

IN THE MATTER OF
THE CANTERBURY EARTHQUAKES ROYAL COMMISSION

BRIEF OF EVIDENCE OF GARY HAVERLAND
27 JANUARY 2012

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1. My full name is Gary Haverland. I am a director of Structex Metro Limited (Structex). I have a Bachelor Degree in Civil Engineering and I am a Chartered Professional Engineer. I have been practicing as a qualified structural engineer for 24 years.
2. My involvement with the Durham Street Methodist Church came about when Arrow International Limited (**Arrow**) engaged Structex. The nature of the engagement was to assist Arrow and the Methodist Church with the assessment of the extent of damage and repairs required for a number of Methodist properties primarily for insurance purposes. We were also asked to comment on aspects associated with accessing buildings.
3. The Methodist Church was located at 309 Durham Street. The Church property consisted of three distinct areas : the Church (**the Church**), the Annex located at the western end of the Church (**the Annex**) and the hall located in the south west corner of the site (**the Hall**). I will refer to each area separately. I will use the term “the Building” when talking about the Church, the Annex and the Hall together. There was also a building referred to as the Aldersgate building which is a much more modern building on the southern side of the Church (**the Aldersgate building**).
4. The Building was generally constructed with stone walls, consisting of a natural stone exterior, a plastered brick and stone interior and a combination of rubble, stone and mortar fill to the cavity. The slate roof is likely to have been supported on battens with timber sarking on purlins and main supporting exposed timber trusses. The ceiling was constructed with lathe and plaster. The ground floor was timber and was likely to consist of timber flooring boards on joists supported on timber bearers on concrete or timber piles. A gallery floor had been constructed in the Church and extended around the perimeter of this area (**the Gallery**). Access to the Gallery was by two stairs at the front of the Church facing Durham Street which were incorporated within the two towers.
5. The Building was damaged in the earthquake on 4 September 2010. I understand that it was given a red placard following a rapid assessment but I was not involved in assessing the Building at that time.

6. In late September 2010 Structex was engaged by Arrow to complete a structural assessment report of the Building. The purpose was to identify and comment on earthquake damage and possible strengthening options. I did not undertake detailed calculations at this stage. I was simply providing strengthening options based on experience and judgement only. This was the first phase of our work. The next phase which we undertook was a detailed strength assessment of the Building.
7. There were no plans available at the time of my inspection and I did not undertake a search of the Council records. I asked Arrow to provide us with any drawings that were available and received a copy of a building plan but that was of limited value. Site plans and elevations were commissioned by Arrow but these were not available until January 2011. At the time of my inspection I was also not aware that RD Sullivan, consulting engineer, had been involved with the Building.
8. The nature of my inspection was a walk over survey of the Building as opposed to a detailed inspection or investigation of the structure; that is, an interior and exterior inspection viewing elements which were visible but without removing linings. Being stone, however, meant that most of the structure was exposed for viewing.
9. There did not appear to have been any structural strengthening carried out prior to September 2010. Some Rosehead washers were present in various locations although it was not known when these were installed and they appeared to have been in place for some time.
10. The September earthquake had reduced the seismic capacity of the Building. This was evident from the extent of the damage and cracks that had formed. My conclusions are detailed in a report dated 4 October 2010 (BUI.DUR309.0013.25). I noted that the Hall had suffered significant damage but that the Annex had suffered limited damage, mainly only to the west wall. The majority of damage was in the Church.

