coarse Thread Screws
- (3) Monarch MF375 Z-Clip 1524 mm (Continuous-Length) cut to 1257,3 mm - attached to stud and intermediate blocking with #8 x 50,8 mm Sheet Metal Screws

Figure 2. Monarch Test Set-up 1 – Strength of Clip Attached to Panel



19.05 mm MDF Panel (1219.2 mm x 1524 mm)

250.8 mm x 101.6 mm SPF intermediate blocking attached to studs at continuous Z-clip locations with 31.75 mm x 3.33 mm nails and A34 clips

Monarch MF375 continuous length Z-clip to be attached to all framing members and intermediate blocking w/ 8 x 50.8 mm sheet metal screws

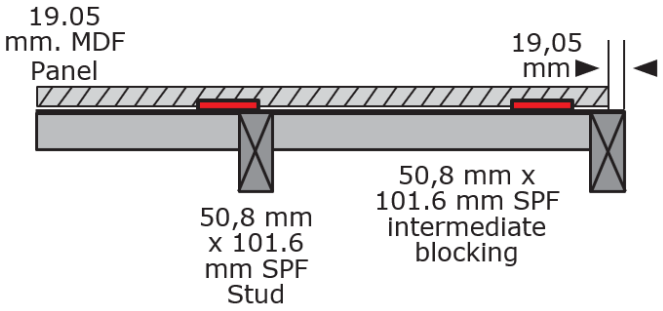
Monarch MF375 Z-clip to be attached to MDF panel at 355.6 mm o.c. w/ 19.05 mm coarse thread screws (3 rows of 4)

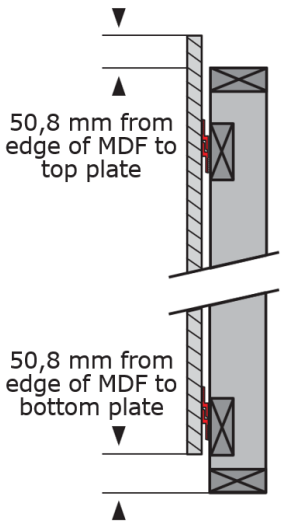
SPF top and bottom plates attached to studs with (3) 31.75 mm x 3.3274 mm smooth-shank nails

FRONT ELEVATION

Monarch MF375 continuous Z-clip strip attached to studs and intermediate blocking w/ #8 x 5,08 mm sheet metal screws.

Monarch MF375 5,08 mm Z-clip attached to MDF panel at 355.6 mm. on-center w/ #8 x 19,05 mm coarse-thread screws.





- 19,05 mm MDF panel 50,8 mm x 101,6 mm MDF panel
- 50,8 x 101,6 mm SPF intermediate blocking
- Monarch MF375 50,8 mm Z-clip attached to MDF panel at 355.6 mm on-center w/ #8 x 19,05 mm coarse-thread screws.
- Monarch MF375 continuous Z-clip strip attached to studs and intermediate blocking w/ #8 x 50,8 mm sheet metal screws
- 50,8 mm x 101,6 mm SPF stud
- 50,8 mm x 101,6 mm SPF bottom plate

Figure 3: Test Setup 1 - Wall Mount

Figure 4: Test Setup 1 - Panel as Mounted

The table below describes the specifics of the test conditions as well as the results of the testing.

Figure 5: Test Setup 1 – Testing Summary

Test Description	Wood Studs with intermediate blocking and track fasteners at 101,6 mm
Stud Material	SPF Stud
Plate Material	SPF No. 2
Wall Mounting	(3) 1219 mm Monarch MF375 Continuous
Lengths Screws Used	#8 x 50,8 mm Pan head sheet metal screws
# of screws	39
Sheathing	N/A
Panel Type	19,05 mm MDF
Panel Mounting	(12) Monarch MF375 Z Clips
Screws Used	#8 x 19,05 mm Pan Phillips deep thread screw # of Screws 24
Mode of Failure	Fasteners in MDF failed in withdrawal & the 50,8 mm clips wedged behind the continuous length

