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FIRE TEST REPORT

FP 4837 ISSUE 2

FIRE RESISTANCE OF PIPE PENETRATIONS IN A 150MM THICK CONCRETE SLAB

REFERENCED STANDARDS
AS 1530.4 - 2005
AS 4072.1 - 2005

CLIENT
Snap Fire Systems
Unit 2-160 Redland Bay Rd,
Capalaba,
4157 QLD
Australia

NATA
ACCREDITED FOR TECHNICAL COMPETENCE

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ilac-MRA 37 new zealand accredited laboratory

TEST SUMMARY

Objective

To determine the fire resistance of nine pipe penetrations and their respective seals through a 150 mm thick concrete slab when tested in accordance with AS 1530.4-2005 with reference to AS 4072.1 – 2005.

Test Sponsor

Snap Fire Systems
Unit 2-160 Redland Bay Rd,
Capalaba,
4157 QLD
Australia

Description of Test Specimen

The test specimen consisted of a reinforced concrete slab placed above a horizontal 2,200 mm x 1,000 mm furnace opening to represent a structural concrete floor. Nine penetrations passed through the nominal 150 mm thick concrete floor. Pipe assemblies orientated vertically are referred in this report as “stack” assemblies. A single specimen consisted of a floor waste with a 35 mm high screed plinth and cast-in collar system. Three specimens consisted of stack pipe assemblies with cast-in collars. Six specimens consisted of stack assemblies with retro-fit collars one of which had an elbow inserted in the body of the retro-fit collar.

Date of Test

24 May 2012

Test Results

No.	Collar Designation	Pipe Designation	FRL
1	110R (Retro-fit)	110 mm x 4.3 mm PE100 SDR 26	-/240/240
2	65-80R (Retro-fit)	80 PVC-U DWV	-/240/240
3	50R (Retro-fit)	40 PVC-U DWV	-/240/240
5	H100S (Cast-in)	100 PVC-U SC DWV	-/240/240
6	L100FWS (Cast-in)	100 PVC-U SC DWV (Floor Waste with Trap)	-/240/240
7	H100FWS (Cast-in)	100 PVC-U SC DWV	-/240/240
8	50R (Retro-fit)	40 mm x 3 mm PE80 S12.5	-/240/240
9	65-80R (Retro-fit)	65 PVC-U DWV	-/240/240
10	50R (Retro-fit)	40 PVC-U DWV (With Elbow socket in collar)	-/240/240

NF = No failure for the duration of the test.

The test standard requires the following statement to be included

"*The results of these fire tests may be used to directly assess fire hazard, but it should be recognised that a single test method will not provide a full assessment of fire hazard under all fire conditions.*"

LIMITATION

The results reported here relate only to the item/s tested.

TERMS AND CONDITIONS

This report is issued in accordance with the Terms and Conditions as detailed and agreed in the BRANZ Services Agreement for this work.

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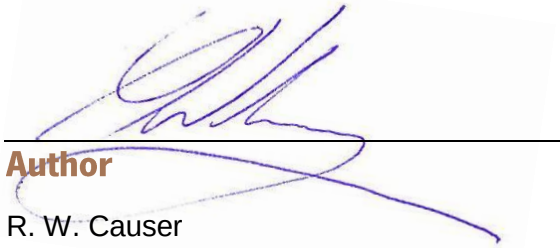
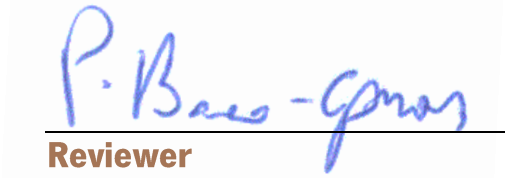


Author

R. W. Causer
Fire Testing Engineer
IANZ Approved Signatory



Reviewer

P. Bano - Chapman
Senior Fire Testing Engineer

DOCUMENT REVISION STATUS

ISSUE No.	DATE ISSUED	DESCRIPTION
1	30 October 2012	Initial Issue
2	30 October 2012	RE issued to include reference to AS 4072.1 - 2005

1. TEST PROCEDURE

The test was conducted in accordance with AS 1530.4-2005, Methods for fire tests on building materials, components and structures, Part 4: Fire–Resistance test of elements of construction with reference to AS 4072.1 – 2005 Service penetrations and control joints, Section 3.1 Fire Resistance Testing.

In accordance with the test standard the fire resistance of the specimen is the time, expressed in minutes, to failure under one or more of the following criteria.

1.1 Integrity

Failure shall be deemed to occur when cracks, fissures or other openings develop through which flames or hot gases can pass. Failure occurs;

- If a gap, crack or fissure develops, which exceeds 6 mm x 150 mm and, allows unobstructed vision into the interior of the furnace from any viewing angle, or a 25 mm gap gauge can be passed through the specimen so that the gauge projects into the furnace; or
- If flaming on the unexposed surface of the specimen is sustained for longer than 10 seconds; or
- When flames and/or hot gases cause flaming or glowing of the cotton fibre pad.

1.2 Insulation

Failure shall be deemed to occur when any of the relevant thermocouples attached to the unexposed face of the test specimen rises more than 180K above the initial temperature.

Temperatures recorded from thermocouples that become embedded in softening material or covered by intumescent material shall be disregarded.

2. DESCRIPTION OF THE TEST SPECIMEN

2.1 General

The test specimens consisted of nine pipe penetrations in a 150 mm thick reinforced concrete slab representing a structural concrete floor. All the pipes consisted of either PVC-U DWV or HDPE DWV plastic pipe.

Five specimens consisted of stack assemblies with retro-fit collars. A single specimen consisted of a floor waste with a 35 mm high screed topping and cast-in collar system. Two specimens consisted of stack assemblies and cast–in collars. One specimen consisted of a stack assembly with an elbow socket inserted into the body of the retro-fit collar.

All the stack pipes protruded a minimum of 500 mm into the furnace and at least 2,000 mm to the unexposed face except for specimen 10 which had an 90°elbow on the exposed face with the elbow socket inserted into the retro-fit collar. The floor waste had typical elbow trap fittings fitted on the exposed face with the exposed pipe suspended from a single masonry pipe anchor fitting. The floor waste trap was filled with 2.6 litres of water prior to the start of the test.

All pipes were capped on the exposed ends and were open on the unexposed ends. Apart from the cast-in collar specimens and specimen 10 the penetrations through the slab had a maximum of 1-2 mm clearance between the pipe and the penetration. For specimen 6 the screed raised plinth was applied around the pipe and grate after the grate had been installed.

The stack test specimens were secured in place using pipe clamps supported by a steel framework at 800 mm and 1,800 mm from the face of the concrete slab.

Bostik Firecaulk fire rated acrylic sealant was applied around the pipe and the floor slab on the unexposed face of specimens 1 to 3, 5 and 7 to 10. No sealant was applied around the grate of specimen No 6.

The density of the concrete at the time of the fire resistance test was calculated to be 2,245 kg/m^3. The moisture content of the concrete at the time of the test was calculated to be 4.4%.

A drawing of the layout is included in this report as Figure 7.

2.2 Pipe Specification

Table 1 lists the nominal and measured pipe dimensions and pipe designation details.

DWV = Drain Waste Vent

The nominal 100 mm PVC-U pipes were of sandwich core construction.

Table 1: Pipe specification

Pipe No	Nominal Ø/ Material/Type	OD (mm)	Wall thick (mm)	Details recorded on pipe
5 - 7	100 PVC-U/S DWV	110.0	3.1	Biplex 100 PVC-U SC DWV SH SN6
9	65 PVCU DWV	69.0	3.0	Vinidex Quality Long Life 65PVCU DWV
3, 10	40 PVC-U DWV	43.0	2.2	Keyplas 40 PVC-U DWV SH
2	80 PVCU DWV	82.3	3.1	Vinidex Quality Long Life Recyclable 80PVCU DWV
8	40 HDPE DWV	40.4	3.4	Coestilen PE80 40Ø x 3 S12.5
1	100 HDPE DWV	110.0	4.7	Vinidex Recyclable PE 100 110 x 4.3 SDR26

2.3 Collar Designation and Materials of Manufacture Details

Table 2 lists the average measured dimensions of the intumescent used in each collar type with number of layers and location of stainless steel mesh. The client advised that the intumescent was named INTUMESH.

The collar housing body for the three cast-in collars, H 100 FWS, L 100 FWS & H 100 S was injection moulded HDPE plastic with an average wall thickness of 1.6 mm. The top ring fitted to the collar body of L 100 FWS cast-in collar was LDPE plastic. The cast-in collars L 100 FWS and H 100 FWS had three grade 304 stainless steel 3.15 mm diameter wire springs located in the body of the collar equally spaced around the perimeter of the collar. The cast-in collar H 100 S had three galvanised steel 3.15 mm diameter wire springs located in the body of the collar equally spaced around the perimeter of the collar. All of the springs were fitted with nylon fuse links.

The type 65-80R and 110 R retro-fit collar bodies were fabricated from 0.95 mm thick galvanised steel. The type 50R retro-fit collar was fabricated from 0.7 mm thick stainless steel. . All the retro-fit collars were secured to the slab with three equally spaced brackets around the perimeter of the collar body with M6.5 x 35 mm sleeve anchors. The brackets were fabricated from 2 mm thick galvanised steel and consisted of a 20 mm wide angle bracket with leg lengths measuring 33 mm and 30 mm. The sleeve anchor passed through an 8 mm Ø hole through the longer leg length, the bracket was screw fixed to the body of the collar with a self tapping screw.

Figures 1 – 6 show detailed construction drawings for each collar type. Where difference between the drawing and the report text exists the text takes precedence.

Table 2: Collar intumescent details

Collar Designation	Pipe No.	Intumescent Details (Average measured dimensions)				
		Width (mm)	Thickness (mm)	No of Layers	Length (mm)	Steel Mesh and Location
50 R	3, 8 & 10	44	4.0	2	L1: 217 L2: 207	1 layer sandwiched between intumescent layers
L 100 FWS	2	85	4.0	1	412	1 layer between intumescent and body of collar
110 R	1	58	3.1	3	L1: 380 L2: 400 L3: 415	1 layer either side of middle intumescent layer
65-80 R	2 & 9	56	4.0	2	L1: 300 L2: 324	1 layer sandwiched between intumescent layers
H 100 FWS	7	85	4.0	1	412	1 layer between intumescent and body of collar
H 100 S	5	85	4.0	1	412	1 layer between intumescent and body of collar

The stainless steel mesh wire measured 0.15 mm thick with 30 squares per inch.