11. The main area of damage to the Church was in the towers where the stairs were located, although the south-east tower had performed better. In terms of the eastern wall there was significant damage in this area with cracks clearly visible on the exterior face, generally in the stone mortar joints. The plaster had also spalled significantly on the interior face with significant damage visible to the brick interior face and to the core of the wall. The timber floor appeared to have bulged in the middle which I thought could be the result of some foundation settlement below the exterior heavy stone walls or heaving of the light timber floor or a combination of both. Stone work jambs around the window frames had dislodged slightly. The north and south side walls, however, were still in good condition with limited cracking on the inside plaster face above the windows. I also noted that some buttresses to the outside wall on the north side had some cracks, generally along the mortar joints between the stone, and the south side buttress had some cracks but were much smaller.
12. I considered that the Church could be retained, although significant work would have to be undertaken mainly to the east wall and the towers. I also noted that some foundation enhancement work would likely be required depending on the existing ground conditions. I indicated that detailed geotechnical information would be required to proceed with the next phase of this work.
13. Later in October I was asked by Arrow to review a temporary propping design which had been undertaken by Dick Sullivan. Arrow provided the drawings to me to review and comment on (BUI.DOR309). My review consisted of an overview of the drawings to provide a second opinion on how appropriate the proposed propping was. It did not include design calculations as it was not part of our brief.
14. I was not required to review any propping details for the Hall west wall or the Annex. Arrow advised that the rear section of the Building would not be propped as it was out of the public area and would be barricaded off.
15. I telephoned Dick Sullivan as a courtesy to let him know that we were involved in the project. We only discussed the temporary propping.

16. Propping was proposed to provide temporary medium term support to the east wall of the Church and the north-east tower. I understood from my discussions with Arrow that the intention of the propping was to provide public safety and avoid the collapse onto the footpath. When reviewing the propping design I therefore considered the risk of collapse onto the footpath. The propping included walers on the outside face with fixings that extended through the wall with large plates on the inside face. These provided additional stability to the damaged wall to reduce the risk of collapse towards the inside.
17. On 21 October 2010 I reported to Arrow following my review of the proposed temporary propping details (BUI.DUR309.0013.60-61). In relation to the propping for the eastern wall and north-east tower I concluded that the proposed propping system and details were appropriate to provide temporary medium support.
18. I advised that based on our inspection and report dated 4 October 2010 I believed that the Church auditorium had not had significant structural damage and was therefore unlikely to collapse as a result of significant aftershocks. The Building had performed well in the September earthquake and the aftershocks that were being experienced at that time were of a shorter duration and lower magnitude. Based on the extent of damage and performance of the Building I considered collapse during an aftershock was unlikely.
19. In my report I indicated that temporary propping in addition to the tower was not considered necessary to allow removal of the organ. I did, however, suggest that building occupancy be minimised to assist in reducing the risk.
20. I cannot remember when I first became aware of the proposal to remove the organ from the Church or how I became aware of it. The organ was situated at the west end of the Church auditorium adjacent to the east Annex wall. That was an area where the damage was low and it was away from the area of greatest damage, namely the east wall of the Church and the north-east tower. I had inspected the west wall of the Church in September. Although the organ was a significant structure I could see a large portion of the wall from inside the Church

(on either side of the organ) and I was also able to see the other side of that wall from inside the Annex.

21. As I have said, although I did not consider additional propping was required I did suggest that building occupancy be minimised to assist in reducing risks to persons carrying out the removal work. This was a part of an overall risk assessment for the building. In considering this issue I had regard to AS/NZS 1170.0: 2002 which incorporates risk factors. Risk factors are a function of the building life and purpose, and affect the earthquake design loads on the building. The higher the risk factor the higher the earthquake design load the building is required to resist. Buildings with a 50 year life containing crowds, such as the Church, have a higher risk factor (1.3). Risk factors for temporary propping and construction works, which have low number of persons working on the site for a shorter period of time, have a lower risk factor (0.5). The risk factor recognises reduced likelihood of a large earthquake occurring over a shorter period of time when construction work, or removal work is carried out.
22. On 22 October 2010 I carried out a further inspection of the site with Colin Messent of Arrow and Ben West, the stone mason. The site inspection was undertaken following concerns expressed by Mr West about the lack of propping on the eastern wall. During this inspection Dick Sullivan's temporary propping design which I had reviewed was not installed as a lead time of 2-3 weeks was expected.
23. At this time the footpath had been closed off along Durham Street and Chester Street West and, I recall, a cordon fencing the area off from public outside the east end of the Church. Loose stone and parapet had already been removed from the towers and east wall. Straps had been wrapped around the top of the towers to secure the top portions of the towers. I noted some significant vertical cracks to the north-east corner of the north-east tower. There was some bulging at the mid height of the tower also occurring which was evidence of instability. I considered the Building's ability to withstand further aftershocks, in particular in relation to the east wall and north-east tower of the Church. I considered that a very significant aftershock would be required to cause instability and possible collapse of the east wall and north east tower and if the tower did collapse it

would fall down, within its own general proximity, rather than falling out onto the street.