TEST	Max Load (KG)	Deflection at Max Load (MM)	Load (KG) at Given Deflection (MM)				Lateral Load Between Sheathing & Clip (KG)		Lateral Load Between Track-Blocking & Blocking-Stud (KG)		
			1,59 MM	3,18 MM	4,76 MM	6,35 MM	Max Test Load	Calculated Strength	Max Test Load	Calculated Strength	
										Track-Blocking	Blocking-Stud
1a	3788,40	9,93	757,95	1766,29	2393,15	2967,4	157,85	157,87	97,07	N/A	314,83
1b	3659,13	8,99	610,53	1400,24	2339,17	3041,33	152,41	157,87	93,89	N/A	314,83
1c	3871,86	8,74	457,67	1516,36	2560,98	3306,23	161,48	157,87	99,34	N/A	314,83
Average	3772,98	9,22	608,72	1560,81	2431,25	3105,29	157,31	157,87	96,62	N/A	314,83

Test Set-up 1 - Conclusion

In these conditions where we controlled the setup to test only the Monarch Clips attached to the rear side of the panels, the panel failed at an average of 3772,35 kilograms. There were (24) #8 x 19,05 mm pan Phillips deep thread screws securing the (12) Monarch MF375 Clips to the back of the panel. The load per screw where the shear failure occurred was 157,39 kilograms. It is important to note that the Monarch Z Clips themselves did not fail at this load.

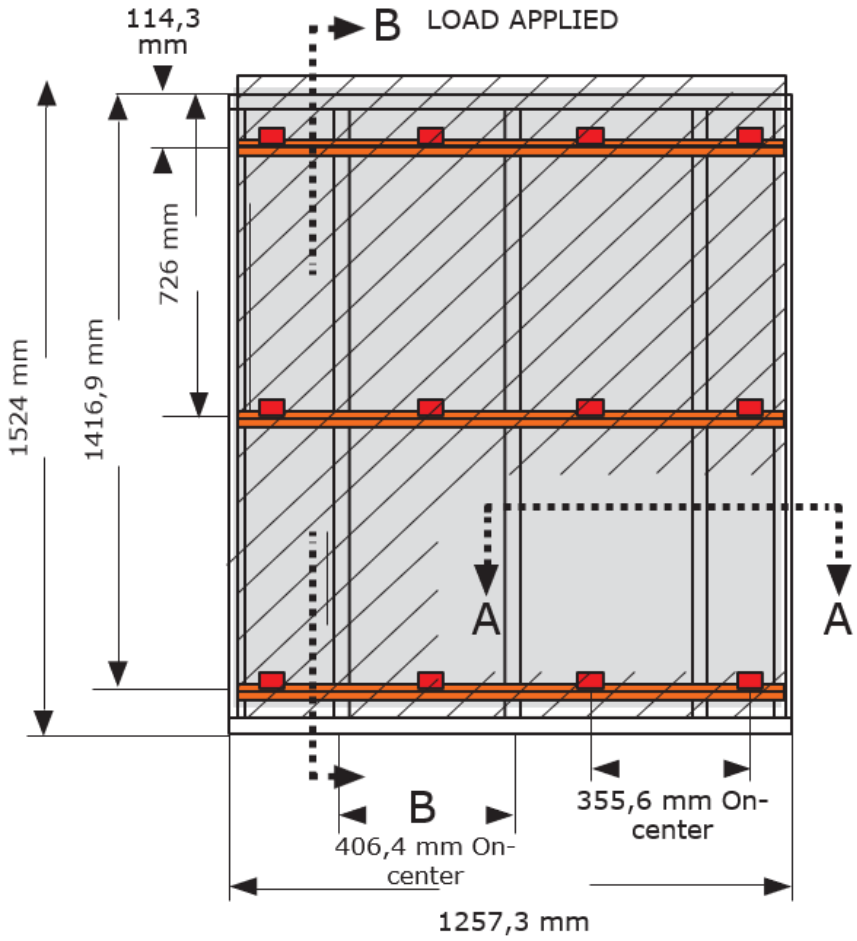
Test Set-up 2 – Standard Installation on Metal Studs with Blocking

The second test set-up was designed to test the shear strength of the Monarch Z Clip System for wall cladding where the base mounting substrate is metal studs with blocking. Qualtim used 19,05 mm OSB for blocking for tests and drilled through the blocking at 406,4 mm on center to secure the continuous lengths to the metal studs.