2.4 Collar Drawings

Figure 1: 50 R Retro-fit Collar installed to specimen No's. 3, 8 & 10

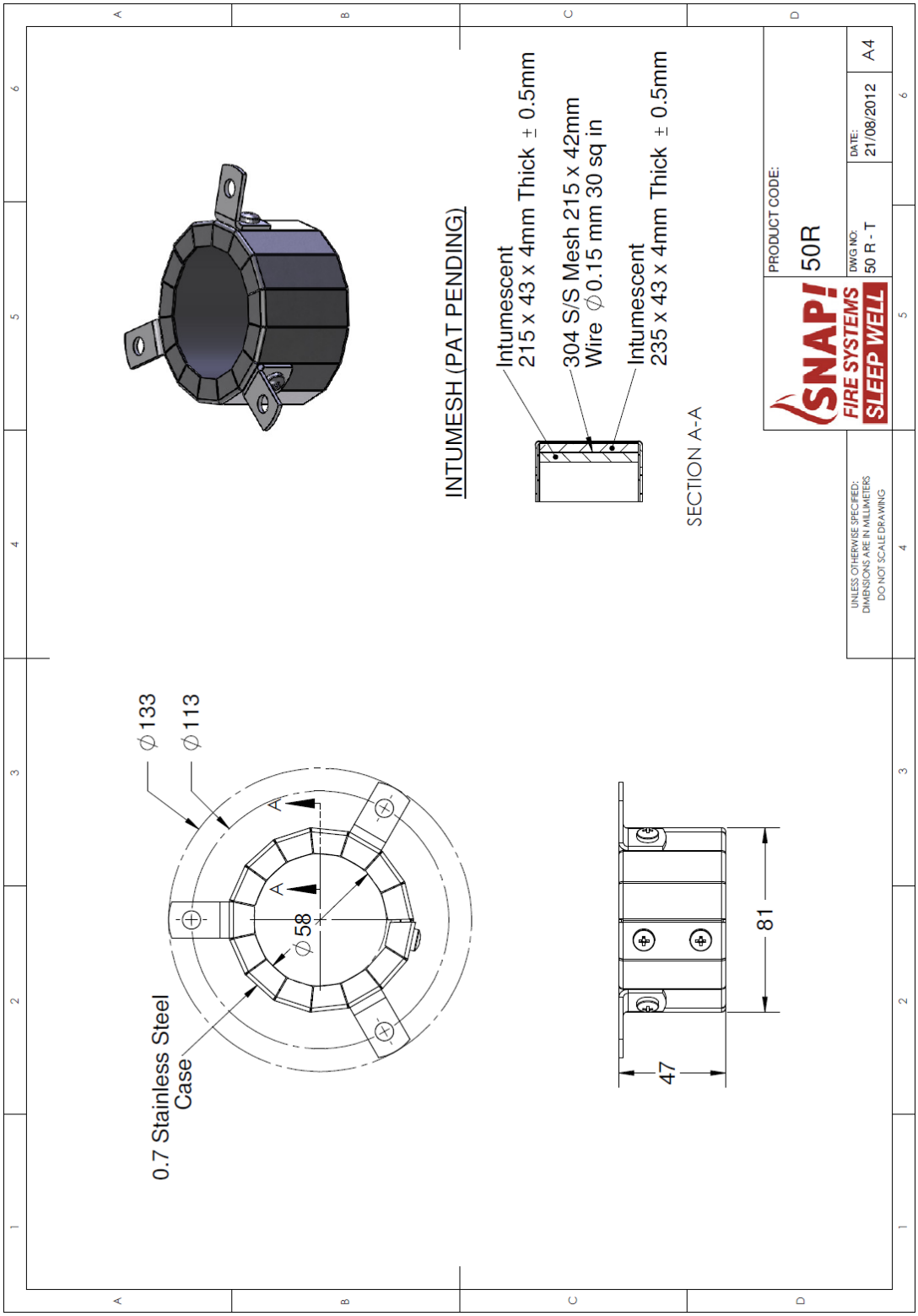


Figure 2: L100 FWS Cast-in Collar installed to specimen No. 6

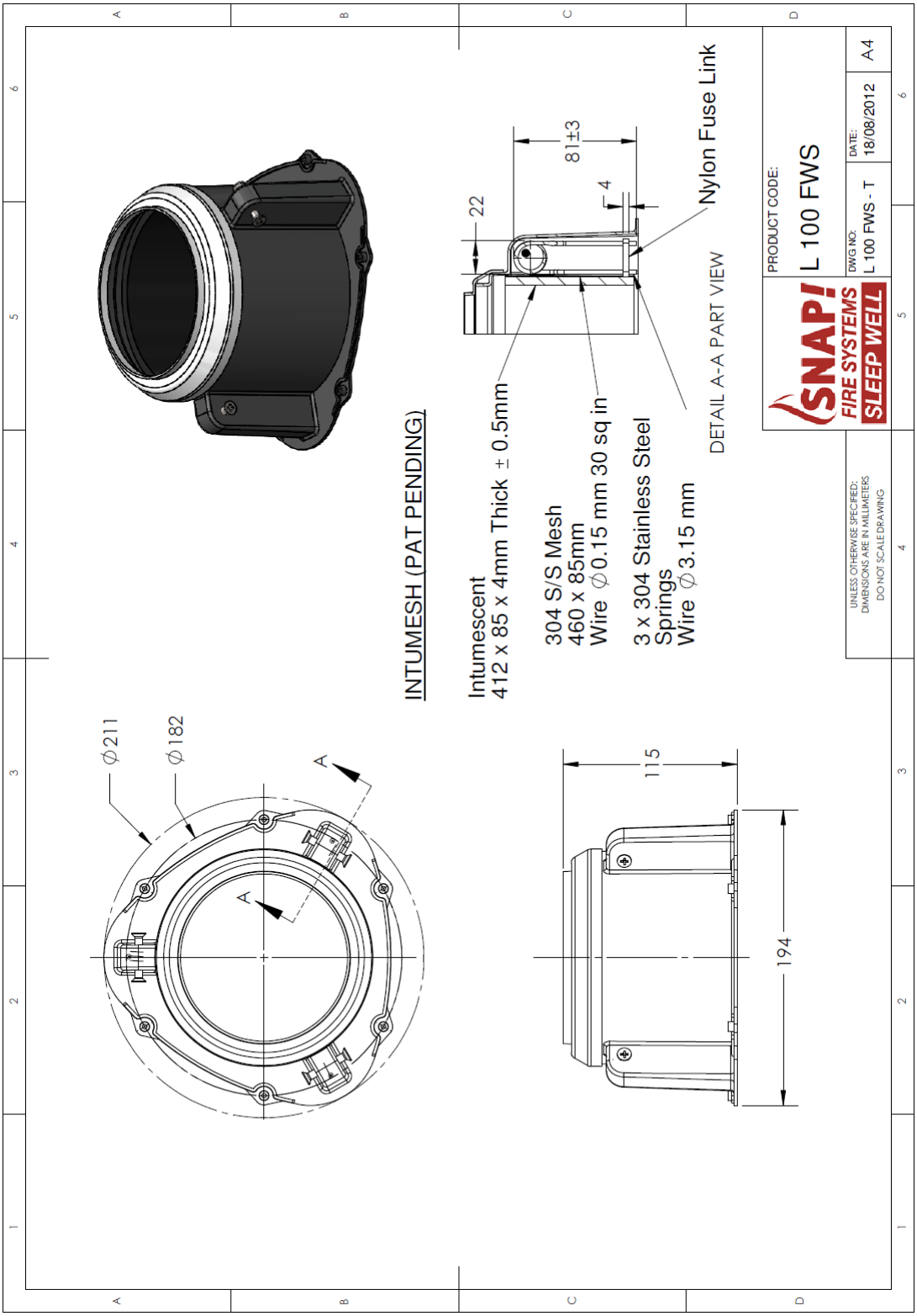


Figure 3: 110 R Retro-fit Collar installed to specimen No. 1

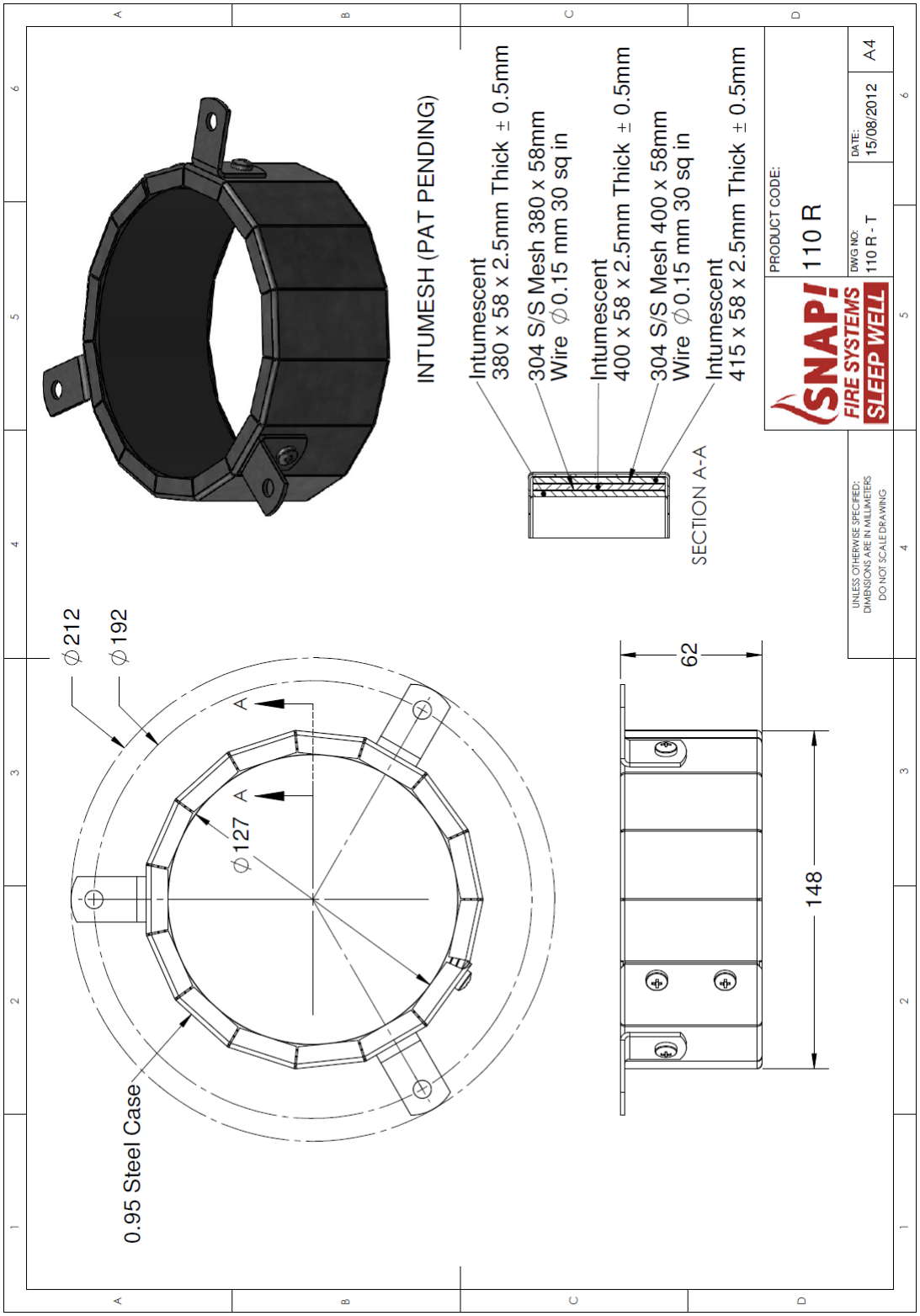


Figure 4: 65-80 R Retro-fit Collar installed to specimen No's. 2 & 9

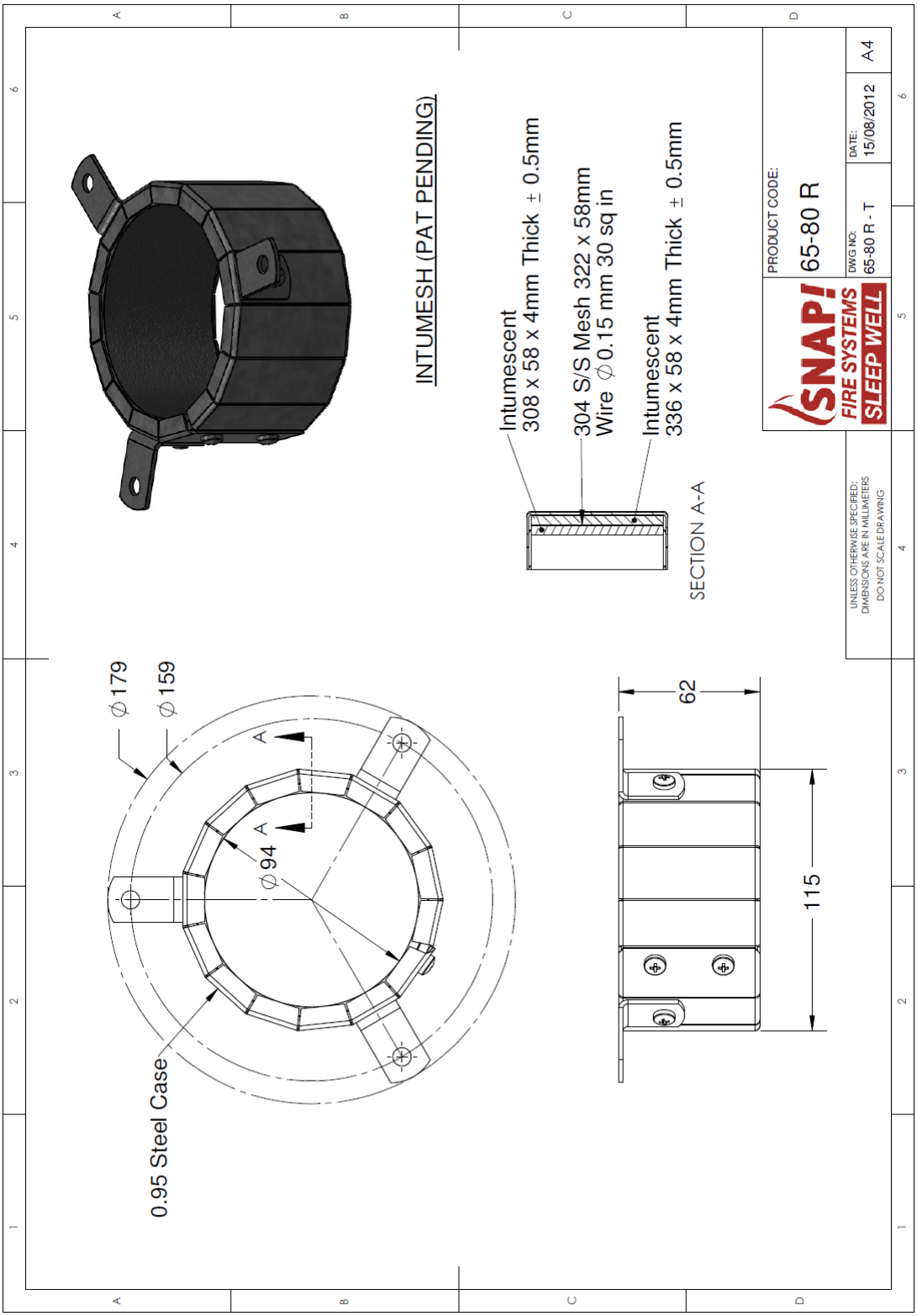


Figure 5: H 100 FWS Cast-in Collar installed to specimen No. 7

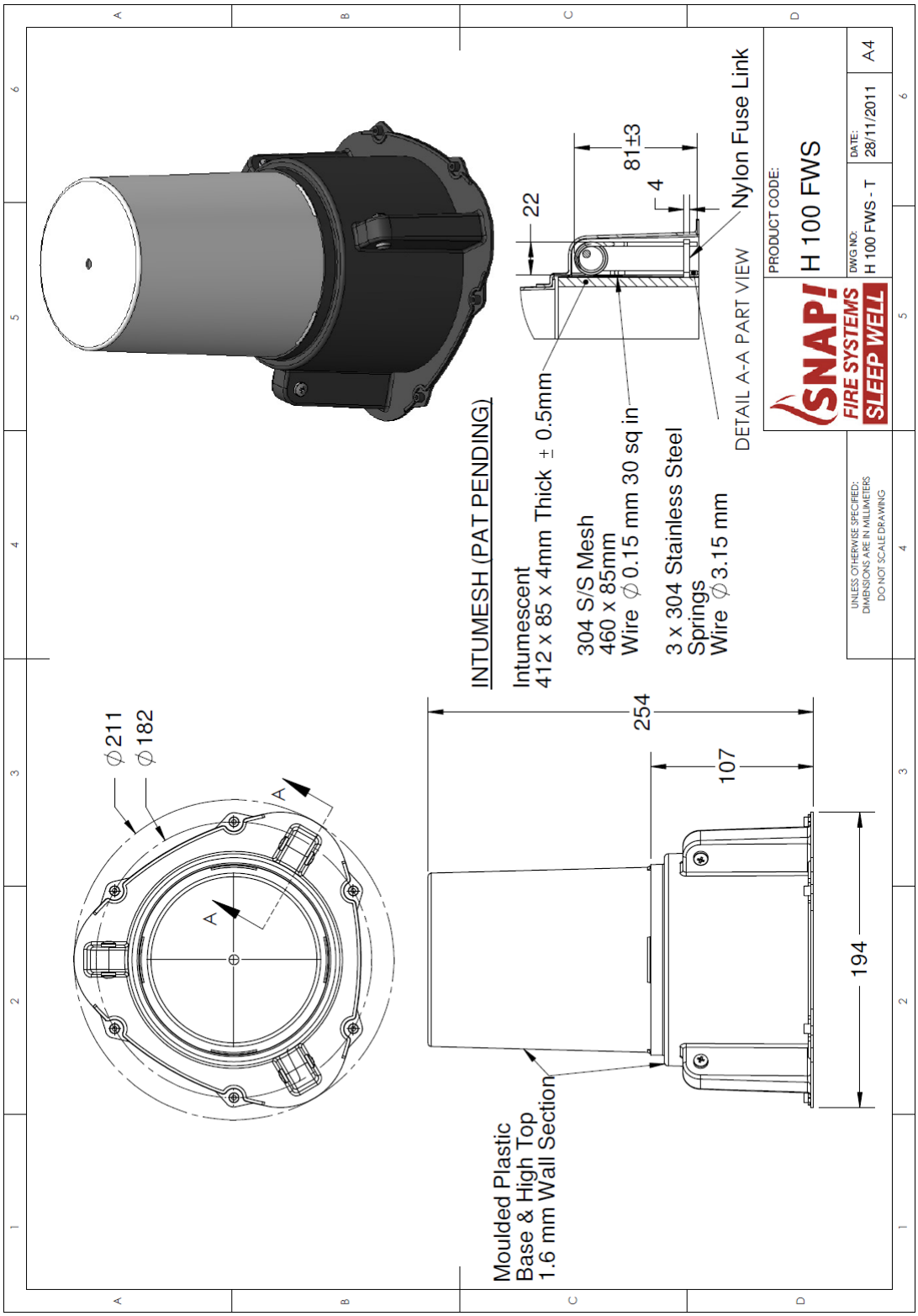
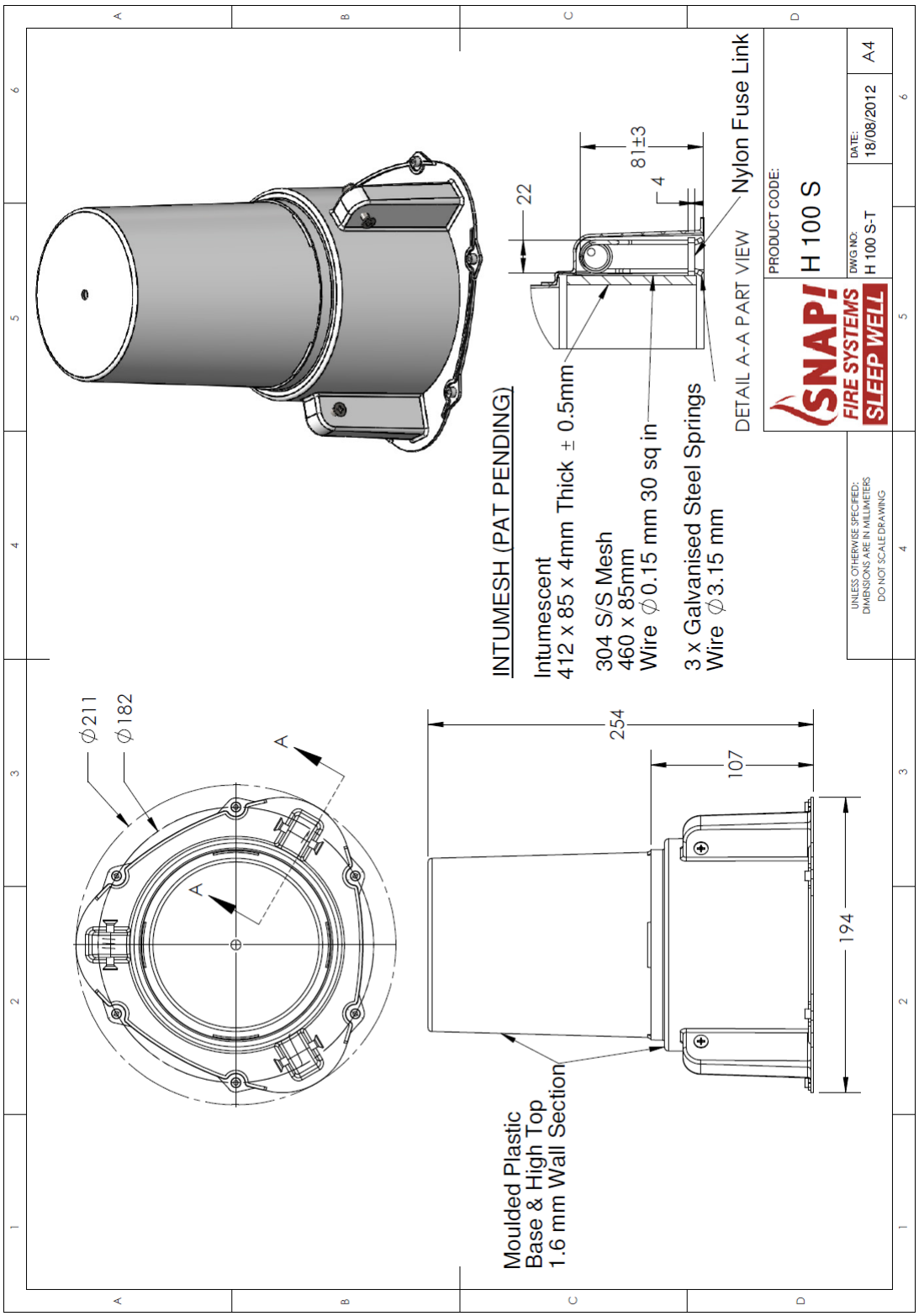