24. The north-east tower was bounded by a stone wall and metal fence on Chester Street West, and I considered that falling stone was unlikely to fall outside the fence line. The fence was acting as a barrier. As the east wall was partially restrained by the inside gallery floor, I thought that collapse of the entire wall was unlikely, and the top portion was most likely to fall well within the entrance courtyard, away from the footpath and current pedestrian area. Although the south east tower had some cracking, the corner buttresses were providing stability.
25. Until the temporary propping was installed and as a precaution I recommended that a line of concrete blocks be installed along the Durham Street footpath. The concrete blocks were each roughly 1 cubic metre, weighing around 2,500 kg and were installed to protect the footpath area from falling hazards. The concrete blocks were expected to be in place by the next day and it was expected that the blocks would be used for the temporary bracing when installed.
26. By 17 November 2010 the temporary propping to the east wall and the north-east tower was installed. I inspected the work. I identified that the bottom brace of the northern tower had only two bolt fixings to the anchor block, when the drawing specified four bolts. I instructed that two additional bolts be installed. Once this was done I considered the temporary propping work was appropriate. As I have said, there was no propping undertaken to the west wall of the Annex and the Hall. This area was fenced off and outside public access. It was blocked off and taped and barricades were put up.
27. On 19 January 2011 I carried out an inspection of the Church and my observations were included in a report dated 1 February 2011 (BUI.DUR309.0013.64). The purpose of the inspections and subsequent report was to observe any additional damage that had occurred as a result of the earthquake on 26 December 2010 and subsequent aftershocks. It was also to determine any safety issues associated with removing the organ from inside the Church. The Building had suffered further damage. I noted:

- 27.1 Cracking to the stonework was significantly worse than its condition on 4 October 2010. There was additional cracking and existing cracks had widened significantly and was particularly evident in 5 of the 7 north side buttresses.
- 27.2 Cracks to the south wall buttresses were still relatively minor.
- 27.3 The west wall of the Annex had displaced further away and a number of stones on the north side of the Annex were dislodged at eave level with a large crack formed above the door on the north Annex wall.
- 27.4 Crack width to the towers had increased and there were 4 cracks to the south tower.
28. Although not noted during my inspection on 19 January I noted on a later inspection that a bow was observed in the west gable wall of the Church. It appeared to be mainly historical but as a precaution I recommended some additional brackets be installed to the gable wall to provide additional stability to the wall while the organ and other chattels were removed. A sketch of the work was provided. (BUI.DUR309.309.0013.66)
29. I considered that it was becoming less likely that this building would be able to be repaired and retained. I reported that I was underway with a detailed assessment for repair and would forward our reports when complete.
30. Although there had been further damage I did not consider the Church was yet in a condition that would prevent the organ from being removed. My reasons for this conclusion included:
- 30.1 The deterioration was gradual and most of the additional damage was likely to have been the result of the Boxing Day event which was considered to be a very significant aftershock in itself, producing larger

ground accelerations than the aftershocks that were typically being experienced.

- 30.2 The stonework generally fell out from the Building and all work was occurring inside. In a structure of this nature the roof and gallery structure would normally prevent the walls from falling in. A safe protected path had also been constructed through Aldersgate. The side walls and end walls were restrained by the Gallery floor which extended all around the perimeter of the Church, as well as the adjacent Annex floor at the mid height, providing additional stability to the west wall of the Church, adjacent to the organ;
- 30.3 The roof trusses were tied together with a steel rod providing a good tie between the stone side wall buttresses; and
- 30.4 The main risk identified at this stage was associated with individual stones falling from the exterior of the Building.
31. On 26 January 2011 Tim Fahy contacted me by email (BUI.DUR309.0013.62). He wanted to discuss access for scaffolders from Chester Street West thereby avoiding the need to come through the Aldersgate building. He also wanted to know whether the scaffolders' truck could be parked next to the Hall while they were erecting and dismantling the scaffolding.
32. On 1 February 2011 Tim Fahy and I inspected the site to view alternative egress routes for removing the organ and other chattels. At that time the designated safe path from the Church was through the protected Aldersgate entry. We looked at the possibility of providing access through the north door of the Annex. I indicated that if access was to be provided through this area protective scaffold would be required over the door in order to provide protection against loose stonework being dislodged from the top of the wall. I also noted some loose large pinnacle stones on adjacent buttresses which I said would have to be removed. I indicated that contractors' trucks could be parked adjacent to the west wall of the Hall. I noted that this wall was on an outward lean but roof ties