Monarch Z-Clip Shear Test 1a-c

- Test Purpose: Ultimate load capacity of MF375 Z-Clip system in typical non-ideal installation
- 406,4 mm On-Center 22 gauge steel stud spacing on interior 3 studs - No intermediate blocking between studs
- 19,05 mm MDF Panel
- (12) Monarch MF375-51 mm Z-Clip (3 Rows of 4 Clips) - Attached to MDF at 355,6 mm o.c. with #8 x 19,05 mm Coarse Thread Screws
- (3) Monarch MF375 Z-Clip 1219,2 mm (Continuous-Length) - Attached to stud through 19,05 mm x 203,2 mm OSB strips with #8 x 51 mm self-drilling sheet metal screws

Figure 6. Monarch Test Set-up 2 – Monarch Z Clip System in Metal Studs w/ Blocking



19,05 mm x 20 OSB sheathing attached to all studs with #8 x 38,1 mm self-drilling sheet metal screws (4 per stud)

19,05 mm MDF panel (1219,2 mm x 1524 mm)

No fasteners installed through 1219,2 mm Z-clip in exterior 2 studs, only interior 3

Monarch MF375 Z-clip to be attached to interior 3 framing members through OSB w/ #8 x 50,8 mm self-drilling sheet metal screws

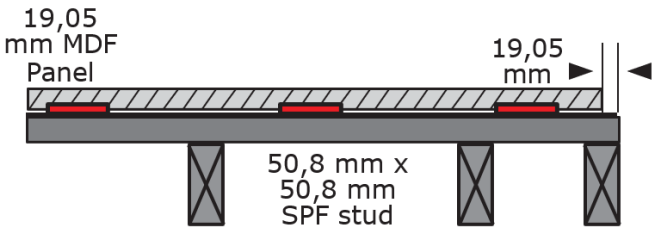
Monarch MF375 Z-clip to be attached to MDF panel w/ 19,05 mm coarse thread screws (3 rows of 4)

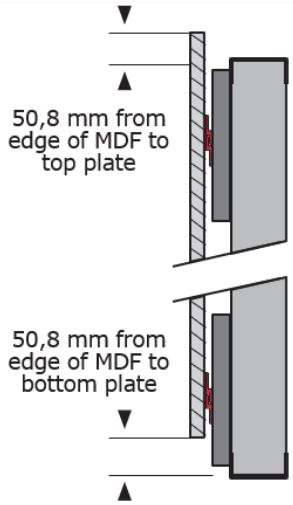
Metal studs attached to metal top and bottom plates of walls

FRONT ELEVATION

Monarch MF375 continuous Z-clip strip attached to studs through 12,7 mm GYP w/ #8 x 50,8 mm sheet metal screws.

Monarch MF375 Z-clip attached to MDF panel at 355,6 mm on-center w/ #8 x 19,05 mm coarse-thread screws.





- 19,05 mm MDF sheathing
- 50,8 mm x 101,6 mm Metal top plate
- 19,05 mm x 203,2 mm wide plywood
- 50,8 mm x 101,6 mm 22ga Metal stud
- 50,8 mm from edge of MDF to top plate sheating strips (typical at Z-clip locations).

- Attach to metal studs w/#8 x 38,1 mm sheet metal screws
- Monarch MF375 50.8 mm Z-clip attached to MDF panel at 355,6 mm on-center w/ #8 x 19,05 mm coarse-thread screws.
- Monarch MF375 continuous Z-clip strip attached to interior 3 studs through osb strips w/ #8 x 50,8 mm self-drilling sheet metal screws.
- 50,8 mm x 101,6 mm Metal stud
- 50,8 mm x 101,6 mm Metal bottom plate

Figure 7: Test Set-up 2 – Wall Mount

Figure 8: Test Set-up 2 – Panel Rear Side

The table below describes the specifics of the test conditions as well as the results of the testing.

