BRANZ
BUILDING ON KNOWLEDGE

FP 3701

FIRE RESISTANCE OF SYSTEMS INTENDED FOR SEALING PIPE PENETRATIONS IN FLOORS

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All tests reported herein have been undertaken at the BRANZ Ltd laboratories located in Judgeford, Porirua, New Zealand, unless stated otherwise.

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FIRE RESISTANCE OF SYSTEMS INTENDED FOR SEALING PIPE PENETRATIONS IN FLOORS

1. CLIENT

Ramset Fasteners (Aust) Pty Ltd
Marcondah Highway
Croydon North
Victoria
Australia

2. TEST STANDARD

2.1 Test Specification

The test was conducted to AS 1530.4-1990, Fire resistance tests of elements of building construction, and AS 4072.1-1992, Service penetrations and control joints. In accordance with the standards, the fire resistance of the specimen is the time, expressed in minutes, to failure under one or more of the following criteria:

2.2 Integrity

Failure shall be deemed to occur when cracks, fissures or other openings develop through which flames or hot furnace gases can pass to the unexposed side of the penetrated element.

2.3 Insulation

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

3. DESCRIPTION OF TEST SPECIMEN

3.1 General

The specimen consisted of a 180 mm thick reinforced concrete slab placed on the horizontal 2.2 m x 1m pilot furnace to represent a structural concrete floor. The measured thickness of the concrete varied between 177 mm and 182 mm and averaged 180 mm. The concrete slab had openings left during construction and six penetrations and sealing systems were inserted later. This report relates to two of the penetrations only, specimens 1 and 2

All pipes were closed on the end within the furnace, left open on the unexposed end and secured by clamps to a steel framework at 530 mm and 1410 mm from the top face of the concrete floor slab. The penetrations protruded at least 100 mm into the furnace and extended at least 2,000 mm from the unexposed face of the concrete.

All dimensions are nominal unless otherwise stated.

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3.2 Sealing Systems

Descriptions of the sealing materials used are as follows:

3.2.1 Blazebrake 201

An acrylic based fire stopping sealant manufactured by Ramset Fasteners (Aust) Pty Ltd.

3.3 Specific Descriptions

Specific descriptions of the sealing systems as constructed are as follows. The pipe size shown is nominal internal diameter (ID). All dimensions are nominal unless otherwise stated.

3.3.1 Specimen 1

Opening: A 244 mm diameter hole through the concrete.

Penetration: A 200 mm diameter copper pipe with 203 mm outside diameter and 2.2 mm average wall thickness.

Seal: A foamed polyurethane former was inserted into the annular gap around the pipe to provide a depth of 20 mm for the Blazebrake 201 sealant gun applied from the unexposed side to finish flush with the surface of the concrete slab.

3.3.2 Specimen 2

Opening: A 100 mm diameter hole through the concrete.

Penetration: Three 20 mm diameter copper pipes each with 21 mm outside diameter and 1.2 mm average wall thickness. The pipes were placed to be approximately evenly distributed between each other and within the hole.

Seal: A foamed polyurethane former was inserted into the annular gap around the pipe to provide a depth of 20 mm for the Blazebrake 201 sealant gun applied from the unexposed side to finish flush with the surface of the concrete slab.

3.4 Plans and Specifications

Copies of client-supplied drawings of Specimens 1 and 2 are shown in Figure 5.

4. TEST PROCEDURE

4.1 General

The specimen was tested on 24 March 1995 at Branz Ltd laboratories, Judgeford, New Zealand. The ambient temperature at the beginning of the test was 19 °C.

The specimen-containing frame was placed on the 2.2 m x 1.0 m horizontal furnace and the temperature and pressure conditions were controlled to the limits defined in AS 1530.4-1990.

4.2 Furnace Temperature Measurement

Temperature measurement within the furnace was made using four chromel-alumel thermocouples uniformly distributed in a horizontal plane approximately 100 mm below the exposed face of the specimen.

