Wi SLOT BLOCK

REPORT ON THE TESTING OF FISCHER FIXINGS & ANCHORS

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Introduction

The Wi Slot Block is increasingly being adopted on large commercial projects, such as London Underground Station upgrades, as part of the Wi System of reinforced concrete blockwork. As many of these walls are located in service areas, or form the structural backing for cladding systems, significant loading may need to be borne by the walls, secured by structural anchors fixed into the wall. These types of anchors will invariably be specified as chemical/resin anchors. However, for non-structural loads, expansion bolts and conventional plugs and screws may be used.

Aims of Test Programme

The aim of this test programme is to determine pull-out loads and design capacities for various types of fixings and anchors. The tests recorded within this report are related to Fischer fixings and anchors. Similar tests have been undertaken with fixings and anchors from other manufacturers in order to provide potential users of the Slot Block the assurance they require that the block is capable of supporting typical project loads expected of a conventional blockwork wall.

Slot Block

The Wi Slot Block is a patented concrete block, currently manufactured under licence as a medium-dense paint grade block with a density of 1450 kg/m³. It is manufactured to the standard UK format size of 215mm high x 440mm long x 100, 140, 190 or 215mm wide. It has a unique arrangement of 6-9 full-depth slots within its construction, depending on its width. These slots serve to significantly increase the mortar/block bond, through superior mortar interlock. They also reduce the weight of the blocks, enabling them to adopted as full-size units, where other traditional blocks would have to be used a "midi" blocks resulting from manual handling guideline restrictions, due to their excessive unit weights.

The Standard Range Of Wi Slot Blocks

Test Methodology

The primary aim of the testing was to obtain reliable pull-out values for various types of fixings and anchors located within the solid parts of the block and within the slots. The tests were mainly undertaken on the face of the blocks, although a number of tests were also completed with fixings into the side of the blocks, to replicate fixing of say a door frame.

All the recorded tests were completed on 6th June 2014 at Wembley Innovation's research facilities. The internal temperature varied between 15-18 °C.

The samples were drilled and the prepared by Ioan Grigorescu of Wembley Innovation, who is an experienced operative familiar with the laying of Slot Blocks and the installation of the type of Fischer fixings and anchors used in the tests. Adrian Jones, Fischer Technical Business Manager, also assisted with the preparation of the samples and carried out the tests using the Hydrajaws Test meter. Tony Sagoo, Wembley Innovation's Head of Engineering, supervised the testing and recorded the results.

The pull-out tests were undertaken using a 20kN Hydrajaws calibrated test meter, which is specifically designed to carry out such tests. The tests were all undertaken on standard 7.3 N/mm² strength 140mm Slot Blocks, typically with 2no. tests per block. For the resin anchors, the drilled holes were blown out using a pump and then brushed-out – this procedure was then repeated a further three times prior to the fixing being installed. Resin-bonded fixings were allowed to cure for a minimum for 30 minutes before being tested. The holes for the mechanical fixings were blown out and brushed once and tested as soon as practical after being installed. The Wallbolt fixings were torqued generally in accordance with the recommended value.

Fixings Tested

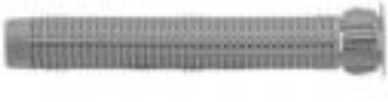
The following fixings were tested:

- **FHY Socket + M10 Stud** – this is a "socket expander" anchor, which is most commonly used in hollow-core concrete slabs. However, due to its versatility, it is also used in blockwork construction for light-duty fixing requirements such as: pipework clips, securing conduits and light services. The M10 anchor is set into a 16mm diameter hole.

- **Wallbolts, M8, M10 & M12** – The Wallbolt is a traditional shield anchor which is widely in concrete and masonry substrates. Whilst it can achieve impressive results, the actual anchor performance can be limited by oversized holes and inexperienced installers. The test anchors were torqued in accordance with Fischer recommendations.

- **FIS V360 Resin + HK Nylon Sleeve, HL Metal Mesh Sleeve & HN Fabric Sleeve, with M10 & M12 Studs**

V360 Resin Cartridge



HK Nylon Sleeve

HN Fabric Sleeve

HL Metal Sleeve

All of the above resin injection sleeves are recommended for concrete and masonry substrates. The purpose of the sleeves is to "contain" the resin and to mitigate excess usage of resin when bonding studs to cellular blocks, or voided substrates. The Nylon sleeve is perhaps the most commonly used option, being suitable for most instances. The Metal Mesh is used for variable or longer depth of bonding. The Fabric Sleeve is most useful for bonding into delicate substrates such as multi-cell terracotta blocks.