Figure 9: Test Setup 2 – Testing Summary

Test Description	Studs with 19,05 mm OSB blocking. Continuous length fastened at 406,4 mm o.c.
Stud Material	20 Ga. Steel
Plate Material	20 Ga. Steel Equivalent
Wall Mounting	(3) 1219,2 mm Monarch MF375 Continuous
Lengths Screws Used	#8 x 50, 8 mm Pan head sheet metal screws
# of screws	9
Sheathing Type	19,05 mm OSB
Panel Type	19,05 mm MDF
Panel Mounting	(12) Monarch MF375 Z Clips
Screws Used	#8 x 19,05 mm Pan Phillips deep thread
screw # of Screws	24
Mode of Failure	19,05 mm OSB Held track in plane while mounting screw rotated in stud. Rotation between clip and track caused failure in the clip screws in withdrawal. Panel bowed under load in both axes.

TEST	Max Load (KG)	Deflection at Max Load (MM)	Load (KG) at Given Deflection (MM)				Lateral Load Between Sheathing & Clip (KG)		Lateral Load Between Track-Blocking & Blocking-Stud (KG)		
			1,59 MM	3,18 MM	4,76 MM	0.25MM	Max Test Load	Calculated Strength	Max Test Load	Calculated Strength	
										Track-Blocking	Blocking-Stud
2a	1842,04	10,95	516,11	920,79	1255,56	1498,61	76,66	157,87	204,57	178.26	223,25
2b	1988,09	13,03	624,19	1036,96	1340,15	1618,65	83	157,87	220,67	178.26	223,25
2c	1959,06	12,78	437,74	882,31	1221,95	1471,85	81,65	157,87	217,72	178.26	223,25
Average	1929,58	12,24	525,72	947,03	1272,48	1529,47	80,29	157,87	214,39	178.26	223,25

Test Set-up 2 - Conclusion

In these conditions where we tried to recreate a typical installation of a 19,05 mm MDF panel using the Monarch Z Clip system on metal studs with plywood blocking, we found that the average panel failed at 1929,56 kilograms. The mode of failure was that the continuous length (as well as the panel) bowed and bent at high pressure, which had the effect of prying the screws holding the Monarch Z Clips to the back of the panel, forcing them to pull out. (24) #8 x 19,05 mm pan Phillips deep thread screws were used to secure the (12) Monarch MF375 Clips to the back of the panel. The load per screw where the shear failure occurred was 80,29 kilograms. It is important to note that the Monarch Z Clips themselves did not fail at this load.

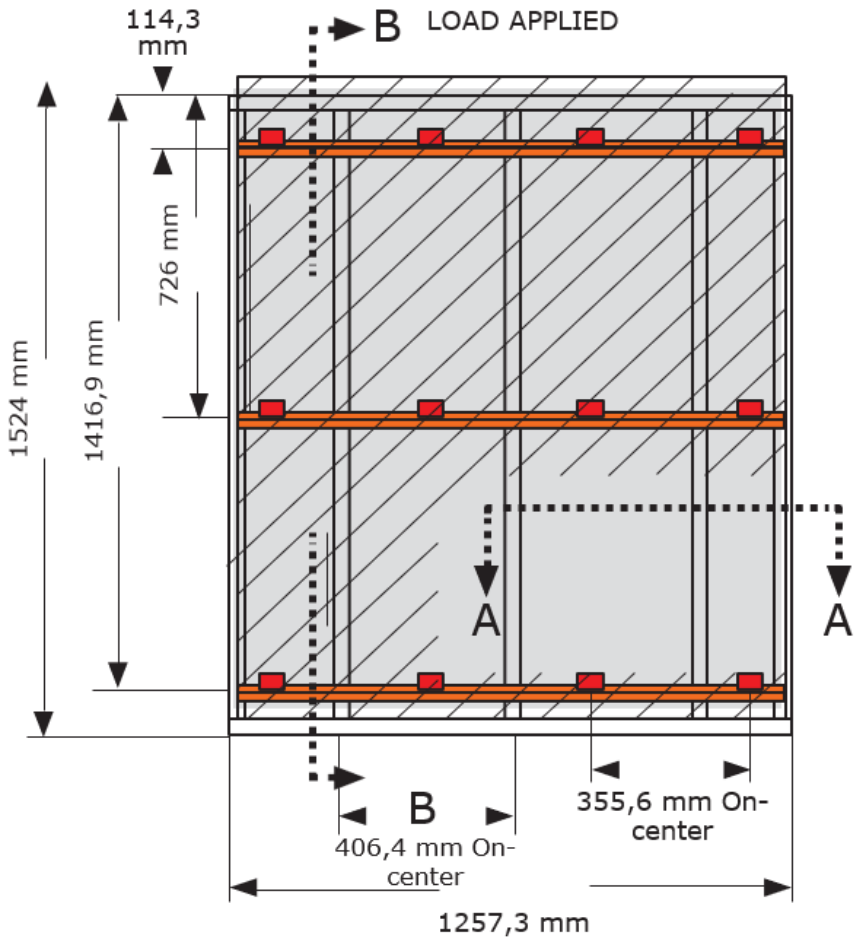
Test Set-up 3 – Standard Installation on Wood Studs with Gypsum