4.3 Specimen Temperature Measurement

In order to monitor heat conduction through the sealing systems, 52 chromel-alumel thermocouples were attached to the specimen. The arrangement consisted of thermocouples placed, as specified in clause 10.3.2 of the test standard specification. Thermocouples were placed on the unexposed surface of the concrete slab 25 mm from the penetrations (designated in the figures as "concrete"), on the seal of the penetrations of specimens 1 and 2 (designated as "seal") and on the pipes at 25 mm and 400 mm from the floor slab (designated “inner pipe”, “outer pipe” respectively). Three additional thermocouples were placed on the unexposed surface of the concrete clear of any of the penetrations.

4.4 Temperature Recording

All the thermocouples described in section 4.2 and 4.3 were connected to a computer controlled data acquisition system which sampled the temperatures at 1 minute intervals.

4.5 Pressure Measurement

The differential pressure was controlled to be not less than 8 Pa above the laboratory atmosphere at 100 mm below the exposed face of the specimen. The differential pressure was monitored using a micromanometer connected to a continuously reading recorder.

5. RESULTS

5.1 Duration

The test was terminated after the specimen had been exposed to the standard fire resistance conditions for 244 minutes.

5.2 Severity of the Test

The severity of the fire resistance test can be established by comparison of the area under the curve of mean furnace temperature with the area under the standard curve for the same period. Figure 1 shows the time-temperature curve from the standard in relation to the actual mean furnace temperature. The severity of this test for 244 minutes was 100%.

5.3 Integrity

Time to integrity failure of each specimen is shown in Table 1.

Significant observations related to the integrity performance of the specimens were as follows at the times stated in minutes and seconds:

5.3.1 Specimen 1

11.00 The seal around the pipe had expanded upwards by approximately 10 mm above the surface of the concrete.

36.00 The seal had expanded by approximately 25 mm above the concrete and had started to shrink away from the pipe.

52.00 The expansion had increased to approximately 30 mm and where it had shrunk back from the pipe had started to char and blacken.

120.25 A small gap with vision into the furnace had developed where the seal had receded away from the pipe. This was considered a failure of integrity. This gap was continuous around approximately one third the circumference of the pipe.

144.00 The annular gap between the seal and the pipe had increased to about one half of the circumference and was approximately 2 mm wide.

202.00 The gap had increased in width to approximately 3 mm.

5.3.2 Specimen 2

11.00 The seal between the pipes had expanded upwards by approximately 10 mm above the surface of the concrete.

36.00 The seal had expanded to approximately 15 mm above the concrete surface.

52.00 The expansion of the seal had increased to approximately 20 mm.

144.00 The seal had blackened between the three pipes and had started to recede back from contact with the pipes.

202.00 The seal between the pipes was black and charred.

5.4 Insulation

The time to insulation failure of each of the seal systems is shown in Table 1.

Figures 2 and 3 show the time/temperature rise graphs for the maximum temperature rise measured by the thermocouples placed on each specimen.

5.4.1 Specimen 1

The temperature rise exceeded 180 K on the pipe at 25 mm from the floor slab at 9 minutes, on the seal at 38 minutes, on the pipe at 400 mm from the floor slab at 64 minutes and on the adjacent concrete at 165 minutes.

5.4.2 Specimen 2

The temperature rise exceeded 180 K on the pipe at 25 mm from the floor slab at 8 minutes, on the seal at 58 minutes, on the pipe at 400 mm from the floor slab at 195 minutes and on the adjacent concrete at 209 minutes.

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6. SUMMARY

6.1 Fire Resistance

Table 1 summarises the performance, under integrity and insulation, of each specimen.