were present which provided some structural stability to the wall. I indicated that parking in this area should be kept to a minimum to reduce the risk. As noted previously, because the time of a person being in this location was very short I considered that the risk exposure is low. It is also a location which is very easy to exit from in the event of an aftershock. I advised that contractors would need to be advised of the risk and evacuate the area immediately if there is a noticeable aftershock. My conclusions are presented in a report dated 1 February 2011 (BUI.DUR309.0013.63).

33. At each stage I was undertaking a risk assessment having regard to the damage that the building had sustained. I was in regular contact with Tim Fahy of Arrow. I was regularly on site and viewing the damage from the exterior and interior. The organ was required to be removed from the Church. Contractors needed to access the building to undertake this work. Given the damage sustained it was not possible to eliminate the risk. The risk had to be minimised by:
- 33.1 Providing for limited access to the building and for a short period of time;
 - 33.2 Safety briefings given by Arrow highlighting the risks to persons entering the building;
 - 33.3 Providing protective scaffolding and safe paths; and
 - 33.4 Installing additional brackets to the Annex wall behind the organ to give additional stability to the wall adjacent to the organ where the work was being carried out.
34. By this time my seismic assessment of the Church and Annex was nearly complete. I had a good understanding of the buildings and their relative strengths and weaknesses. I was also now aware that the areas which would be accessed by the contractors were the areas of least damage and they would be working in the strongest part of the Building.

35. On 16 February 2011 I advised Arrow that the seismic assessment of the Church and Hall was now complete. The seismic assessment report relating to the Church is dated 17 February 2011 (BUI.DUR309.0013.115). The assessed strength was based on the undamaged state of the building that would have existed prior to the earthquakes, for a building having a 50 year life with a crowd loading. I assessed the Church to have a lateral load capacity of between 10% and 87% of current code and a longitudinal capacity of 15% to 20% of current code. Propping at the east end had been installed which would have improved the lateral load capacity in this direction.
36. Prior to completing the detailed calculations and assessments that led to the findings in the seismic assessment, it was unknown as to whether the Building was earthquake prone in the context of the Christchurch Earthquake Prone Building Policy. Our seismic assessment showed that the areas of the Building having the highest risk of earthquake damage were the side walls and towers, both in the longitudinal and transverse directions (along and across the building). This conclusion differed from the damage evident on site. Although the towers were damaged as expected the side walls had little damage. There was also no permanent shearing of the buttress where we expected load to be highest. The weakest area of the Building was the Church which had a transverse lateral load capacity of 10% of current code. That assessment did not take into account, however, the additional stability and load sharing ability provided by the Gallery. Having regard to the limited damage that was evident in the Church auditorium to the north and south walls, my view was that the Gallery provided significant additional strength to the Building.
37. We observed further damage, particularly to the north wall of the Annex and increased cracking of the side wall buttresses that had occurred since the Boxing Day earthquake. I advised Arrow on 16 February that further damage would continue to occur as a result of on-going aftershocks, which could result in the Building becoming unsafe. I advised that it would be necessary for additional temporary bracing to be installed to the north wall of the Church, as well as the west wall of the Hall to provide longer term protection to the building and its contents in the event of significant on-going aftershocks.