Test Observations and Discussions

The resin anchor samples were prepared first, in order to allow them to cure sufficiently before being tested.

FHY Socket + M10 Stud

The FHY Socket anchors were tested first and their results are shown in Table 1 of the Appendix A – Test Results. The testing was noted to be consistent, with all failures occurring due to slippage of the anchor, which is to be expected within blockwork (and indeed concrete). Slightly higher pull-out values were obtained within the solid sections, compared to the slot locations, again as expected due to the additional 22mm of embedment.

Wallbolts, M8, M10 & M12

Installation of these Wallbolts involved torqueing them to the recommended values of 25nm, 40Nm and 60Nm, respectively. Despite the apparently high torque of 60Nm for the M12 anchor, no signs of adverse cracking were noted within the block prior to testing. Generally, the pull-out capacities increased with the anchor size.

We also found no issues with the installation of the anchors, apart from needing to restrain the stud from turning, when torqueing the nut – this is often encountered on site but not always overcome, leading to a decrease in the capacity of the anchor. This can in turn lead to a "preference" for other fixings, even though the Wallbolts are perfectly capable performing adequately.

FIS V360 Resin + HK Nylon Sleeve, HL Metal Mesh Sleeve & HN Fabric Sleeve, with M10 & M12 Studs

These range of resin anchors undoubtedly gave the highest pull-out results, leading invariably to failure of the substrate, or results beyond the range of the meter (> 20kN).

Recommended Safe Working Loads

In order to provide guidance for potential installers of anchors within Slot Block walls, the following recommended safe working loads are given for initial assessment. As with all anchor design, each case may need to be considered uniquely, depending on the variable factors and how critical failure of the anchor would be.

In the recommended values given, the Factor of Safety applied to the test ultimate loads is 4.0. This value may need to be re-assessed and perhaps increased if the design case is deemed to be critical, or the substrate is likely to be variable. It is also worth noting that most loading may well be in shear, although initial selection of anchor loads invariably defaults to pull-out values.

FHY Socket + M10 Stud

Test No.	Ultimate Pull-out (kN)
1	6.0
2	4.5
3	4.0
4	4.5
5	5.0
6	5.0
	Lowest value = 4.0kN

Safe Working Load = 4.0/4 = **1.0kN**

(Compare with Tarmac Topcrete 140mm Multicore 7.0N/mm² averaged SWL = 0.35kN)

Wallbolts, M8

Test No.	Ultimate Pull-out (kN)
1	5.0
2	5.5
3	6.0
4	7.5
5	6.0
	Lowest value = 5.0kN

Safe Working Load = 5.0/4 = **1.25kN**

(No comparison data available from Fischer Substrate Report)

Wallbolts, M10

Test No.	Ultimate Pull-out (kN)
1	8.0
2	6.5
3	6.5
4	7.0
5	6.5
	Lowest value = 6.5kN

Safe Working Load = 6.5/4 = **1.625kN**

(Compare with Tarmac Hemlite 100mm Solid 7.3N/mm² FSA M10 Anchor averaged SWL = 1.53N)

Wallbolts, M12

Test No.	Ultimate Pull-out (kN)
1	8.0
2	9.5
3	8.0
4	8.0
	Lowest value = 8.0kN

Safe Working Load = 8.0/4 = **2.0kN**

(Compare with Tarmac Hemlite 100mm Solid 7.3N/mm² FSA M10 Anchor averaged SWL = 1.53N)

FIS V360 Resin + HK Nylon Sleeve – M10 Stud

Test No.	Ultimate Pull-out (kN)
1	17.0
2	15.0
3	16.0
4	14.0
5	15.0
6	20.0
7	15.0
8	14.0
9	14.0
10	14.0
11	14.0
	Lowest value = 14.0kN

HK Nylon Sleeve

Safe Working Load = 14.0/4 = **3.5kN**

(Compare with Tarmac Hemlite 100mm Solid 7.3N/mm² FIS 360 + M10 Stud averaged SWL = 2.01N)