Table 1 - Time to Failure

SPECIMEN	TIME TO FAILURE (minutes)	
	INTEGRITY	INSULATION
1	120	9
2	244 NF	8

NF = No failure up to the termination of the test at 244 minutes

6.2 Fire-resistance level (FRL)

For the purposes of the building regulations in Australia the seals and penetrations achieved fire resistance levels (FRL) as shown in Table 2:

Table 2 - Fire Resistance Levels

Specimen	FRL
1	-/120/0
2	-/240/0

The test standard requires the following statement to be included: "The results only relate to the behaviour of the specimen of the element of construction under the particular conditions of test; they are not intended to be the sole criteria for assessing the potential fire performance of the element in use nor do they reflect the actual behaviour in fires."

7. ATTACHMENTS

Figure	1	Furnace Temperatures
	2	Temperature Rise - Specimen 1
	3	Temperature Rise - Specimen 2
	4	Temperature Rise - Concrete
	5	Ramset Drawings of Specimens 1, 2

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Fig 1 Furnace Temperatures

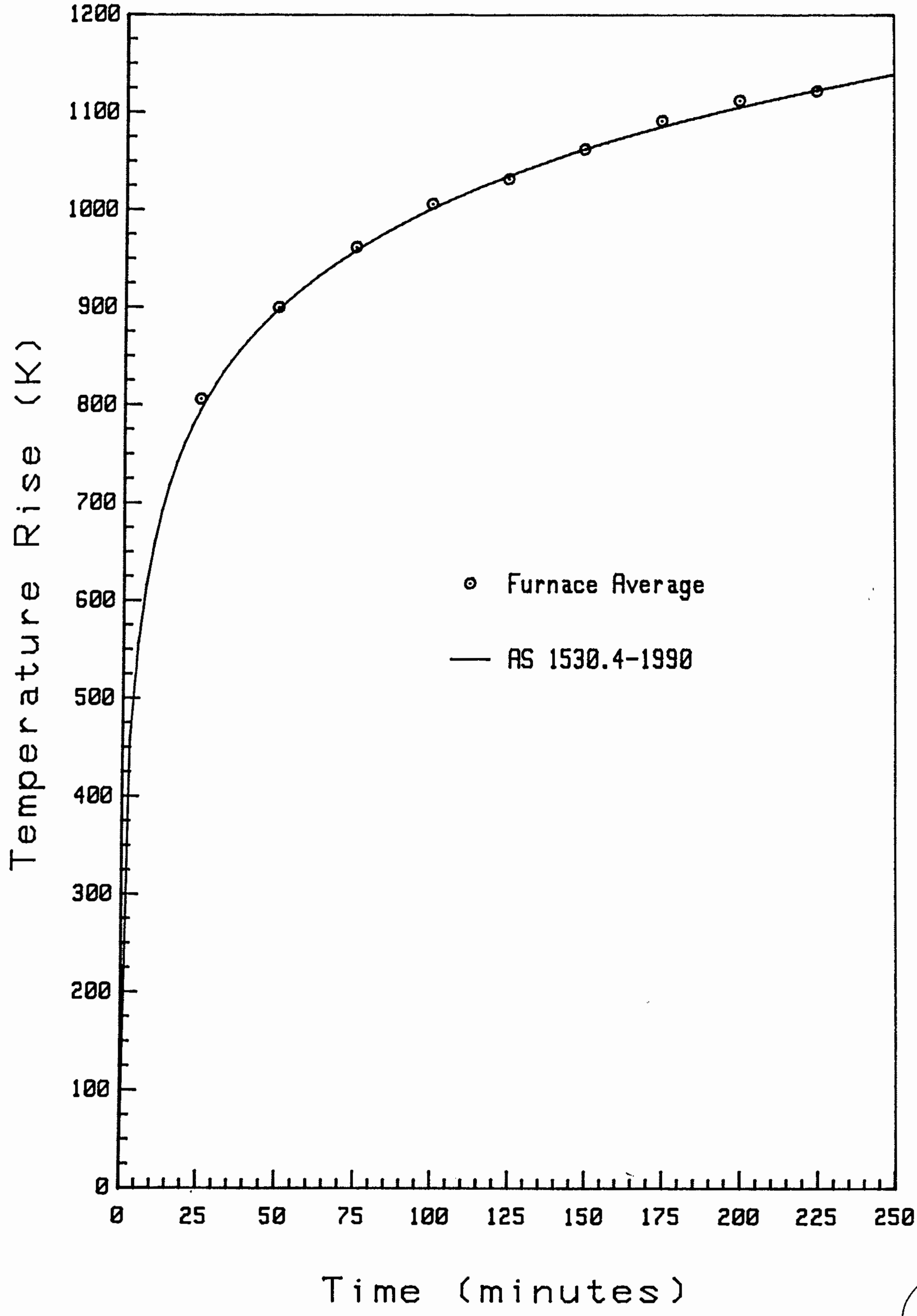

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Fig 2 Temperature Rise - Specimen 1