Figure 6: H 100 S Cast-in Collar installed in specimen No. 5



2.5 Test Specimen Layout

Figure 7 shows the concrete slab and general test specimen layout. Figures 8 to 16 show cross sectional views for individual test specimens.

Figure 7: Test Specimen Layout

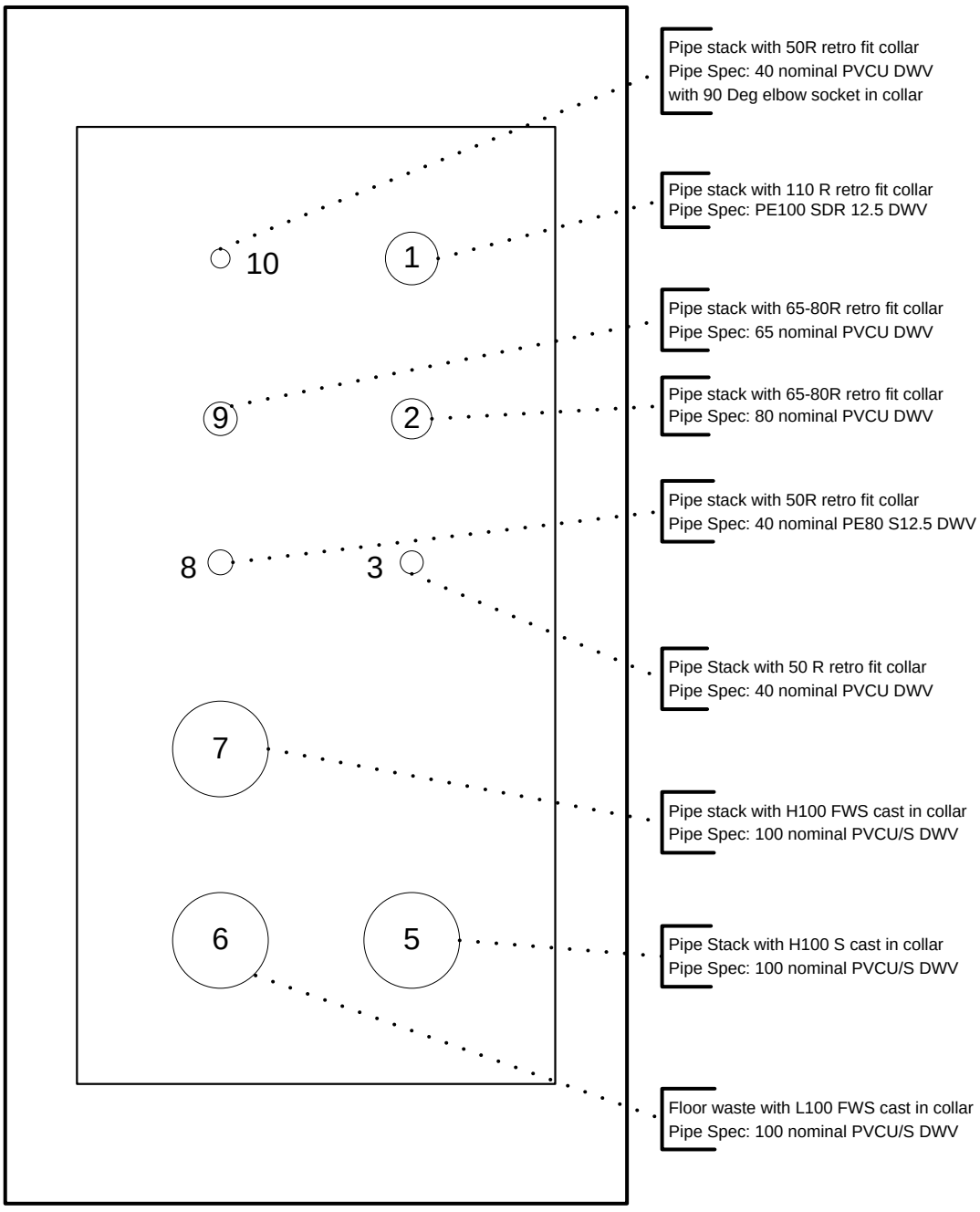


Figure 8: Specimen 1. 110 mm Ø PE100 Pipe Stack with 110R Retro-fit Collar

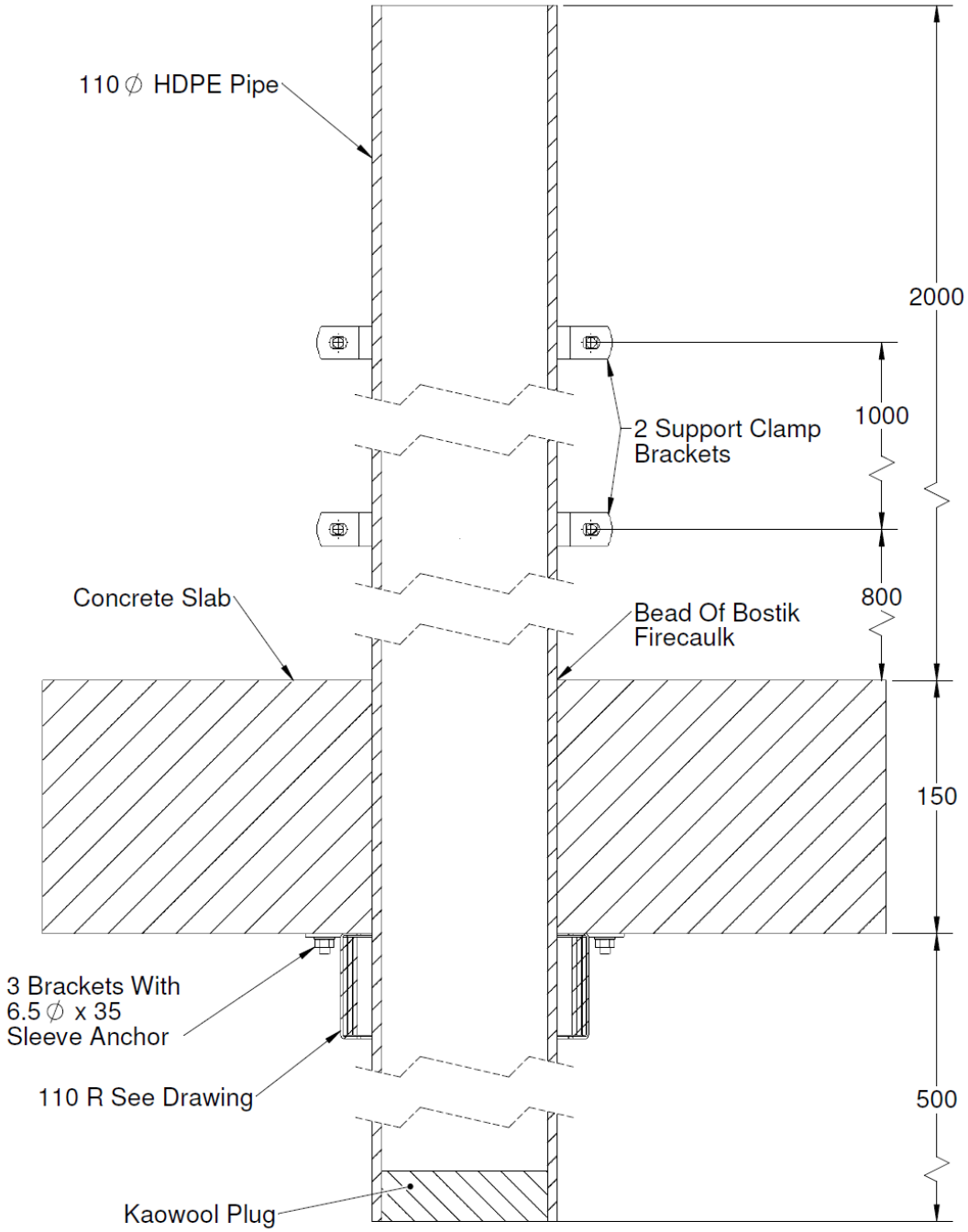


Figure 9: Specimen 2. 80 mm Ø PVCU Pipe Stack with 65-80R Retro-fit Collar

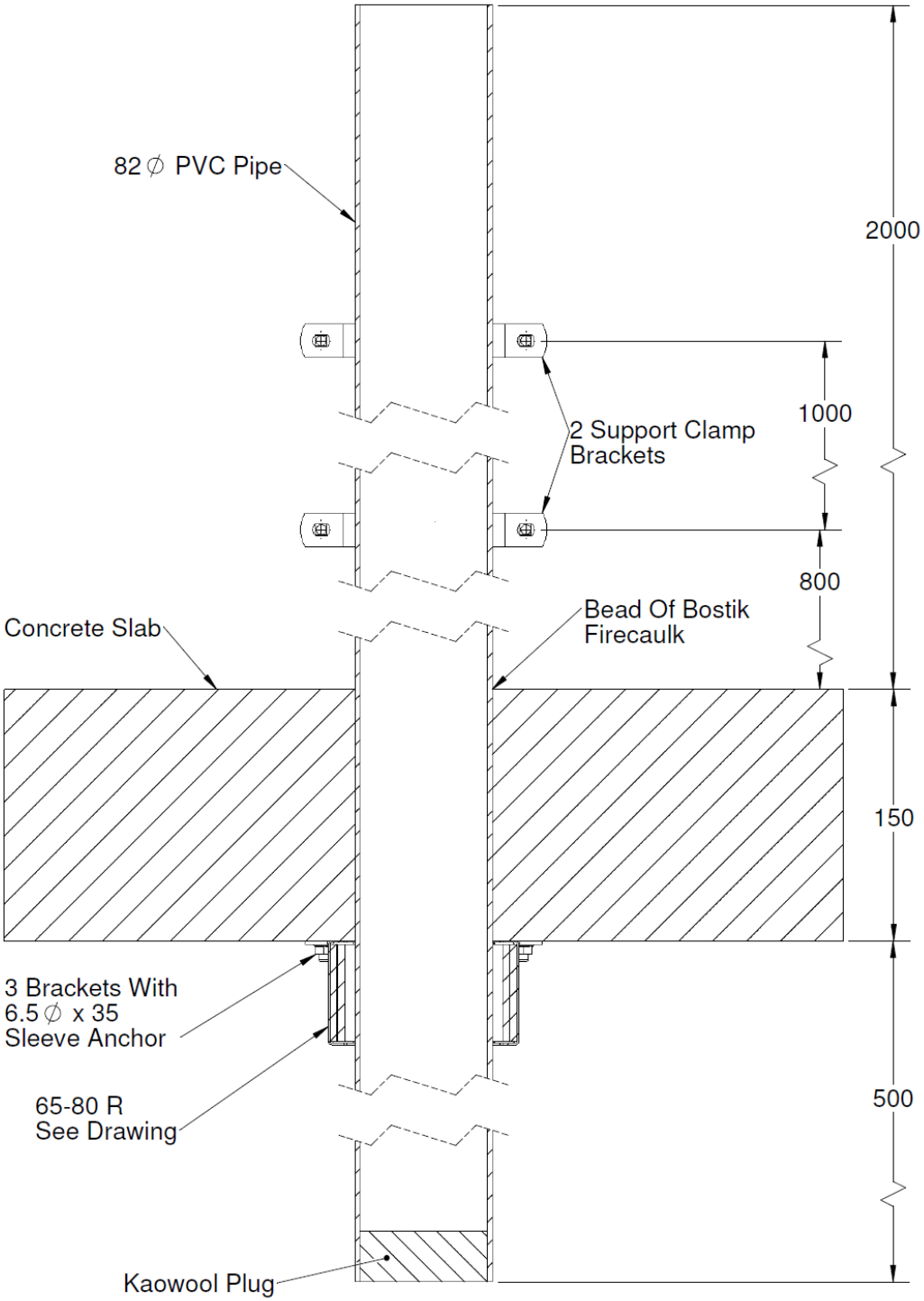


Figure 10: Specimen 3. 40 mm Ø PVCU Pipe Stack with 50R Retro-fit Collar

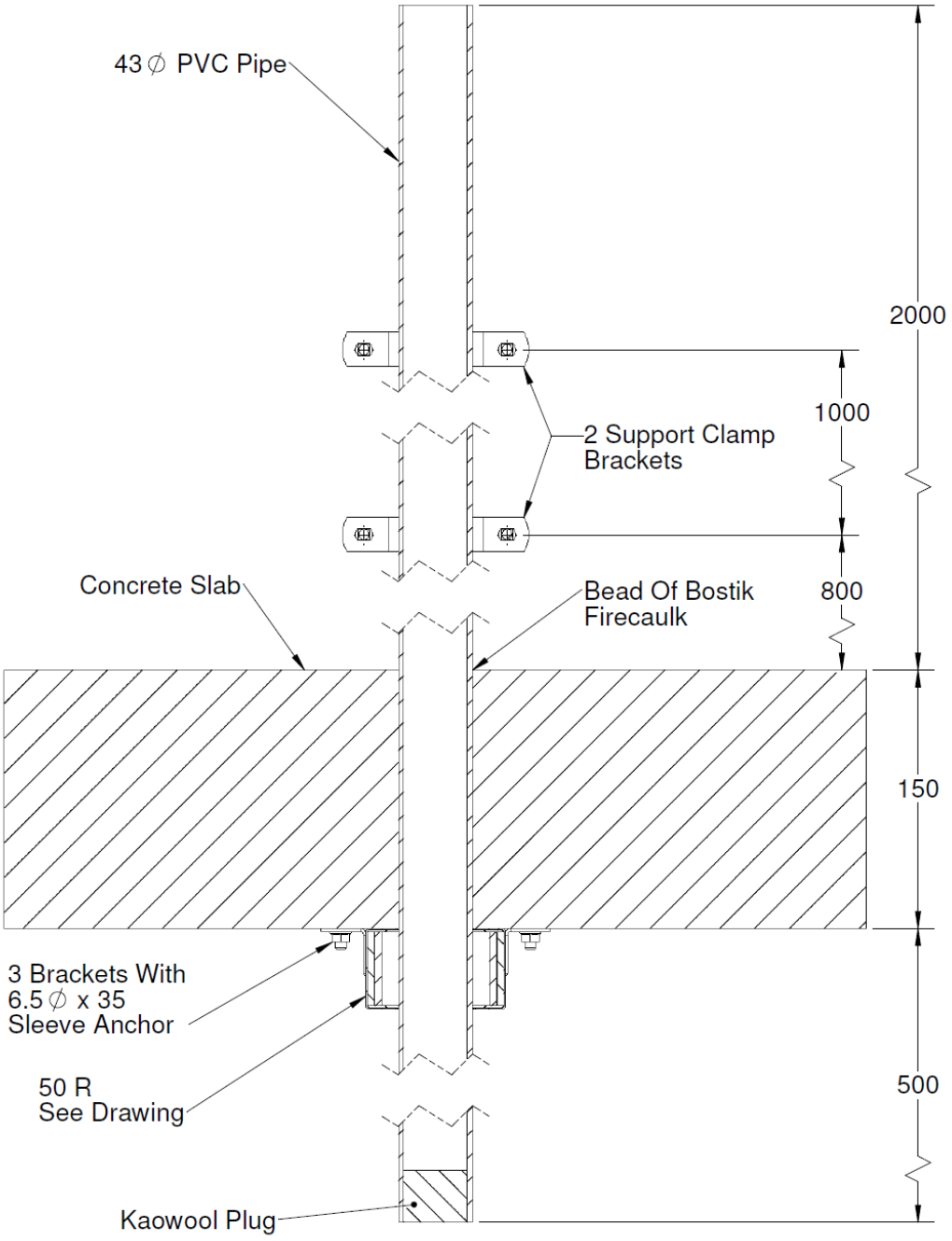


Figure 11: Specimen 5. 100 mm Ø PVCU Pipe Stack with H 100 S Cast-in Collar

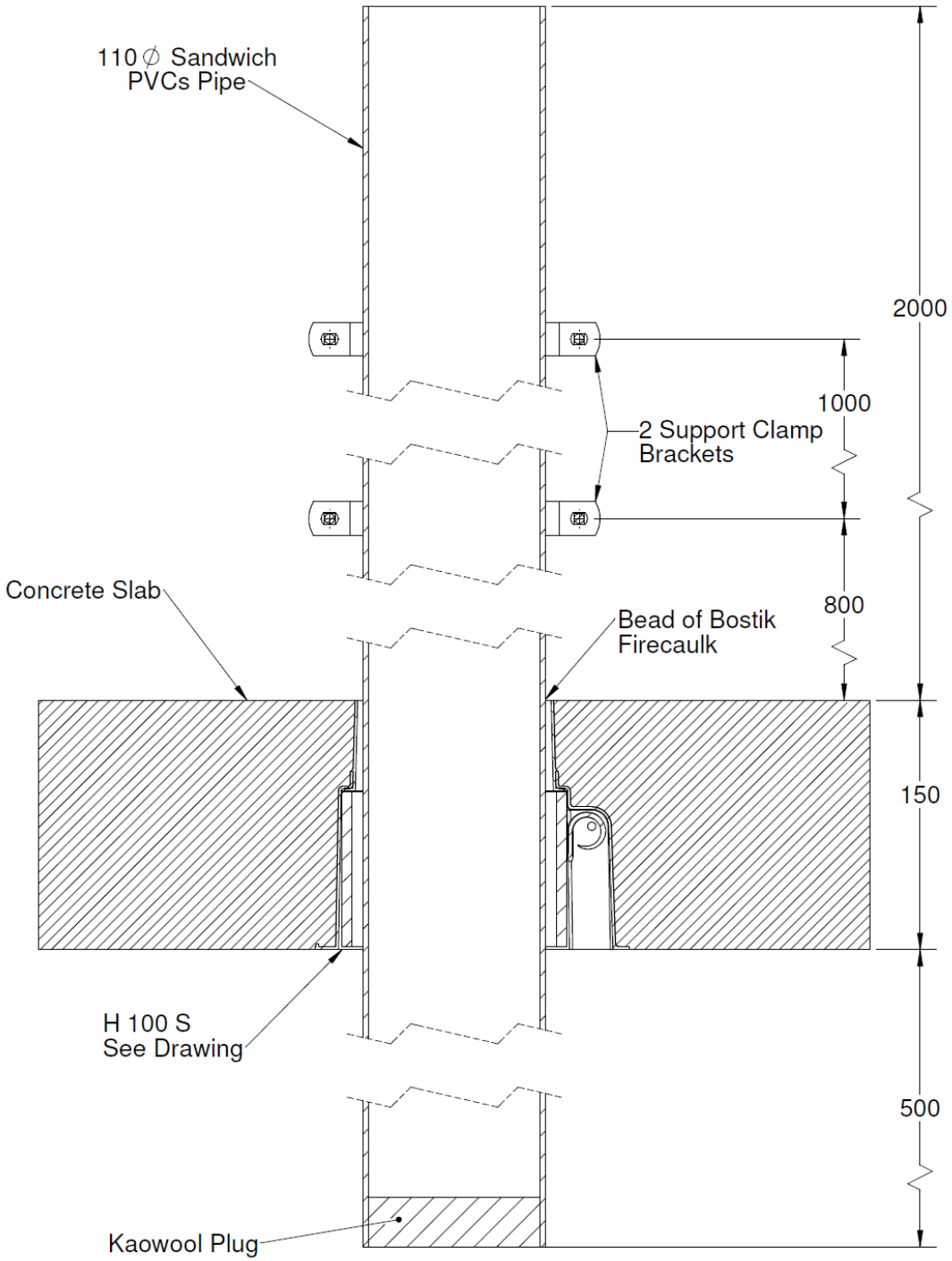


Figure 12: Specimen 6. 100 mm Ø PVCU Floor Waste with L 100 FWS Cast-in Collar

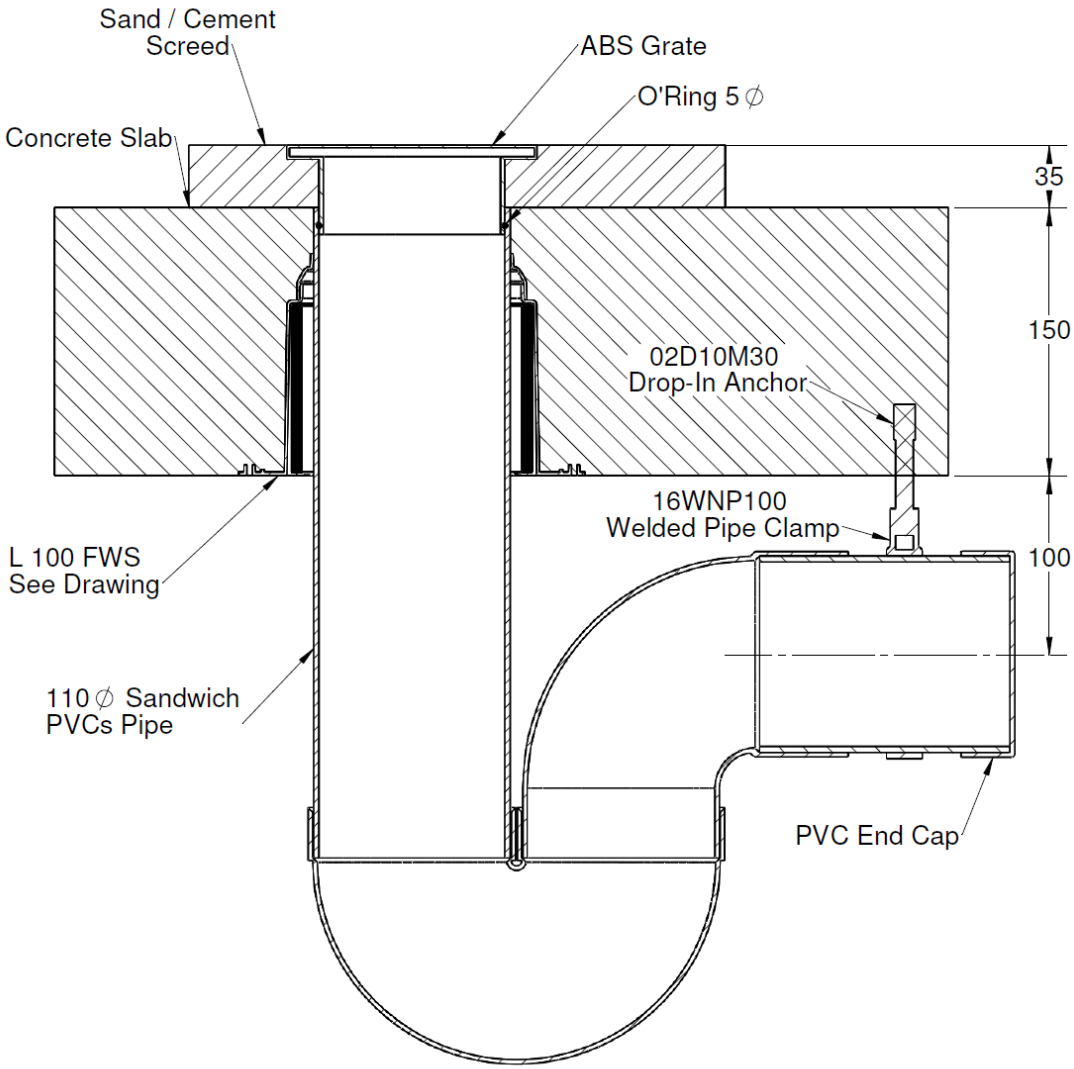