FIS V360 Resin + HL Metal Mesh Sleeve – M10 Stud

Test No.	Ultimate Pull-out (kN)
1	18.0
2	12.0
3	12.0
4	19.0
5	20.0
6	20.0
7	20.0
8	16.0
9	20.0
10	17.0
11	16.0
12	19.0
	Lowest value = 12.0kN

HL Metal Sleeve

Safe Working Load = 12.0/4 = **3.0kN**

(Compare with Tarmac Topcrete 140mm Cellular 7.3N/mm² FIS 360 + M12 Stud averaged SWL = 1.72kN)

FIS V360 Resin + HN Fabric Sleeve – M10 Stud

Test No.	Ultimate Pull-out (kN)
1	20.0
2	19.0
3	20.0
4	20.0
	Lowest value = 19.0kN

HN Fabric Sleeve

Safe Working Load = 19.0/4 = **4.75kN**

(Compare with Al Master Block 140mm Multicell 7.0N/mm² averaged SWL = 1.77kN)

FIS V360 Resin + HN Fabric Sleeve – M12 Stud

Test No.	Ultimate Pull-out (kN)
5	16.0
6	20.0
7	20.0
8	20.0
9	20.0
10	20.0
11	20.0
12	20.0
13	20.0
14	20.0
	Lowest value = 16.0kN

HN Fabric Sleeve

Safe Working Load = 16.0/4 = **4.0kN**

(Compare with Tarmac Topcrete 140mm Cellular 7.3N/mm² FIS 360 + M12 Stud averaged SWL = 1.72kN)

FIS V360 Resin + HN Fabric Sleeve – M12 Stud (Side of Block)

Test No.	Ultimate Pull-out (kN)
15	12.0
16	12.0
	Lowest value = 16.0kN

HN Fabric Sleeve

Safe Working Load = 12.0/4 = **3.0kN**

Conclusions

From the testing undertaken and reported herein, it would be reasonable to conclude that all the tested anchors performed satisfactorily. The Safe Working Loads given are based on a factor of safety of 4.0 on the lowest test result achieved.

Where available, comparable results from the Fischer Substrate Report 2012/01are also included, although it should be noted that those results are based on averaged values and therefore will be less conservative than the Slot Block results. By reviewing these comparable results, it can be seen that the Slot Block results outperform the comparable tests.

A range of fixings were tested in order to reflect current site practice. Whilst the Socket anchors, or the Wallbolts are not routinely used in blockwork, the test results indicate that they are effective in Slot Blocks.

As might have been expected, the resin anchors performed very well, often achieving pull-outs beyond the range of the test meter. Such anchors are clearly the preferred option due to their significantly superior performance. Such resin anchors will also be the most capable type of anchor to resist cyclical or dynamic loading.

Eur Ing **Tony Sagoo** BSc (Hons) MBA CEng MICE

Head of Engineering

Disclaimer for Loads, Recommendations and Use of Anchors/Fixings

The results contained in this report are factual results obtained from tests carried out at Wembley Innovation in conjunction with Fischer. They were not carried out under laboratory conditions or to any specific test standard. Therefore, any Safe Working Loads should be regarded as initial guideline values only, to be verified by pre-installation trial tests and/or site proof tests.

It is the responsibility of the specifier, designer and installer to satisfy themselves as to the suitability and performance of any anchor/fixing to reflect field conditions, substrates, application requirements, environmental factors and edge distances.

Design and validation of anchors and fixings should follow the guidelines issued by the Construction Fixings Association (CFA https://www.the-cfa.co.uk/).

Additional advice can be sought from Fischer and Wembley Innovation for specific requirements.

APPENDIX A – TEST RESULTS

SLOT BLOCK FISCHER FIXINGS TEST TESULTS 6th June 2014

Table 1

Test No.	Fixing Type	Block size	Solid/Slot	Face/side	Depth	Ultimate Pull-out (N)	Comments
1	FHY M 10 - Socket	140	Solid	Face	52mm	6000	Failure due to anchor slipage at washer/retaining nut
2	FHY M 10 - Socket	140	Slot	Face	52mm	4500	
3	FHY M 10 - Socket	140	Slot	Face	52mm	4000	
4	FHY M 10 - Socket	140	Solid	Face	52mm	4500	
5	FHY M 10 - Socket	140	Solid	Face	52mm	5000	
6	FHY M 10 - Socket	140	Slot	Face	52mm	5000	