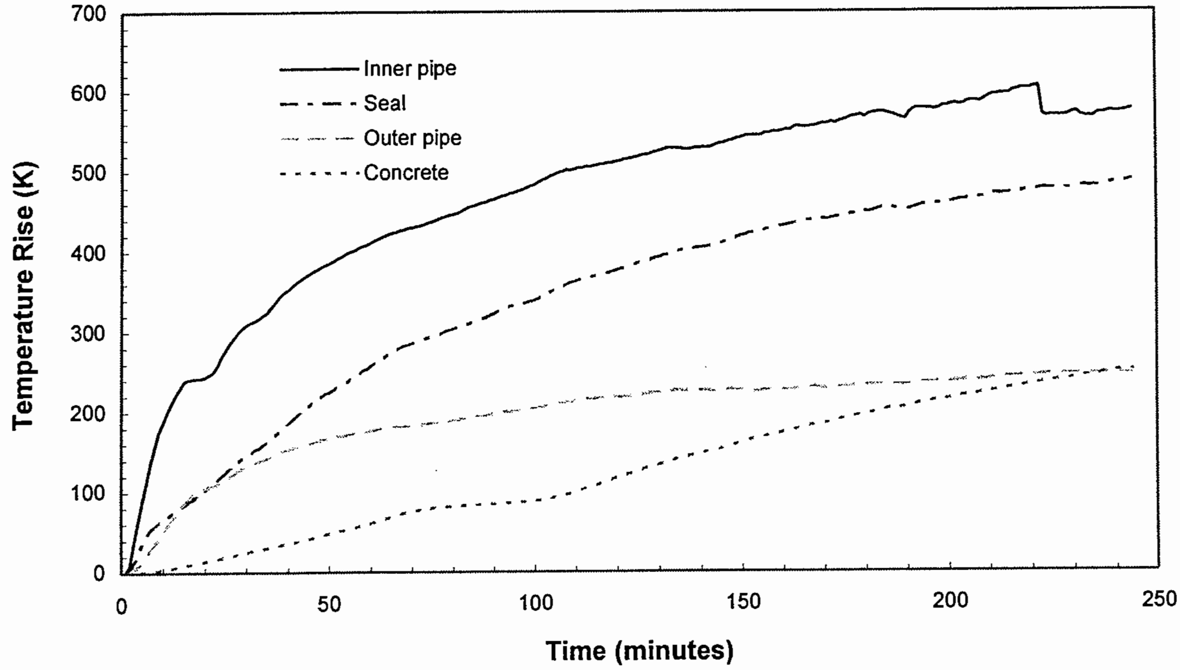

Fig 3 Temperature Rise - Specimen 2

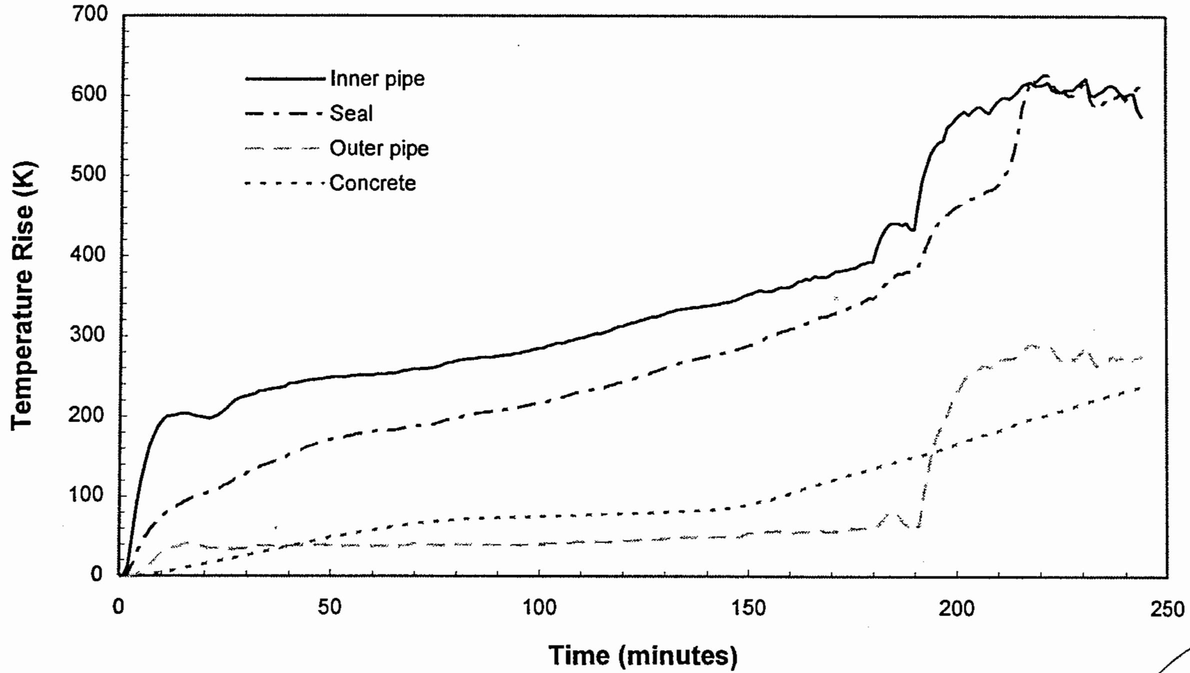

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Fig 8 Temperature Rise - Concrete