Figure 13: Specimen 7. 100 mm Ø PVCU Pipe Stack with H 100 FWS Cast-in Collar

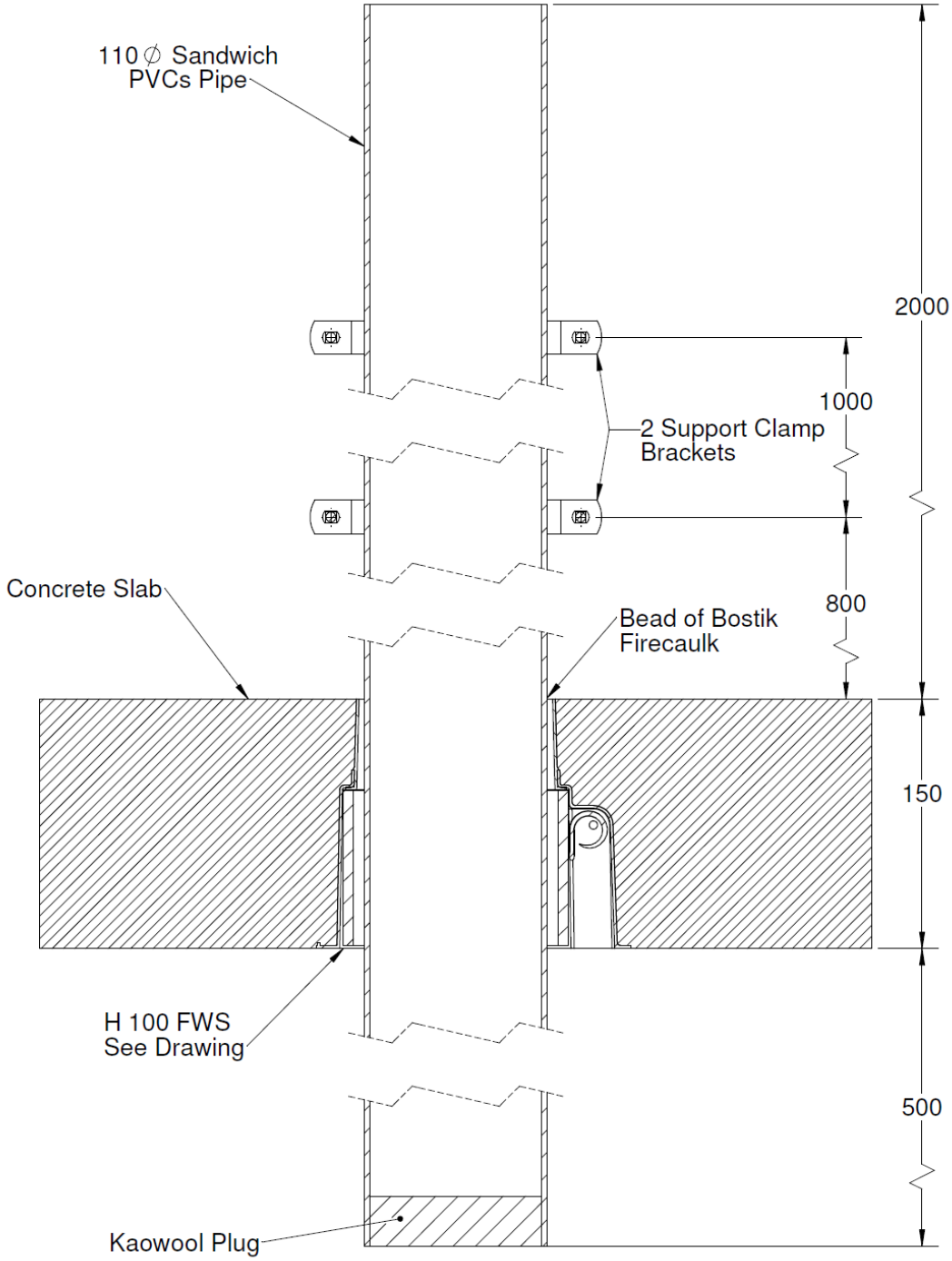


Figure 14: Specimen 8. 40 mm Ø PE80 S12.5 Pipe Stack with 50R Retro-fit Collar

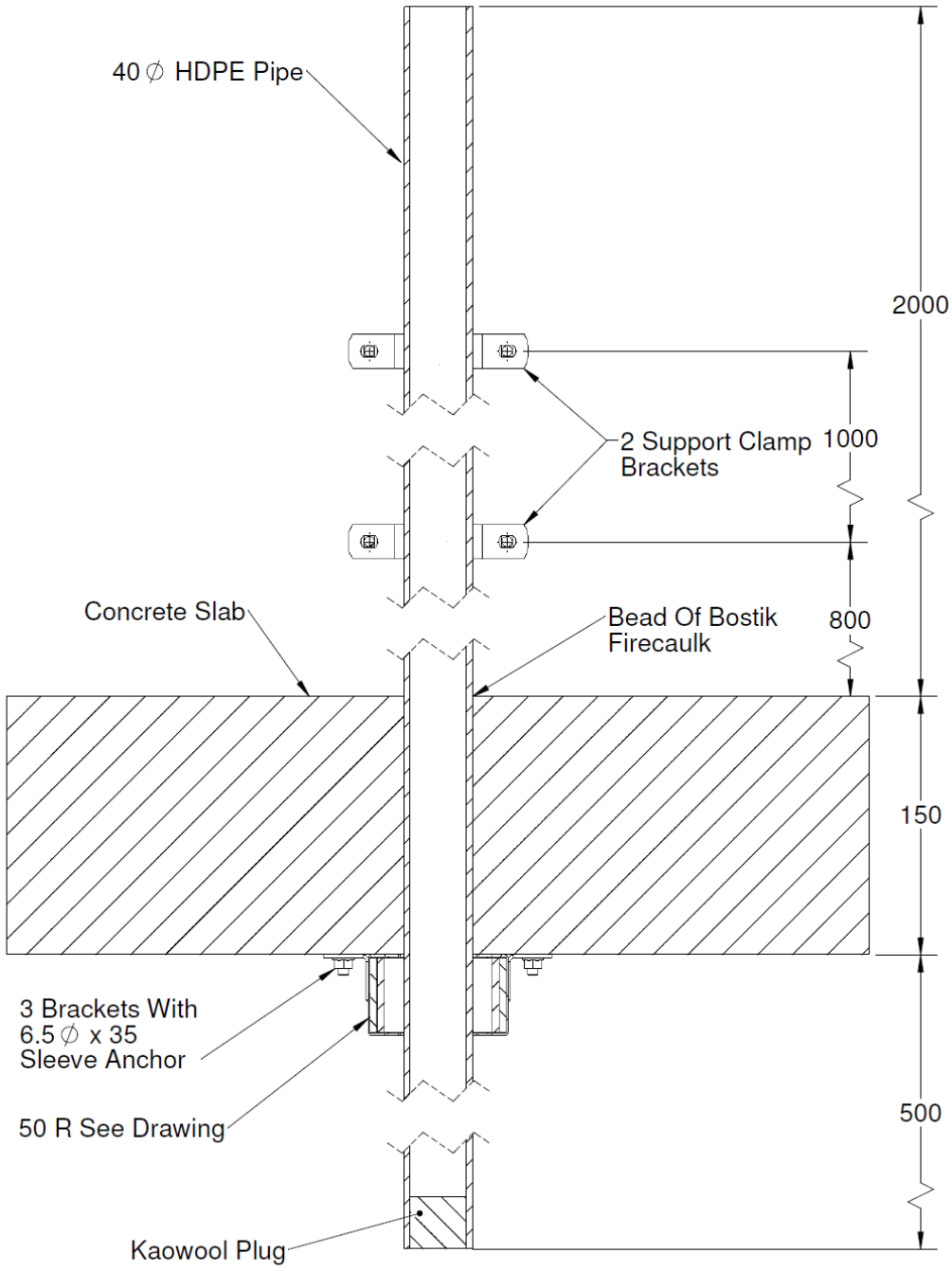


Figure 15: Specimen 9. 65 mm Ø PVCU Pipe Stack with 65-80R Retro-fit Collar

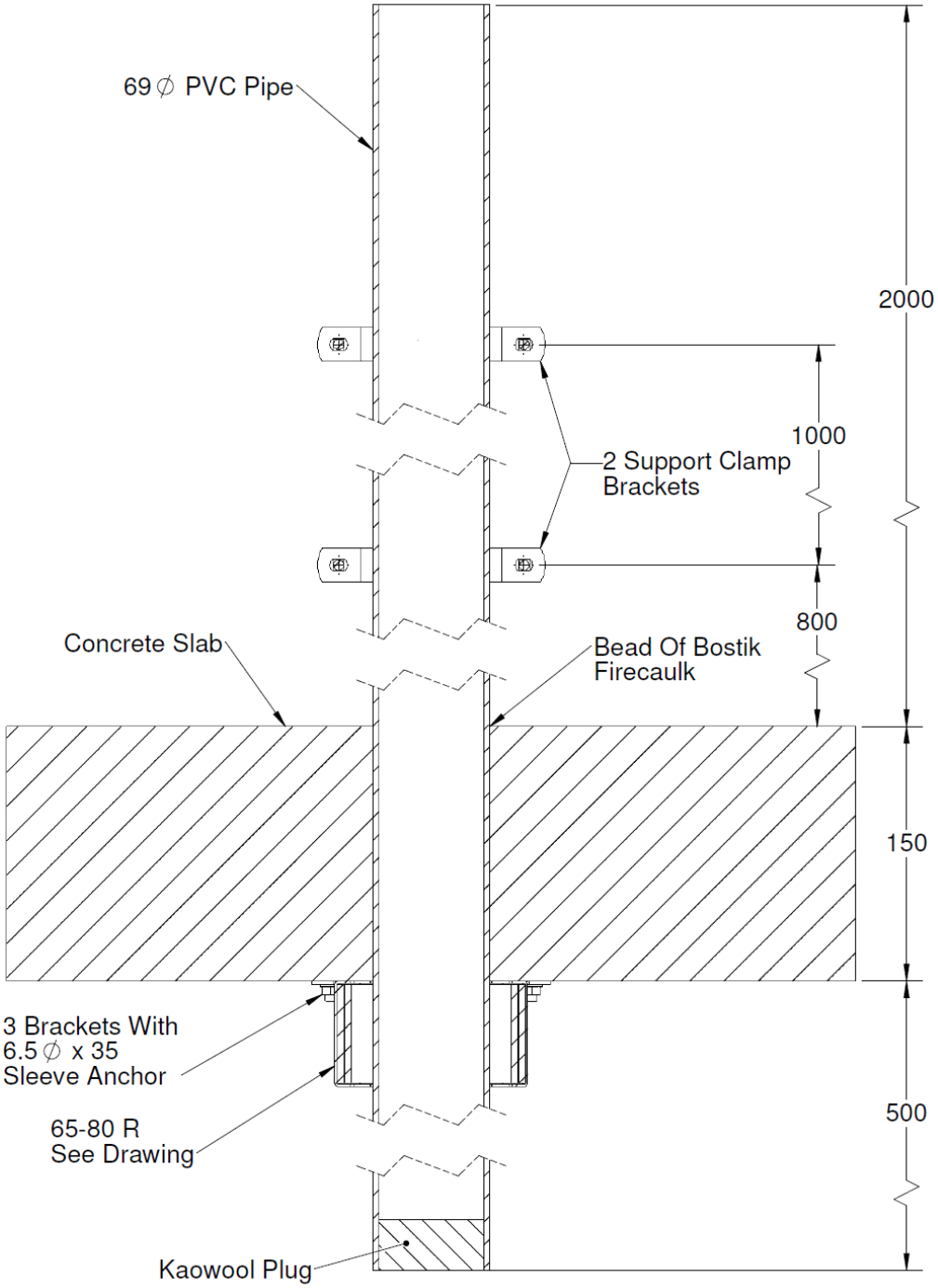
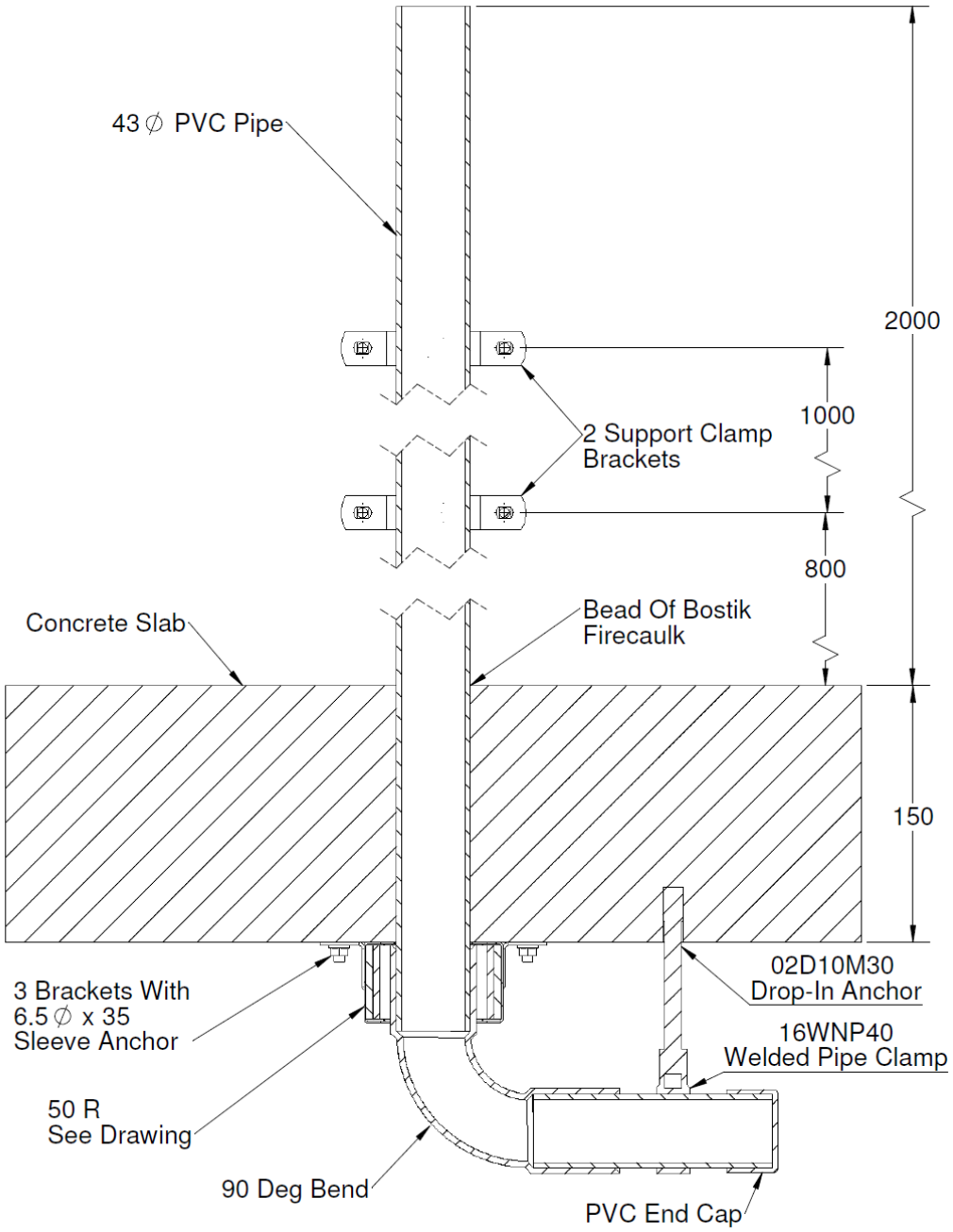


Figure 16: Specimen 10. 40 mm Ø PVCU Pipe Stack with 90° Elbow in 50R Retro-fit Collar



3. TEST CONDITIONS AND RESULTS

3.1 General

The specimen was tested on the 24 May 2012 at BRANZ laboratories, Judgeford, New Zealand, in the presence of a representative of the client. The ambient temperature at the beginning of the test was 12°C.

The concrete slab containing the specimens was placed against the horizontal 2,200 mm x 1,000 mm furnace aperture and the temperature and pressure conditions were controlled to the limits defined in AS 1530.4-2005.