SLOT BLOCK FISCHER FIXINGS TEST TESULTS 6th June 2014

Table 2

Test No.	Fixing Type	Block size	Solid/Slot	Face/side	Depth	Ultimate Pull-out (N)	Comments
1	FWB M8 - Wallbolt	140	Slot	Face	50mm	5000	Torqued to 25Nm, Failure due to anchor slippage
2	FWB M8 - Wallbolt	140	Solid	Face	50mm	5000	
3	FWB M8 - Wallbolt	140	Slot	Face	50mm	6000	
4	FWB M8 - Wallbolt	140	Solid	Face	50mm	7000	
5	FWB M8 - Wallbolt	140		Side	50mm	6000	

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SLOT BLOCK FISCHER FIXINGS TEST TESULTS 6th June 2014

Table 3

Test No.	Fixing Type	Block size	Solid/Slot	Face/side	Depth	Ultimate Pull-out (N)	Comments
1	FWB M10 - Wallbolt	140	Solid	Face	60mm	8000	Torqued to 40Nm, Failure due to anchor slippage
2	FWB M10 - Wallbolt	140	Slot	Face	60mm	6500	
3	FWB M10 - Wallbolt	140		Side	60mm	6500	
4	FWB M10 - Wallbolt	140		Side	60mm	7000	
5	FWB M10 - Wallbolt	140		Side	60mm	6500	

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SLOT BLOCK FISCHER FIXINGS TEST TESULTS 6th June 2014

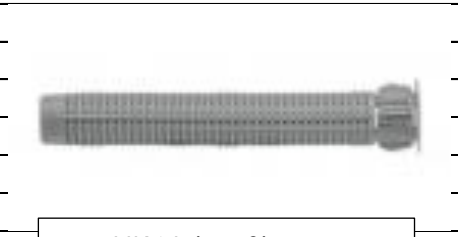
Table 4

Test No.	Fixing Type	Block size	Solid/Slot	Face/side	Depth	Ultimate Pull-out (N)	Comments
1	Wallbolts - M12	140	Solid	Face	75mm	8000	Torqued to 60Nm, Failure due to anchor slippage
2	Wallbolts - M12	140	Slot	Face	75mm	9000	
3	Wallbolts - M12	140	Slot	Face	75mm	8000	
4	Wallbolts - M12	140	Solid	Face	75mm	8000	
							

SLOT BLOCK FISCHER FIXINGS TEST TESULTS 6th June 2014

Table 5

Test No.	Fixing Type	Block size	Solid/Slot	Face/side	Depth	Ultimate Pull-out (N)	Comments
1	V360 Resin + 16 x 85 Nylon Sleeve + M10 Stud	140	Solid	Face	85mm	17000	
2	V360 Resin + 16 x 85 Nylon Sleeve + M10 Stud	140	Slot	Face	85mm	15000	
3	V360 Resin + 16 x 85 Nylon Sleeve + M10 Stud	140	Solid	Face	85mm	16000	
4	V360 Resin + 16 x 85 Nylon Sleeve + M10 Stud	140	Slot	Face	85mm	14000	
5	V360 Resin + 16 x 85 Nylon Sleeve + M10 Stud	140	Slot	Face	85mm	15000	
6	V360 Resin + 16 x 85 Nylon Sleeve + M10 Stud	140	Solid	Face	85mm	20000	Substrate failure
7	V360 Resin + 16 x 85 Nylon Sleeve + M10 Stud	140	Slot	Face	85mm	15000	
8	V360 Resin + 16 x 85 Nylon Sleeve + M10 Stud	140	Solid	Face	85mm	14000	
9	V360 Resin + 16 x 85 Nylon Sleeve + M10 Stud	140	Slot	Face	85mm	14000	
10	V360 Resin + 16 x 85 Nylon Sleeve + M10 Stud	140	Solid	Face	85mm	14000	
11	V360 Resin + 16 x 85 Nylon Sleeve + M10 Stud	140	Slot	Face	85mm	14000	