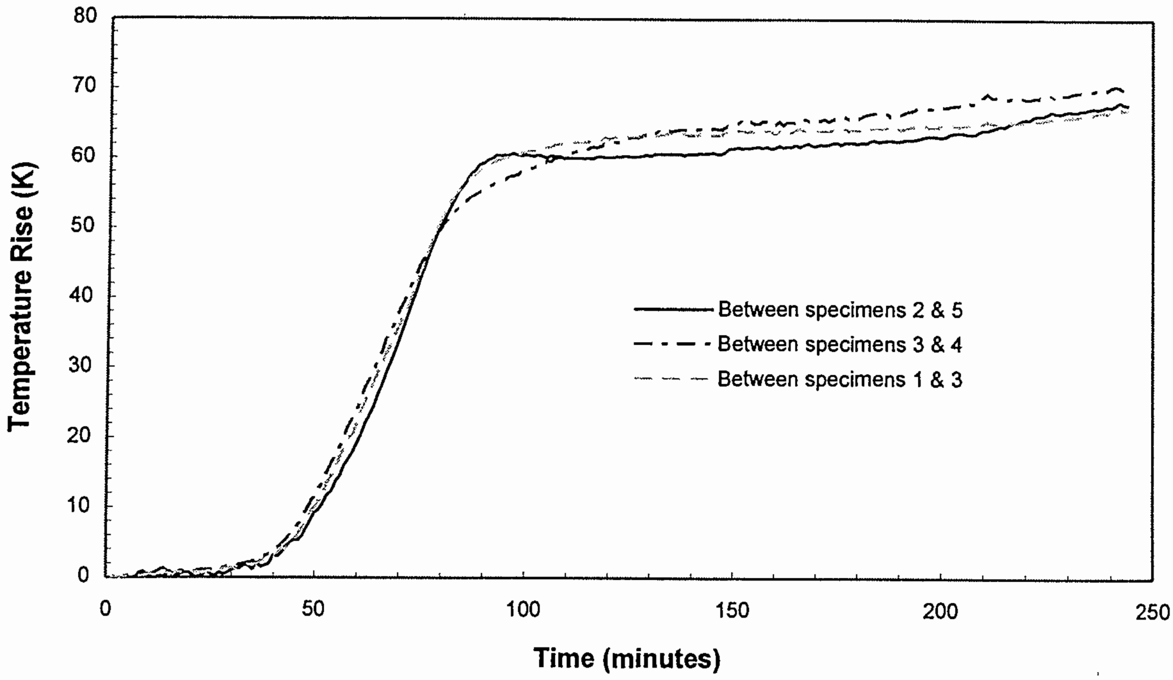

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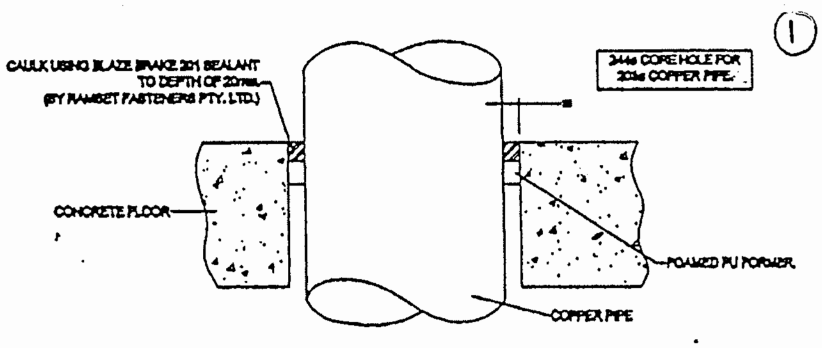
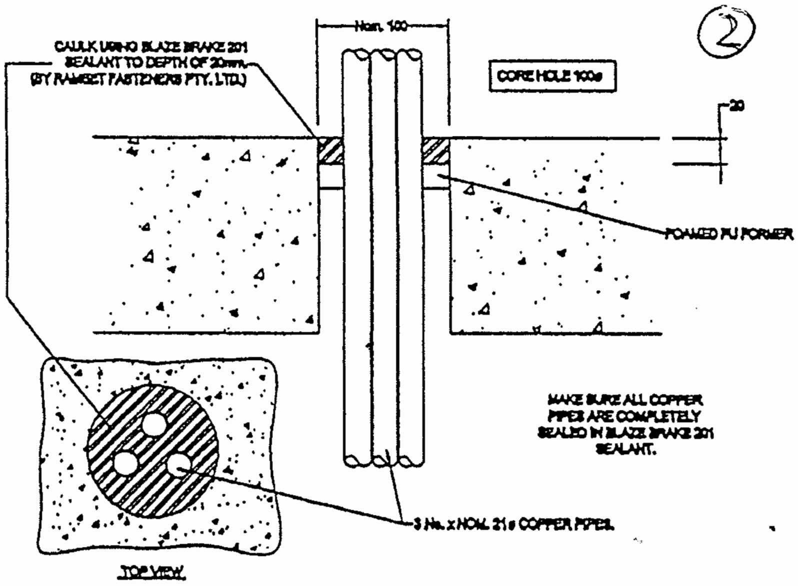
Fig 5 Ramset Drawings of Specimens 1, 2



2 HR. PIPE PENETRATION - CONCRETE FLOOR



4 HR. PIPE PENETRATION - CONCRETE FLOOR

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