38. To be clear, this work related to longer term protection of the Building. I did not consider that the Building was unsafe for short term access. My view was that it still had a low probability of collapse during an aftershock, particularly the nature of aftershocks that were being experienced. I did not consider that additional propping would be required for the organ removal. The proposed bracing to the west wall of the Hall was outside the area of occupancy and the north wall was not considered to be a high risk of collapse in the aftershocks that were being experienced at that time.
39. Tim Fahy contacted me on 10 February 2011 after receiving an earlier draft copy of my report dated 17 February 2011 and asked about my conclusions and whether it was appropriate for the organ removal to proceed. I discussed my conclusions with Mr Fahy. I pointed out that:
- 39.1 The Building had performed well and beyond expectations during the September and Boxing Day earthquakes. Apart from the east wall and the towers which were braced it did not show significant signs of collapse under lateral loads associated with the aftershocks that were being experienced;
- 39.2 The assessments of this level of analysis are typically conservative; The calculations used for the Building assessment are for a 50 year design life with crowd loading; and
- 39.3 There are other redundancies in the structure which were not taken into account in the analysis which would have provided significant improvement in stability such as the Gallery floor at mid height and the steel roof ties.
40. My view remained that it was appropriate to use a risk factor of 0.5 for construction loads as these were appropriate for short term access. This would also be consistent with the propping design carried out by Dick Sullivan. A risk factor of 1.3 would have assumed full use with full occupancy for a 50 year life. In assessing the risk involved with contractors being on site at this stage it was

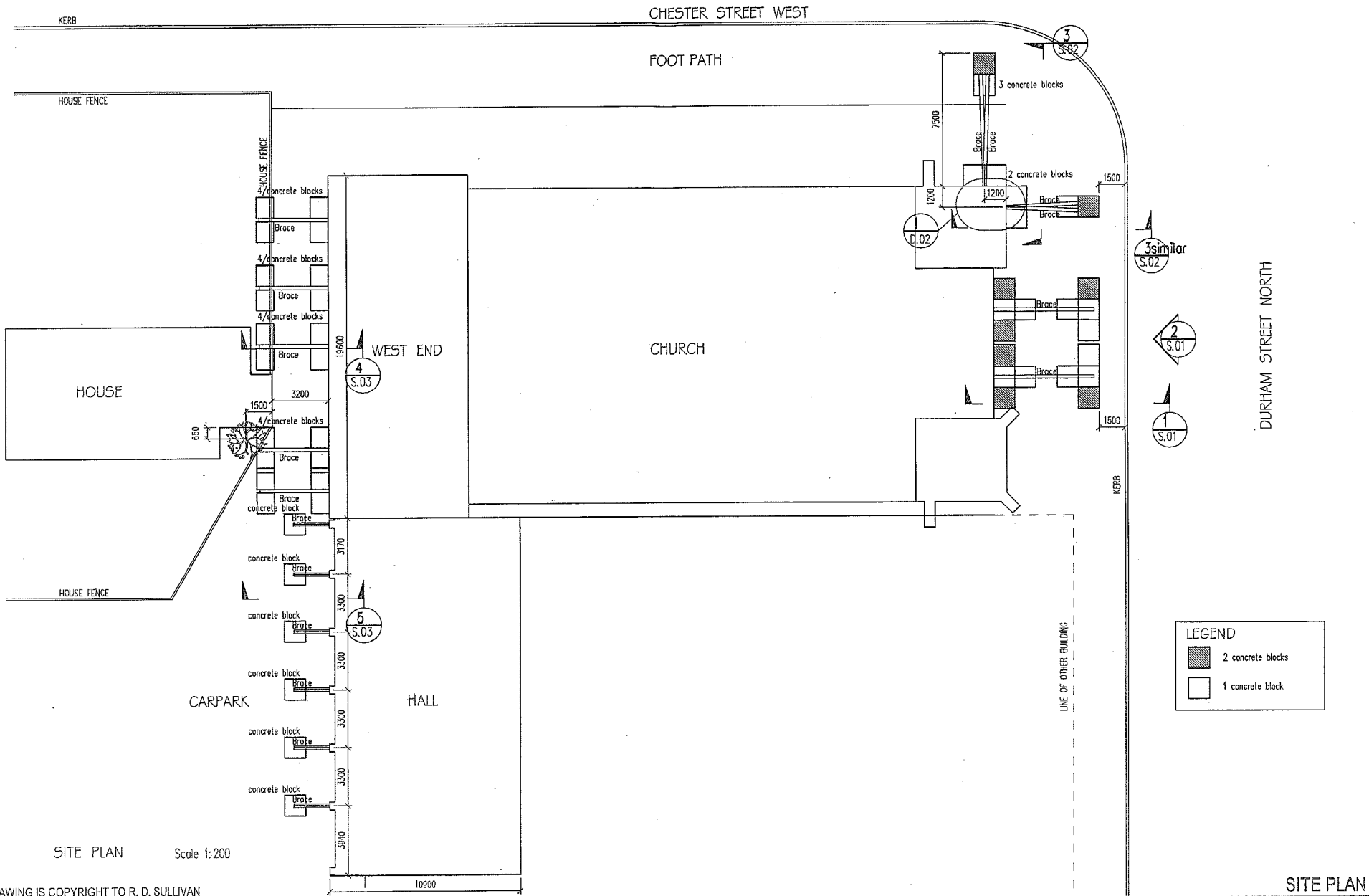
appropriate, in my view, to scale these figures to take account the factors referred to in AS/NZS 1170.0:2002 such as the limited access. In that sense it would have been possible to scale the figures in relation to contractor short term access from 10% to 26% or in the case of the west wall adjacent to the organ from 87% to 226%.