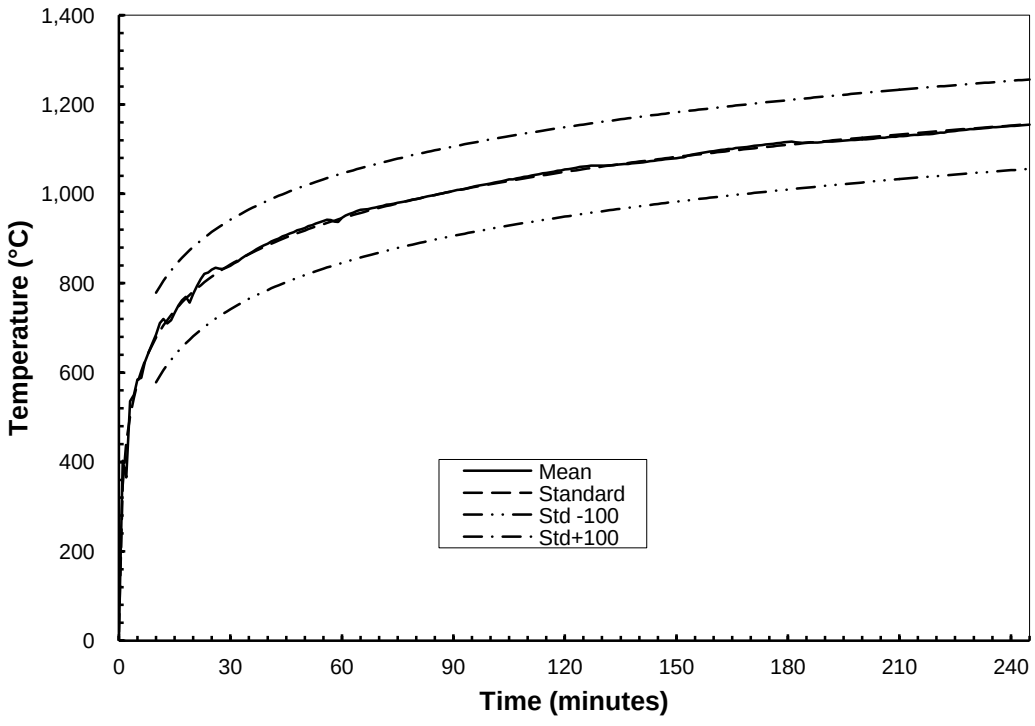
3.2 Furnace Temperature Measurement

The temperature measurement within the furnace was made using twelve mineral insulated metal sheathed (MIMS) chromel-alumel thermocouples distributed uniformly in a vertical plane approximately 100 mm from the exposed face of the separating element. In summary the furnace conditions complied with the test standard.

The furnace thermocouples were connected to a computer controlled data acquisition system which recorded the temperatures at 15 second intervals.

Figure 17 shows the furnace temperature curve and the permitted upper and lower limits in accordance with AS 1530.4: 2005.

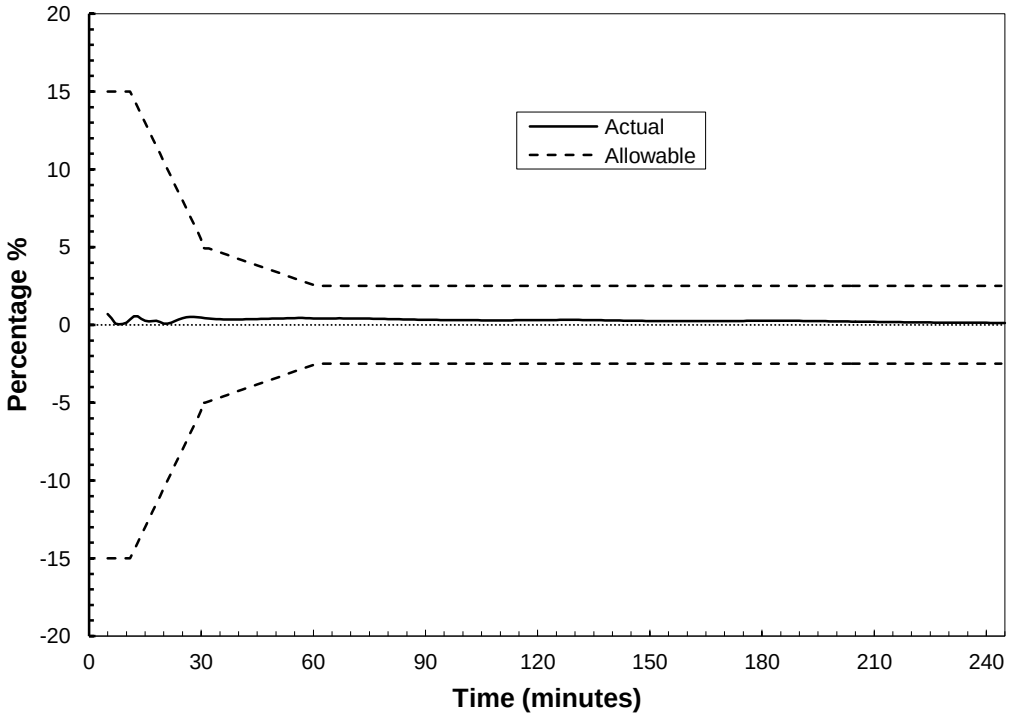
Figure 17: Furnace Temperature



3.3 Furnace Control

The percentage deviation of the furnace mean temperature from the standard time temperature curve is shown in Figure 18 and was within the standard requirements.