The third test set-up was designed to test the shear strength of the Monarch Z Clip System for wall cladding where the base mounting substrate is SPF wood studs with 12,7 mm gypsum sheathing.

Monarch Z-Clip Shear Test 1a-c

- Test Purpose: Ultimate load capacity of MF375 Z-Clip system in typical non-ideal installation
- 406,4 mm On-Center SPF stud spacing on interior 3 studs - No intermediate blocking between studs
- 19,05 mm MDF Panel
- 12,7 mm Gypsum attached to wall with #6 x 31,75 mm drywall screws at 16:16 spacing
- (12) Monarch MF375 Z-clip (3 rows of 4 clips) - Attached to MDF at 355,6 mm o.c. with #8 x 19,05 mm coarse thread screws
- (3) Monarch MF375 Z-clip 1219,2 mm (Continuous-Length) - Attached to stud through 12,7 mm Gypsum with #8 x 50,8 mm sheet metal screws

Figure 10. Monarch Test Set-up 3 – Monarch Z Clip System in Metal Studs with Blocking



12,7 mm Gypsum (1219,2 mm x 1524 mm) installed with #6 x 31,75 mm drywall screws at 16:16 spacing. (panel not shown for clarity, see sections A-A, B-B)

19,05 mm MDF panel (1219,2 mm x 1524 mm)

No fasteners installed through 1219,2 mm Z-clip in exterior 2 studs, only interior 3

Monarch MF375 Z-clip to be attached to interior 3 framing members through 12,7 mm GYP w/ #8 x 50,8 mm sheet metal screws

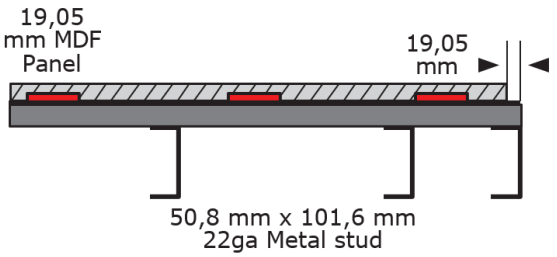
Monarch MF375 Z-clip to be attached to MDF panel w/ 19,05 mm coarse thread screws (3 rows of 4)

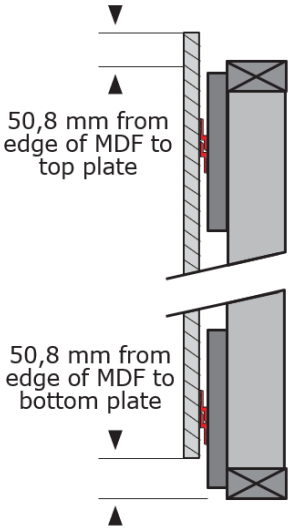
SPF top and bottom plates attached to studs with (3) 82,55 mm x 3,3 mm smooth-shank nails

FRONT ELEVATION

Monarch MF375 continuous Z-clip strip attached to interior 3 studs through OSB w/ #8 x 50,8 mm self-drilling sheet metal screws.

Monarch MF375 50,8 mm Z-clip attached to MDF panel at 355,6 mm on-center w/ #8 x 19,05 mm coarse-thread screws.





- 19,05 mm MDF sheathing
- 50,8 mm x 101,6 mm SPF top plate
- 12,7 mm gypsum attached to wall with #6 31,75 mm drywall screws at 16:16 spacing
- Monarch MF375 Z-clip attached to MDF panel at 355,6 mm on-center w/ #8 x 19,05 mm coarse-thread screws.
- Monarch MF375 continuous Z-clip strip attached to interior 3 studs through 12,7 mm GYP w/
- #8 x 50,8 mm sheet metal screws.
- 50,8 mm x 101,6 mm SPF stud
- 50,8 mm x 101,6 mm SPF bottom plate

Figure 11: Test Set-up 3 – Wall Mount

Figure 12: Test Set-up 3 – Panel Rear Side (Failed)

The table below describes the specifics of the test conditions as well as the results of the testing.