This statement is true to the best of my knowledge and belief and was made by me knowing that it may be used as evidence for the purposes of the Royal Commission of Inquiry into the Canterbury Earthquakes.

Dated 27 January 2012

Gary Haverland





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SITE PLAN

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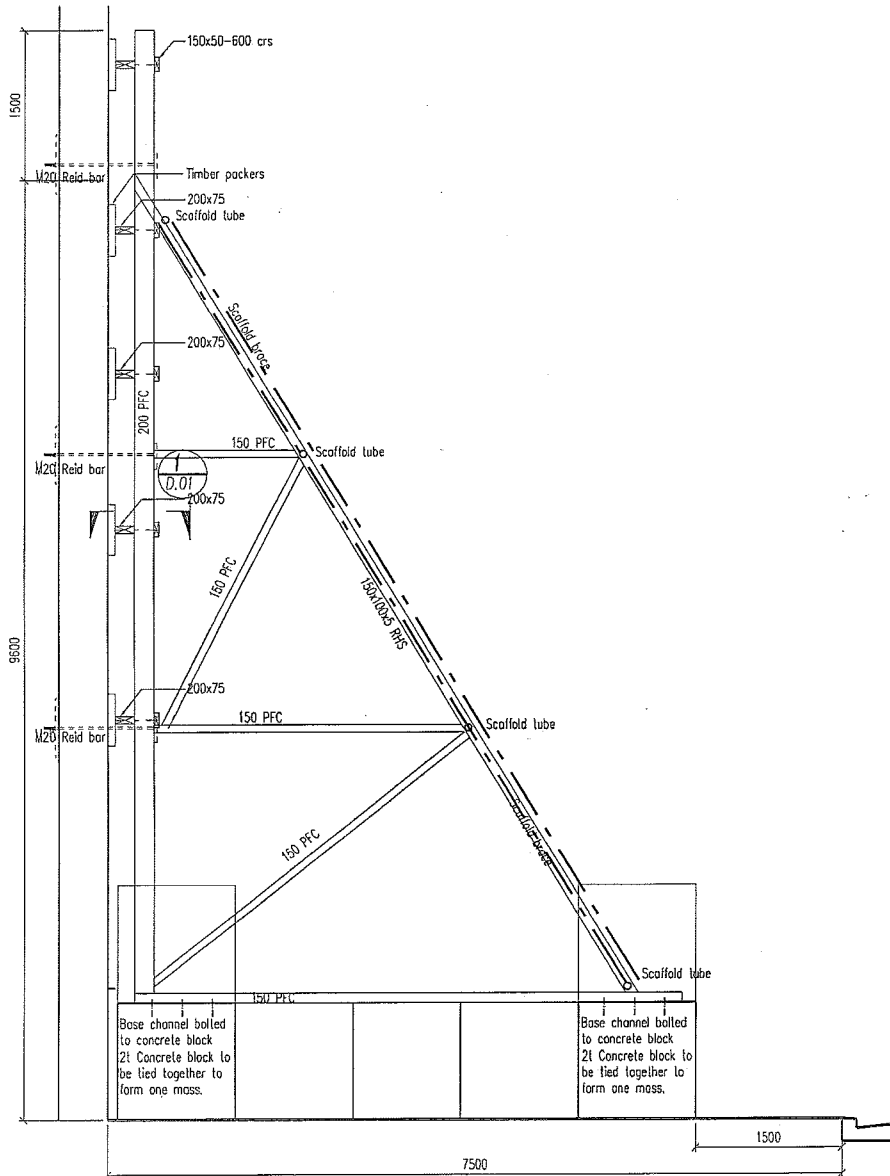
DURHAM ST METHODIST CHURCH