Figure 18: Percentage Deviation of the Mean Furnace Temperature from the Standard Curve



3.4 Pressure Measurements

The differential pressure was controlled to be not less than 20 Pa 100 mm below the underside of the concrete slab. The differential pressure was monitored using a micromanometer connected to a computer controlled data acquisition system which recorded the pressure at 15 second intervals.

The furnace pressure was monitored and controlled during the test so that the calculated pressure at the probe does not deviate as follows:

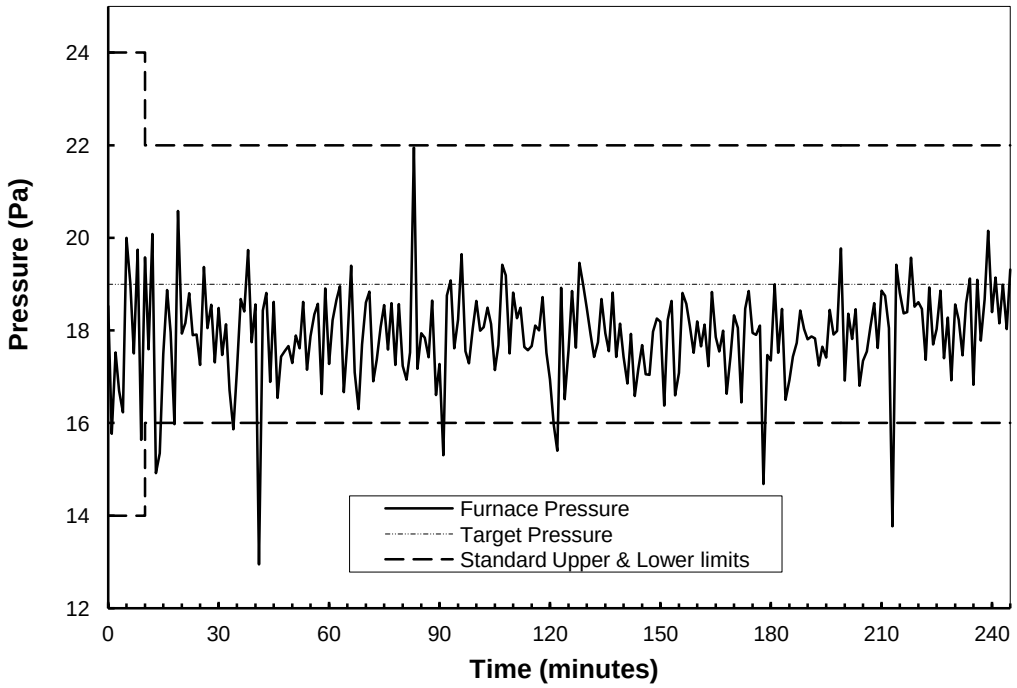
for $5 < t < 10$ minutes - $\pm$ 5 Pa

for $t \geq 10$ minutes - $\pm$ 3 Pa.

The pressure sensor was located 250 mm below the floor slab.

Minor pressure deviations outside of the lower limits occurred on six occasions, these minor variations are not considered to have impacted on the test result.

Figure 19: Furnace Pressure



3.5 Specimen Temperature Measurement

Thirty five chromel-alumel thermocouples were attached to the specimens. The arrangement consisted of thermocouples placed as specified in clause 10.5 of the test standard AS 1530.4-2005.

Thermocouples were placed on the unexposed surface of the concrete slab at 25 mm from the penetrations, on the pipes at 25 mm from the slab and a single thermocouple was placed on the centre of the floor waste. Two additional thermocouples were placed on the unexposed surface of the slab clear of any of the penetrations.

All the thermocouples described above were connected to a computer controlled data acquisition system which recorded the temperatures at 15 second intervals.

The following figures show the relevant maximum temperature rise for each test specimen.

Figure 20: Specimen 1 Temperature Rise

Figure 21: Specimen 2 Temperature Rise

Figure 22: Specimen 3 Temperature Rise

3.6 Specimen Insulation

None of the test specimens exceeded the insulation criteria before 245 minutes. Table 3 shows the maximum temperature rise achieved by each specimen and the location of the relevant thermocouple.

Thermocouple No. 25 located 25 mm from the pipe of specimen No. 7 was disregarded after 134 minutes due to becoming embedded in softening material from the collar that projected above the slab.

Table 3: Specimen Maximum Temperature

Pipe Specimen	Maximum Temperature and time	Thermocouple Location
1	106K @ 245 minutes	On the slab 25 mm from the pipe
2	135K @ 245 minutes	On the slab 25 mm from the pipe
3	133K @ 245 minutes	On the slab 25 mm from the pipe
5	147K @ 245 minutes	On the slab 25 mm from the pipe
6	124K @ 245 minutes	On the slab 25 mm from the grate
7	173K @ 245 minutes	On the slab 25 mm from the pipe
8	130K @ 245 minutes	On the slab 25 mm from the pipe
9	122K @ 245 minutes	On the slab 25 mm from the pipe
10	132K @ 245 minutes	On the slab 25 mm from the pipe