Figure 13: Test Setup 3 – Testing Summary

Test Description	Wood studs with 12,7 mm gypsum sheathing
Stud Material	SPF Stud
Plate Material	SPF No. 2
Wall Mounting	(3) 1219,2 mm Monarch MF375 Continuous
Lengths Screws Used	#8 x 50,8 mm Pan head sheet metal screws
# of screws	9
Sheathing Type	12,7 mm Gypsum
Panel Type	19,05 mm MDF
Panel Mounting	(12) Monarch MF375 Z Clips
Screws Used	#8 x 19,05 mm Pan Phillips deep thread
screw # of Screws	24
Mode of Failure	Continuous length track bent mounting screws and rotated down into gypsum. Fasteners in clips in MDF began to fall in withdrawal as panel clips rotated with wall MDF panel bowed under load in both axes Continuous length bent across length and clips wedged into the gypsum behind the track

TEST	Max Load (KG)	Deflection at Max Load (MM)	Load (KG) at Given Deflection (MM)				Lateral Load Between Sheathing & Clip (KG)		Lateral Load Between Track-Blocking & Blocking-Stud (KG)		
			1,59 MM	3,18 MM	4,76 MM	6,35 MM	Max Test Load	Calculated Strength	Max Test Load	Calculated Strength	
										Track-Blocking	Blocking-Stud
3a	1996,09	14,68	385,06	697,68	982,21	1240,66	83,01	157,87	221,8	N/A	239,5
3b	1678,29	11,76	477,03	844,38	1121,58	1346,92	69,85	157,87	186,43	N/A	239,5
3c	1780,95	12,29	518,11	846,65	1141,75	1366,27	74,39	157,87	197,77	N/A	239,5
Average	1818,06	12,90	460,24	796,33	1082,08	1317,37	75,75	157,87	201,85	N/A	223,25

Test Set-up 3 - Conclusion

In these conditions where we tried to recreate a typical installation of a 19,05 mm MDF panel using the Monarch Z Clip system on SPF wood studs with gypsum sheathing, we found that the average panel failed at 1818,47 kilograms. The mode of failure was that the continuous length (as well as the panel) bowed and bent at high pressure, which had the effect of prying the screws holding the Monarch Z Clips to the back of the panel, forcing them to pull out. There were (24) #8 x 19,05 mm pan Phillips deep thread black oxide screws securing the (12) Monarch MF375 Clips to the back of the panel. The load per screw where the shear failure occurred was 75,75 kilograms. It is important to note that the Monarch Z Clips themselves did not fail at this load.

SUMMARY

Monarch conducted testing to determine the ultimate shear strength of a standard installation using the Monarch Z Clip system and determined that the system failed at between 1678,29 to 1995,29 kilograms in the setup tested. In a panel installation, the Monarch Z Clip is only one element of five in the hanging system: (i) the material and thickness of the surface the panel is being mounted to, (ii) the screw used to fasten the Monarch Continuous length to the mounting surface, (iii) the Monarch Z Clip System used, (iv) the screw used to fasten the Monarch Clips to the back of the panel, and (v) the material and thickness of the panel. The testing indicated that in a standard installation, the weak point of the system was the screw holding the Monarch Clip to the back of the panel. The mode of failure was to pull out of the screws securing the Monarch Clips to the back of the panel, as the continuous lengths bent across the length and wedged under the shorter panel clips.

DISCLAIMER:

The tested capacity of the clips as defined herein is merely intended to guide all end-users on the capacity that is available when #8 x 19,05 mm Pan Phillips Deep Thread screws are used to attach clips to MDF panels. This capacity has been developed through testing under a given set of testing conditions that represent typical installations. Decisions made, by the end user, concerning capacities must take into account installation deviations from the tested application, accuracy of screw placement, any potential for overdriving of the screws, panel misuse, improper panel or clip storage, panel and clip handling, etc. The final capacity to be used for any installation is the responsibility of the end-user.