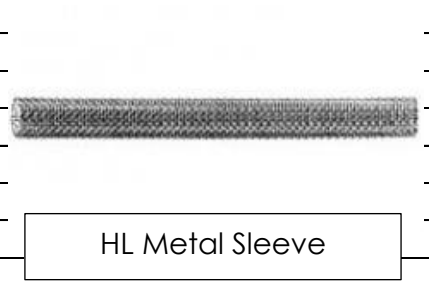


HK Nylon Sleeve

SLOT BLOCK FISCHER FIXINGS TEST TESULTS 6th June 2014

Table 6

Test No.	Fixing Type	Block size	Solid/Slot	Face/side	Depth	Ultimate Pull-out (N)	Comments
1	V360 Resin + 16 Metal Mesh Sleeve + M10 Stud	140	Slot	Face	85mm	18000	Substrate failure, * = end of meter range
2	V360 Resin + 16 Metal Mesh Sleeve + M10 Stud	140	Solid	Face	85mm	12000	
3	V360 Resin + 16 Metal Mesh Sleeve + M10 Stud	140	Solid	Face	85mm	12000	
4	V360 Resin + 16 Metal Mesh Sleeve + M10 Stud	140	Slot	Face	85mm	19000	
5	V360 Resin + 16 Metal Mesh Sleeve + M10 Stud	140	Solid	Face	85mm	>20000 *	
6	V360 Resin + 16 Metal Mesh Sleeve + M10 Stud	140	Slot	Face	85mm	>20000 *	
7	V360 Resin + 16 Metal Mesh Sleeve + M10 Stud	140	Slot	Face	85mm	>20000 *	
8	V360 Resin + 16 Metal Mesh Sleeve + M10 Stud	140	Solid	Face	85mm	16000	
9	V360 Resin + 16 Metal Mesh Sleeve + M10 Stud	140	Solid	Face	85mm	>20000 *	
10	V360 Resin + 16 Metal Mesh Sleeve + M10 Stud	140	Slot	Face	85mm	17000	
11	V360 Resin + 16 Metal Mesh Sleeve + M10 Stud	140	Solid	Face	85mm	16000	
12	V360 Resin + 16 Metal Mesh Sleeve + M10 Stud	140	Slot	Face	85mm	19000	



HL Metal Sleeve

SLOT BLOCK FISCHER FIXINGS TEST TESULTS							6th June 2014
Table 7							
Test No.	**Fixing Type**	**Block size**	**Solid/Slot**	**Face/side**	**Depth**	**Ultimate Pull-out (N)**	**Comments**
1	V360 Resin + 18 x 85 Sock Sleeve + M10 Stud	140	Slot	Face	85mm	>20000 *	
2	V360 Resin + 18 x 85 Sock Sleeve + M10 Stud	140	Solid	Face	85mm	19000	
3	V360 Resin + 18 x 85 Sock Sleeve + M10 Stud	140	Solid	Face	85mm	> 20000 *	
4	V360 Resin + 18 x 85 Sock Sleeve + M10 Stud	140	Slot	Face	85mm	> 20000 *	
5	V360 Resin + 20 x 85 Sock Sleeve + M12 Stud	140	Solid	Face	85mm	16000	
6	V360 Resin + 20 x 85 Sock Sleeve + M12 Stud	140	Slot	Face	85mm	>20000 *	
7	V360 Resin + 20 x 85 Sock Sleeve + M12 Stud	140	Solid	Face	85mm	>20000 *	Substrate failure, * = end of meter range
8	V360 Resin + 20 x 85 Sock Sleeve + M12 Stud	140	Slot	Face	85mm	>20000 *	
9	V360 Resin + 20 x 85 Sock Sleeve + M12 Stud	140	Solid	Face	85mm	>20000 *	
10	V360 Resin + 20 x 85 Sock Sleeve + M12 Stud	140	Slot	Face	85mm	>20000 *	
11	V360 Resin + 20 x 85 Sock Sleeve + M12 Stud	140	Slot	Face	85mm	>20000 *	
13	V360 Resin + 20 x 85 Sock Sleeve + M12 Stud	140	Slot	Face	85mm	>20000 *	
14	V360 Resin + 20 x 85 Sock Sleeve + M12 Stud	140	Slot	Face	85mm	>20000 *	
15	V360 Resin + 20 x 85 Sock Sleeve + M12 Stud	140		Side	85mm	12000	Anchor slippage
16	V360 Resin + 20 x 85 Sock Sleeve + M12 Stud	140		Side	85mm	12000	

HN Fabric Sleeve