Figure 20: Specimen 1 Temperature Rise

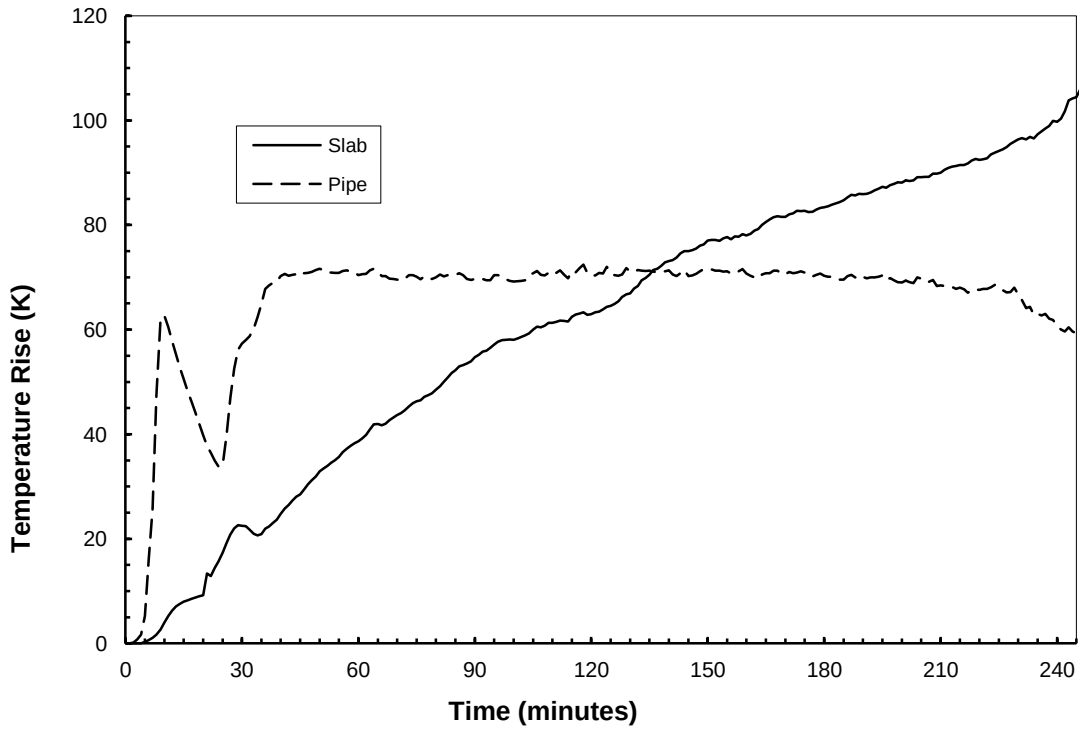


Figure 21: Specimen 2 Temperature Rise

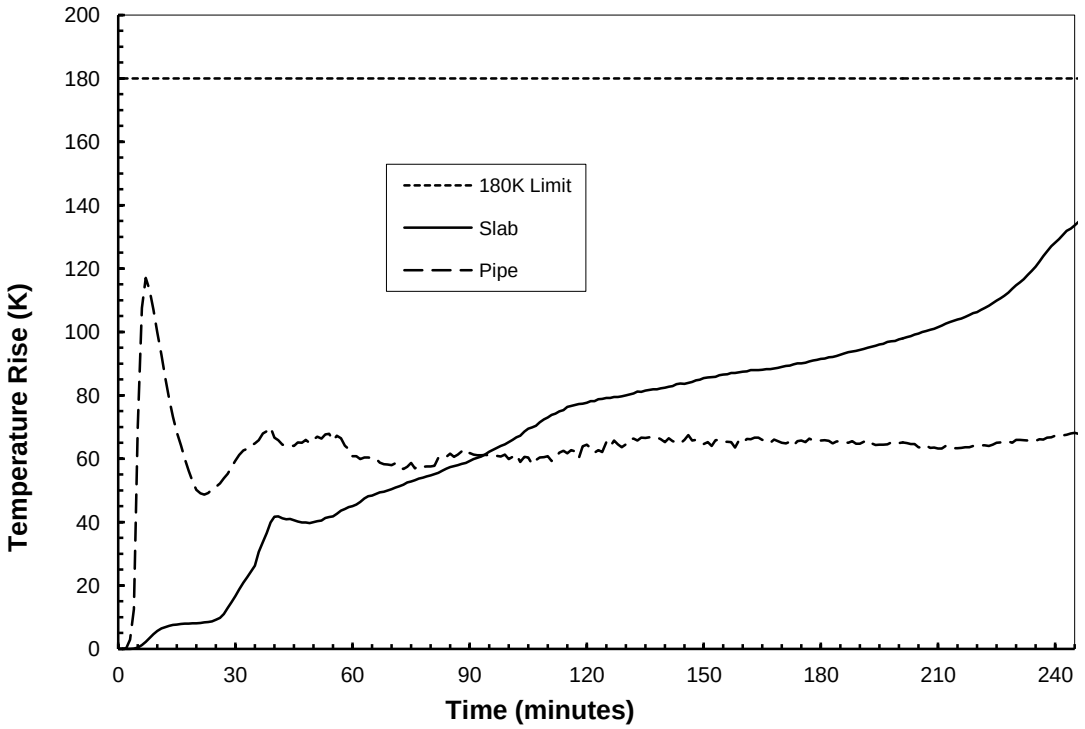


Figure 22: Specimen 3 Temperature Rise

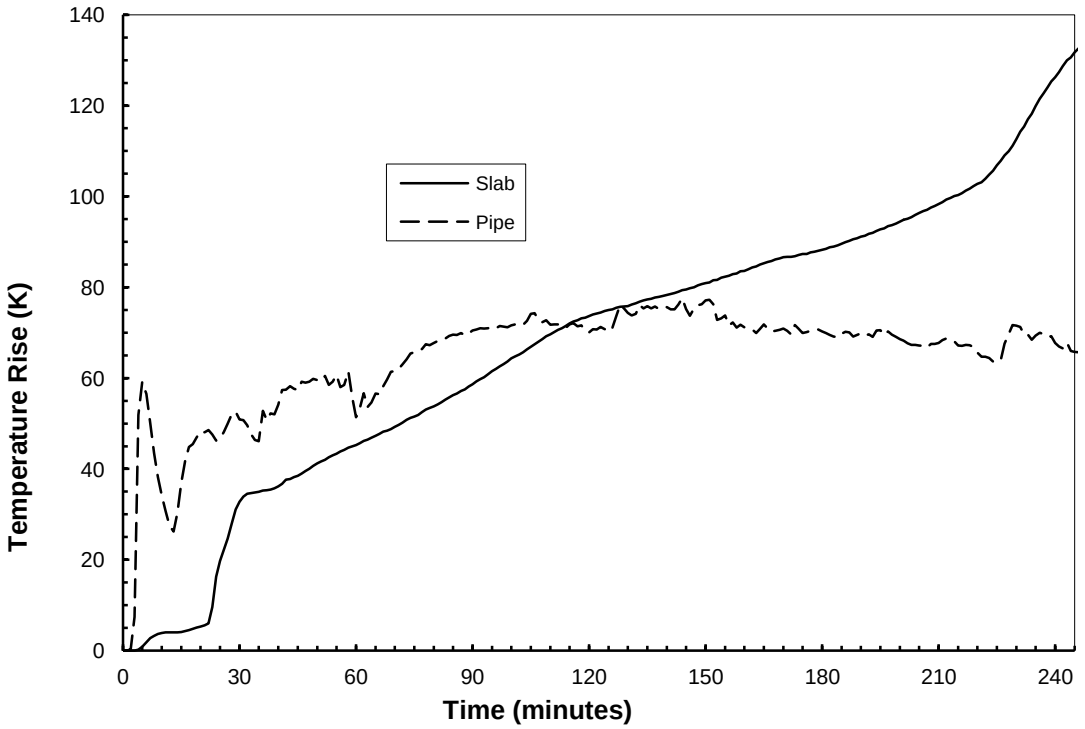


Figure 23: Specimen 5 Temperature Rise

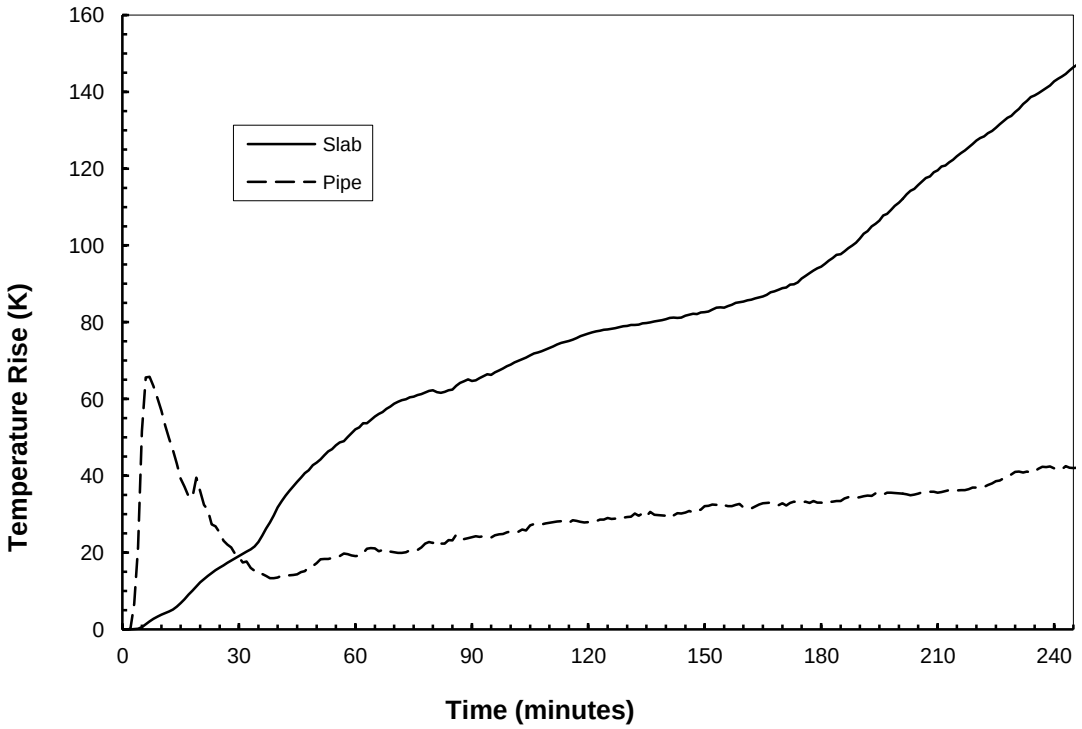


Figure 24: Specimen 6 Temperature Rise

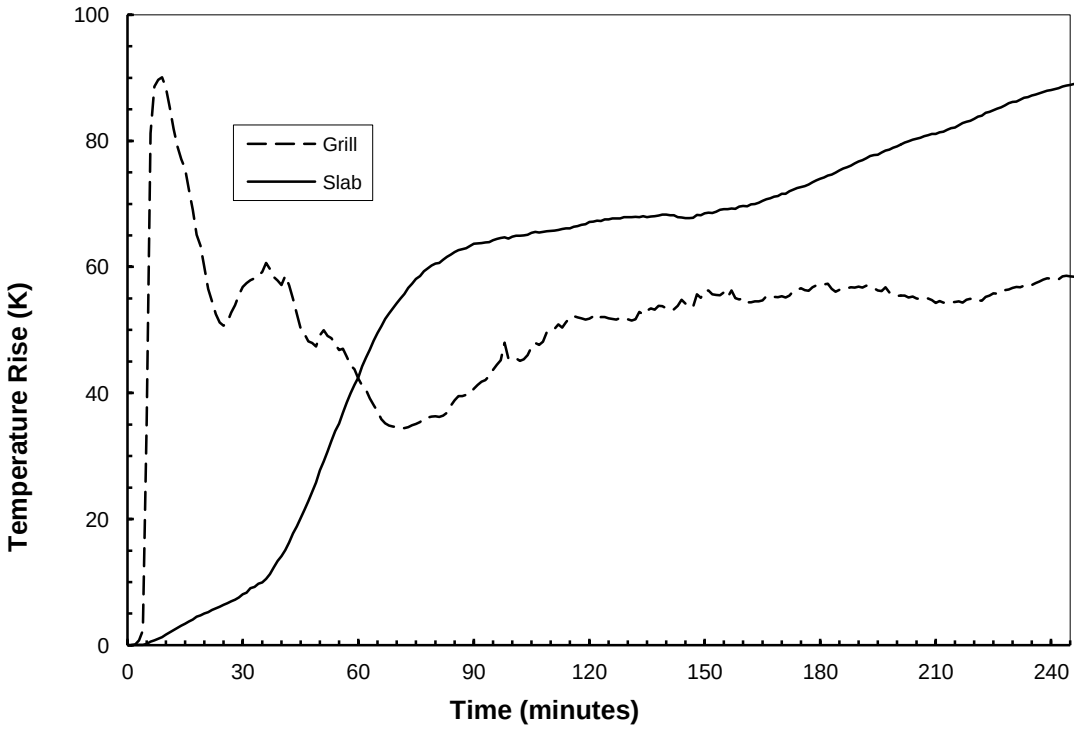


Figure 25: Specimen 7 Temperature Rise

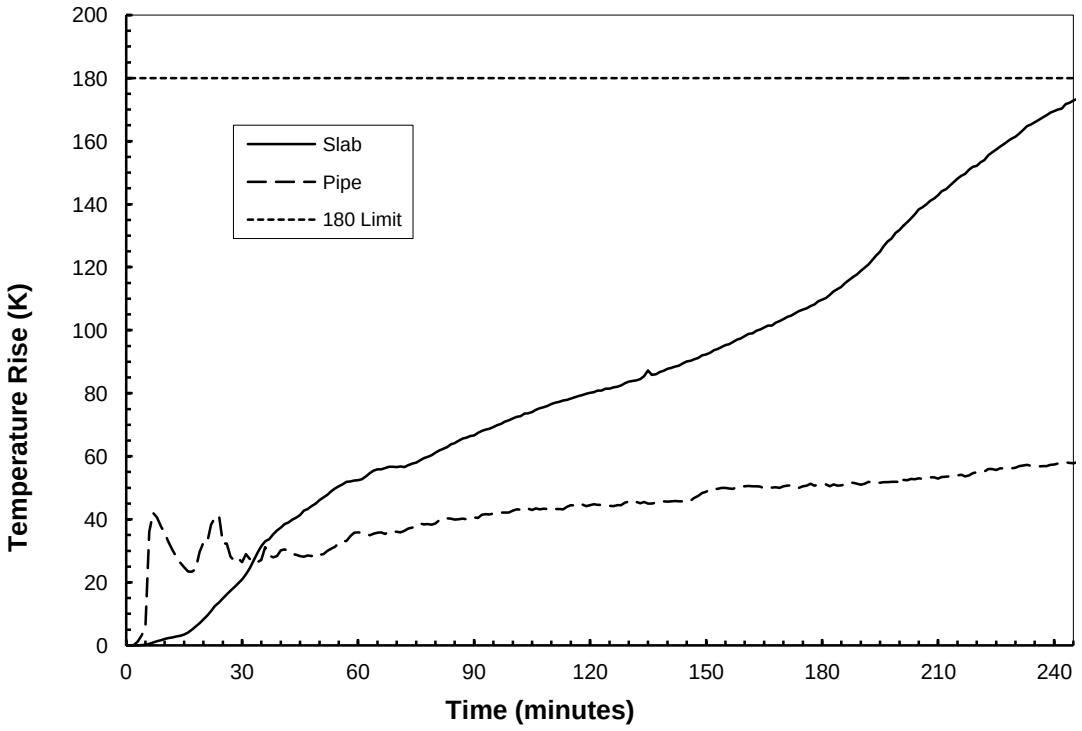


Figure 26: Specimen 8 Temperature Rise

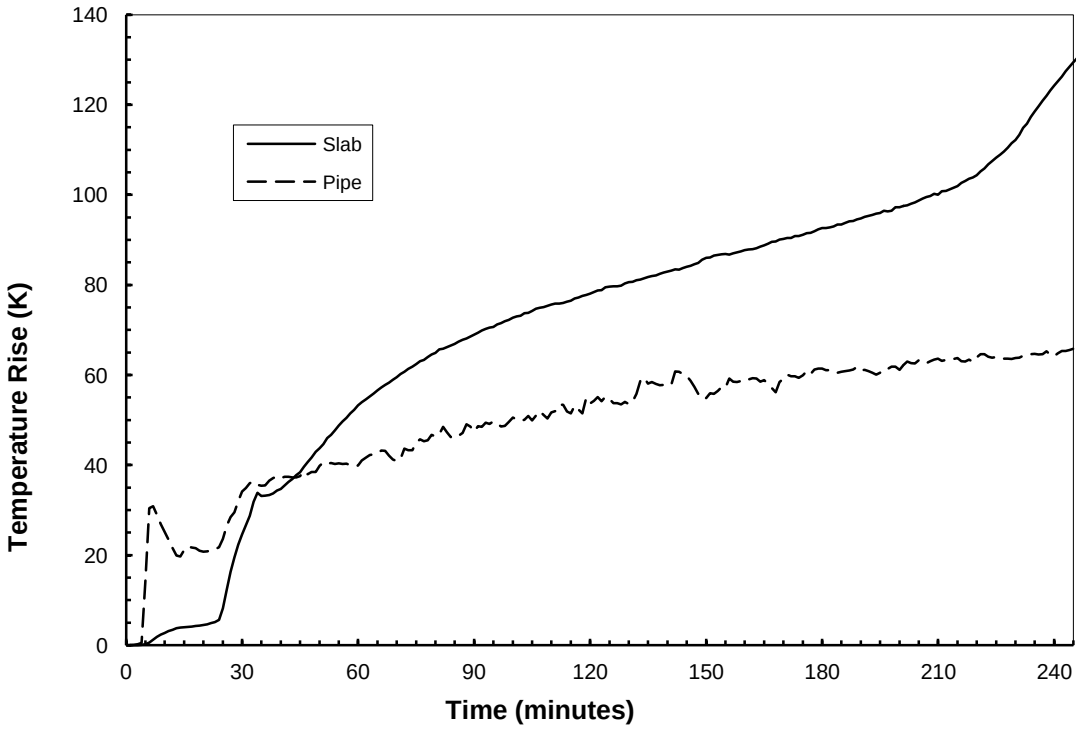


Figure 27: Specimen 9 Temperature Rise

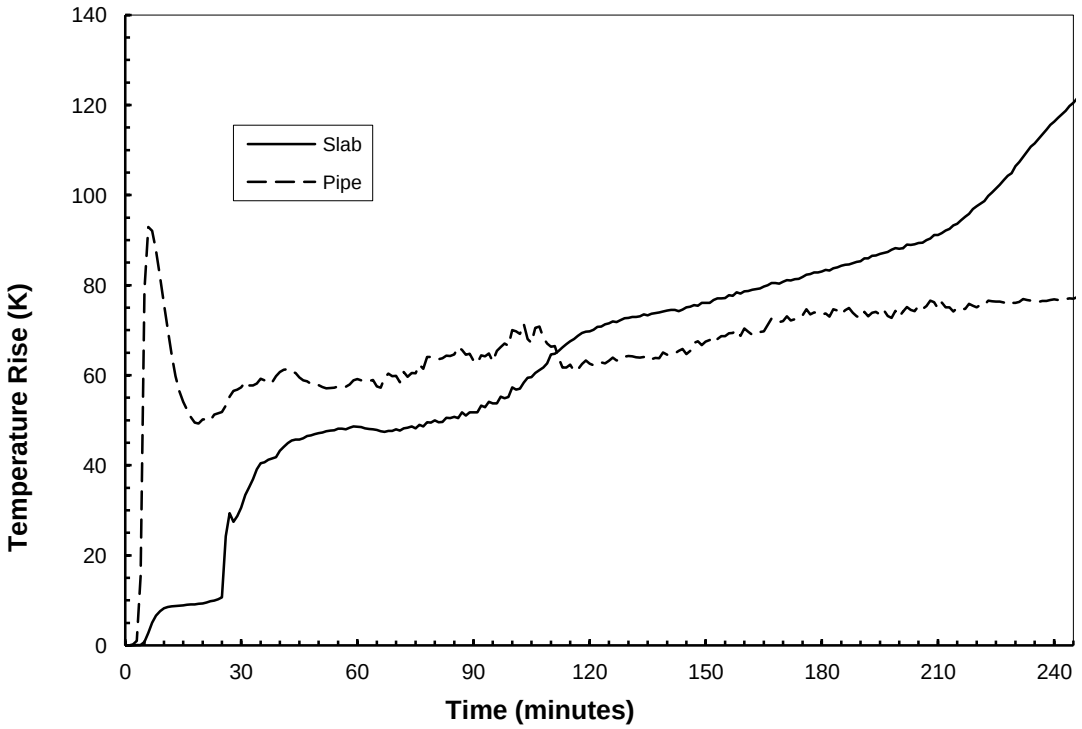
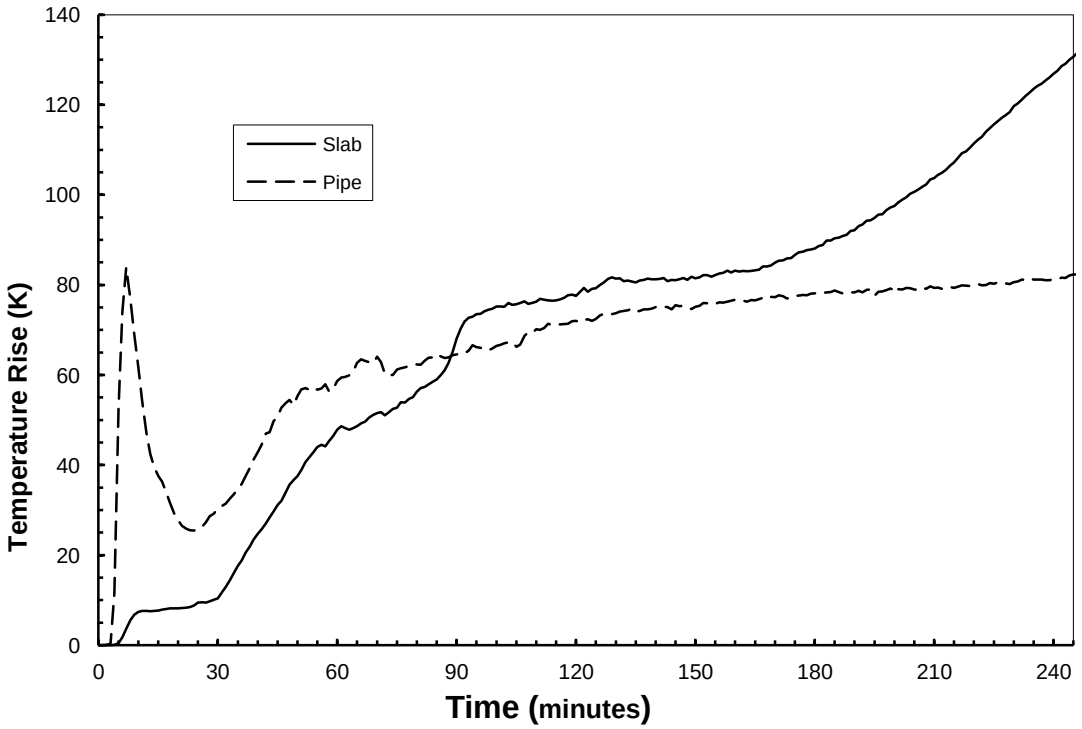


Figure 28: Specimen 10 Temperature Rise



3.7 Integrity Observations

Observations related to the integrity performance of the specimens were at the times stated in minutes and seconds.

Table 4: Integrity Observations

Time **Min:sec**	Specimen (#)	Description
1:32	2, 3 & 5	Smoke and particles were issuing from the end of pipes 2 & 5 and in a steady stream from the end of pipe No 3.
2:35	3	The smoke issuing from pipe 3 had become denser.
2:44	1, 9 & 10	Smoke was issuing from pipes 1, 9 & 10. Smoke issuing from the end of pipe 9 was in a steady stream.
2:00	2 & 5	The volume of smoke issuing from the end of pipe 2 had increased in volume. The smoke issuing from the end of pipe 5 had become dark in colour and had increased in volume.
3:22	8	Smoke was issuing from the end of pipe 8.
3:31	3	The volume of smoke issuing from the end of the pipe had reduced significantly.
3:50	5	The volume of smoke issuing from the end of the pipe had reduced significantly.
3:58	1	The volume of smoke issuing from the end of the pipe had reduced significantly.
4:07	6 & 7	Smoke was issuing from pipe 7 and from the floor waste grate of specimen 6.
4:26	2	A steady stream of smoke was issuing from the end of pipe 2.
6:57	1, 5 & 6	Smoke was issuing from the end of the stack pipes and a small amount from the floor waste.
9:26	1-10	Smoke issuing from all the pipes had greatly reduced in volume.
12:42	5	The pipe had been pushed out of the slab by approximately 10 mm.
13:48	6	There was an increase in the smoke issuing from the floor waste grate.
14:10	2, 7-10	The pipes had been pushed out of the slab by approximately 10 mm.
15:49	5 & 6	A steady stream of smoke was issuing from the floor waste grate. Smoke was issuing from between the pipe and the slab of pipe 5.
18:32	6	There was a significant increase in the volume of smoke issuing from the floor grate.
39:35	3	The pipe had been pushed up out of the slab by approximately 25 mm.

Time **Min:sec**	Specimen (#)	Description
50:12	2-5 7 - 10	Pipe 5 had distorted slightly were it exits the slab. The pipe had been pushed up out of the slab by approximately 25 mm. Pipes 2, 3, & 7 - 10 had been pushed up out of the slab by approximately 30 mm.
120:00	5	Pipe 5 had been pushed out of the slab by approximately 30 mm.
134:00	7	Part of the top hat plastic section of the cast-in collar had melted around half the perimeter of the pipe and had flowed around thermocouple (T/C) number 25.
151:39	6	The grate had started to be pushed up out of the slab.
156:00	7	The roving T/C was applied next to T/C No 25 and achieved 96°C absolute rising very slowly.
156:32	7	The pipe had distorted slightly were it exits the slab adjacent to T/C No 25.
171:43	2, 3, 5, 6 7 - 10	Pipes 2, 3, 5, & 7 - 10 had pushed up out of the slab by between 30 to 40 mm. The grate of the floor waste was lifting up out of the slab.
181:03	6	The grate had lifted up out of the slab all around the perimeter of the grate by as much as 5 mm on one side.
214:58	1	The pipe had lifted up out of the slab by approximately 10 mm.
234:55	7	The roving thermocouple was applied next to T/C 25 achieving 75°C absolute rising very slowly.
245:00		Test stopped

3.8 Test Result

The fire resistance in minutes, in accordance with AS 1530.4-2005 with reference to AS 4072.1 - 2005, of nine pipe penetrations and their sealing systems in a concrete slab, was as follows:

NF = No failure for the duration of the test.

Table 5: Test Result

Specimen No.	Collar Designation	Pipe Designation	Integrity (Minutes)	Insulation (Minutes)	FRL
1	110R (Retro-fit)	110 mm x 4.3 mm PE100 SDR 26	245NF	245NF	-/240/240
2	65-80R (Retro-fit)	80 PVC-U DWV	245NF	245NF	-/240/240
3	50R (Retro-fit)	40 PVC-U DWV	245NF	245NF	-/240/240
5	H100S (Cast-in)	100 PVC-U S DWV*	245NF	245NF	-/240/240
6	L100FWS (Cast-in)	100 PVC-U S DWV* (Floor Waste with Trap)	245NF	245NF	-/240/240
7	H100FWS (Cast-in)	100 PVC-U S DWV*	245NF	245NF	-/240/240
8	50R (Retro-fit)	40 mm x 3 mm PE80 S12.5	245NF	245NF	-/240/240
9	65-80R (Retro-fit)	65 PVC-U DWV	245NF	245NF	-/240/240
10	50R (Retro-fit)	40 PVC-U DWV (With Elbow socket in collar)	245NF	245NF	-/240/240

* = PVC-U pipe sandwich construction

"This report details the methods of construction, the test conditions and the results obtained when the specific element of construction described herein was tested following the procedure outlined in this standard. any significant variation with respect to size, constructional details, loads, stresses, edge or end conditions, other than those allowed under the field or direct application in the relevant test method, is not covered by this report.

Because of the nature of fire resistance testing and the consequent difficulty in quantifying the uncertainty of measurement of fire resistance, it is not possible to provide a stated degree of accuracy of the result."

4. PERMISSIBLE VARIATIONS

Taken from AS 1530.4 -2005 as applicable to this test specimen.

The results of the fire test contained in the test report are directly applicable without reference to the testing authority to similar constructions where one or more of the changes set out in Clauses 10.11.2 to 10.11.6 have been made.

Results obtained for sealing systems in various types of concrete construction may be applied as follows:

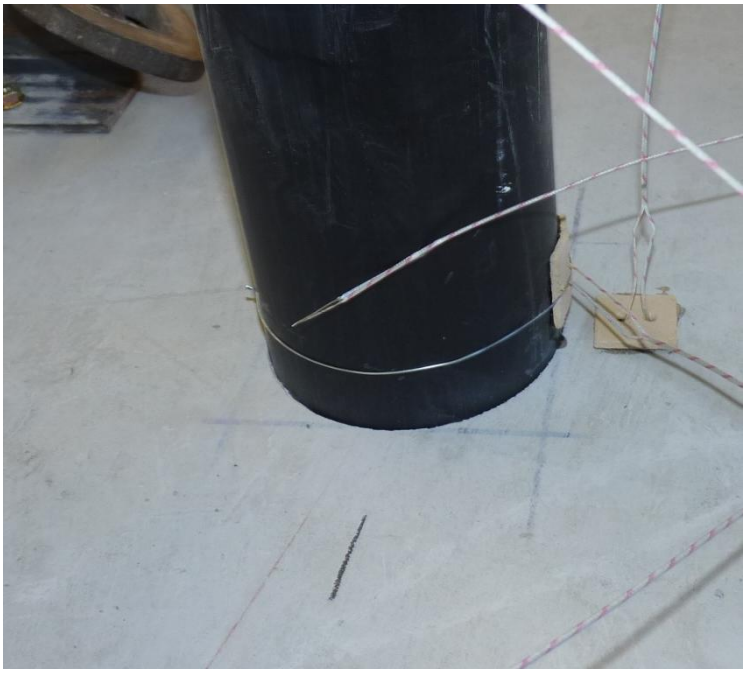
1. The results of the prototype test may be applied to concrete of density 2,245 kg/m^3 ± 15%.
2. Plastic pipes
    a. The test results may be directly applied to concrete elements thicker than the tested prototype.
    b. Penetrations not perpendicular to the plane of the element are acceptable provided that the fire-stopping system is used as reported here and the fire exposure is from below the slab.

5. SPECIMEN PHOTOGRAPHS

The unexposed photographs show the test specimens prior to the Bostic Firecaulk fire rated acrylic sealant application around the perimeter of the pipe at the slab face.

5.1 Specimen 1

Unexposed Face



Exposed Face

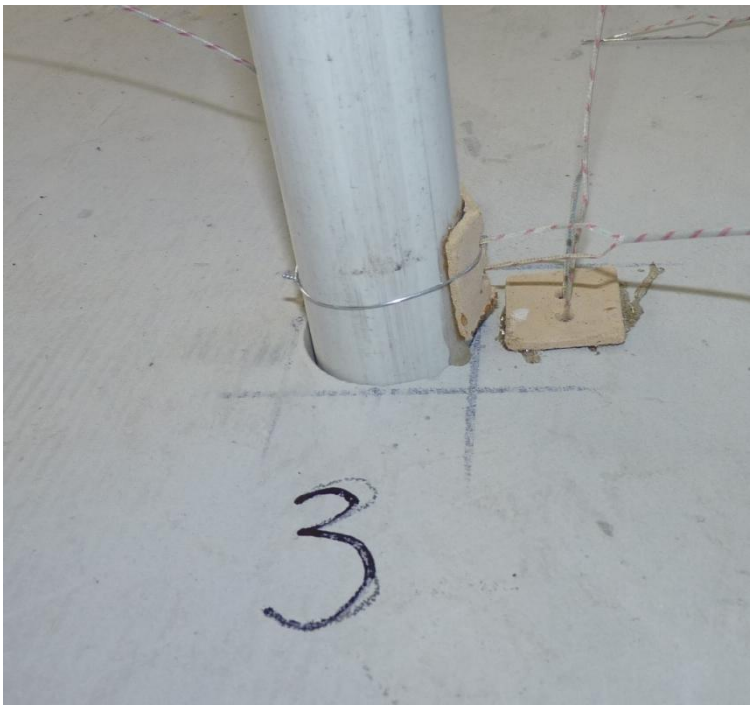
5.2 Specimen 2

Unexposed Face

Exposed Face

5.3 Specimen 3

Unexposed Face



Exposed Face

5.4 Specimen 5

H100S Collar Installation

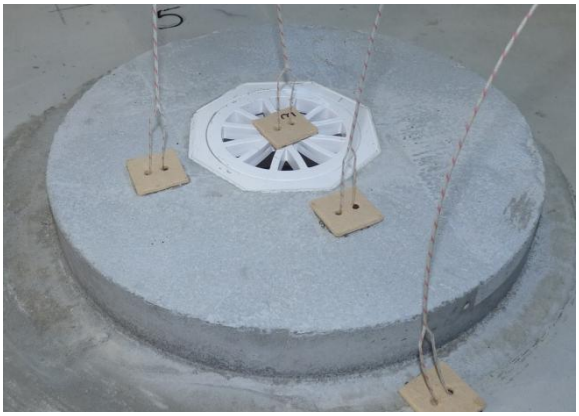
Unexposed Face after grouting

Exposed Face

5.5 Specimen 6

L100FWS Collar Installation

Unexposed Face after Grouting and 35 mm thick Screed Topping

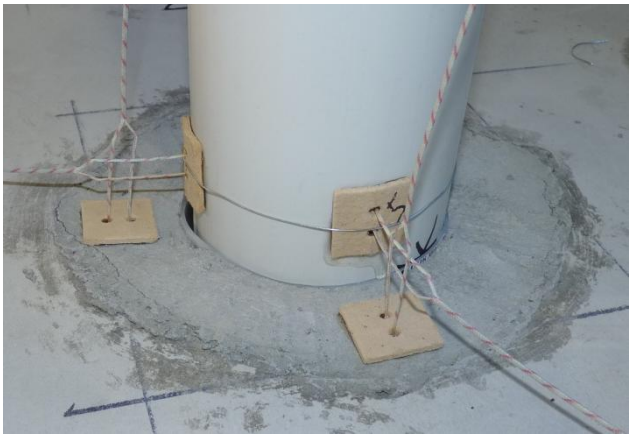


Exposed Face

5.6 Specimen 7

H100FWS Collar Installation

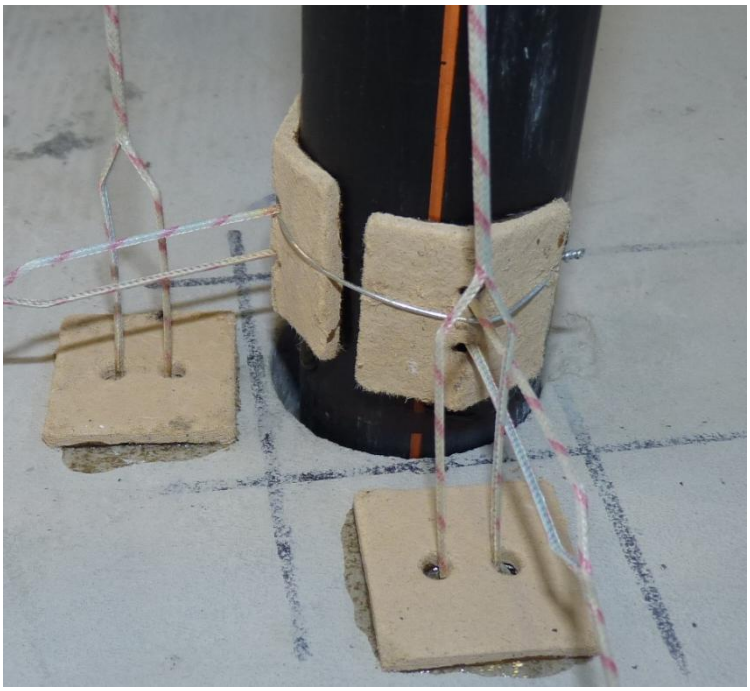
Unexposed Face after Grouting



Exposed Face

5.7 Specimen 8

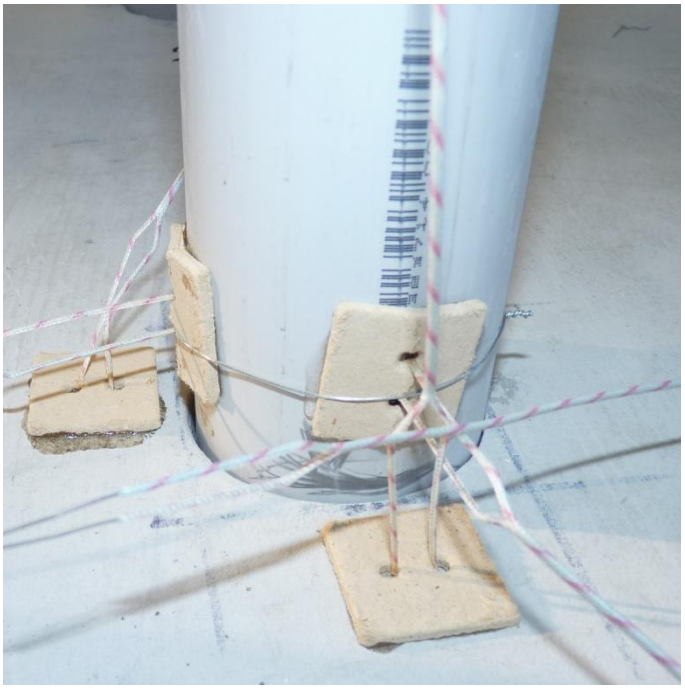
Unexposed Face



Exposed Face

5.8 Specimen 9

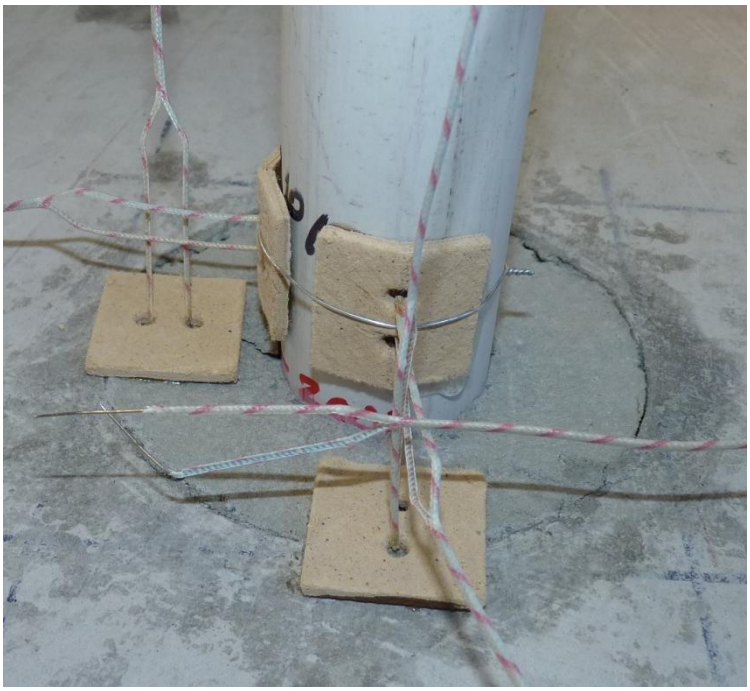
Unexposed Face



Exposed Face

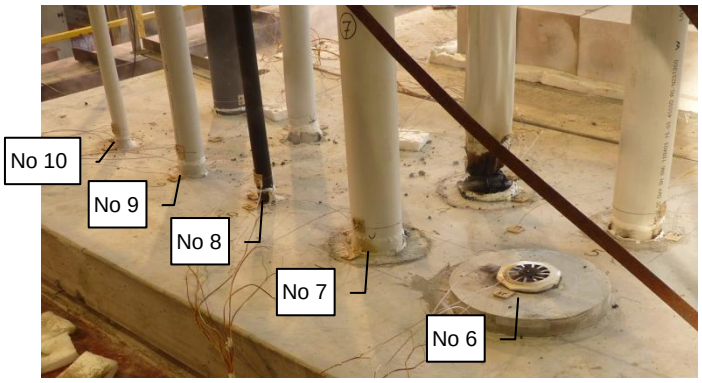
5.9 Specimen 10

Unexposed Face



Exposed Face

5.10 Unexposed Face At 240 Minutes



5.11 Exposed Face at End of Test