CNR OF DURHAM ST & CHESTER ST WEST, CHRISTCHURCH

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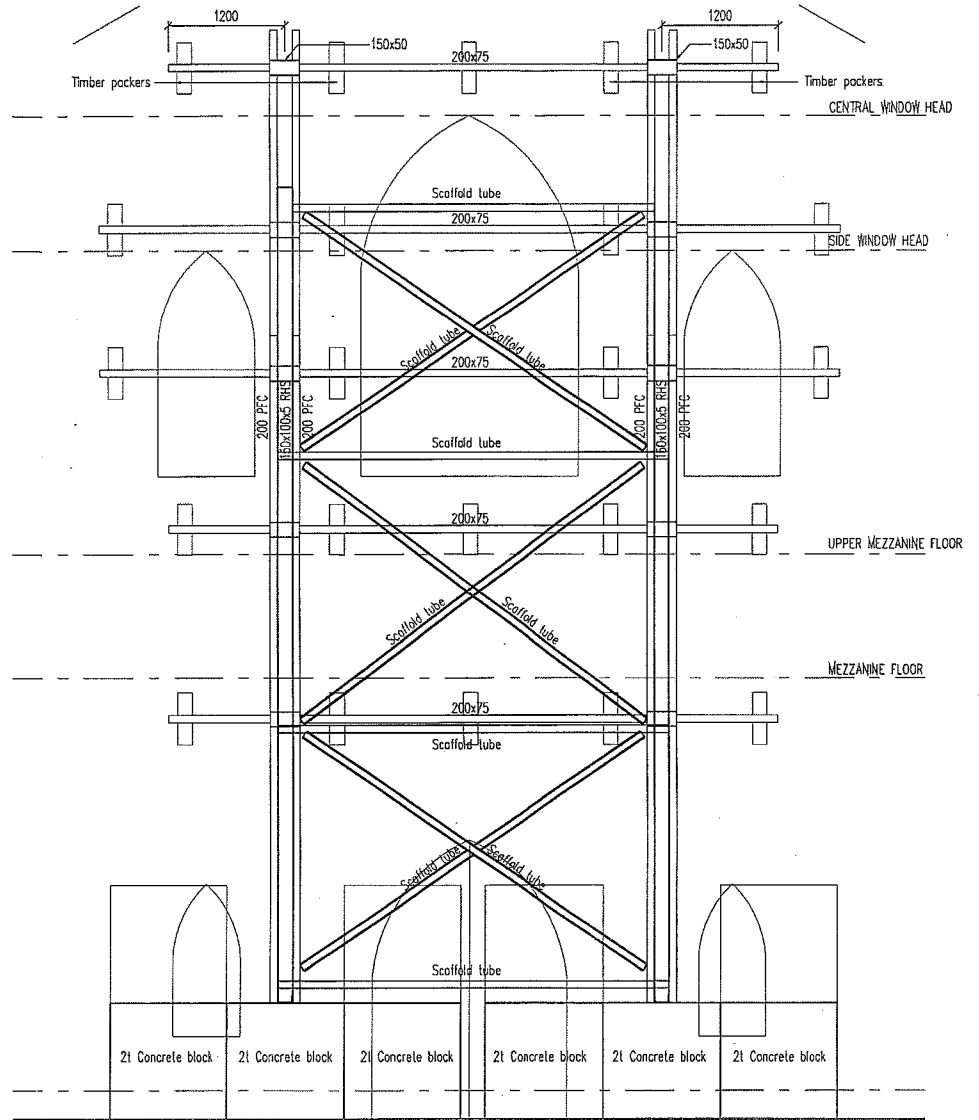
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BRACE ELEVATION 2 Scale 1:50

SECTIONS

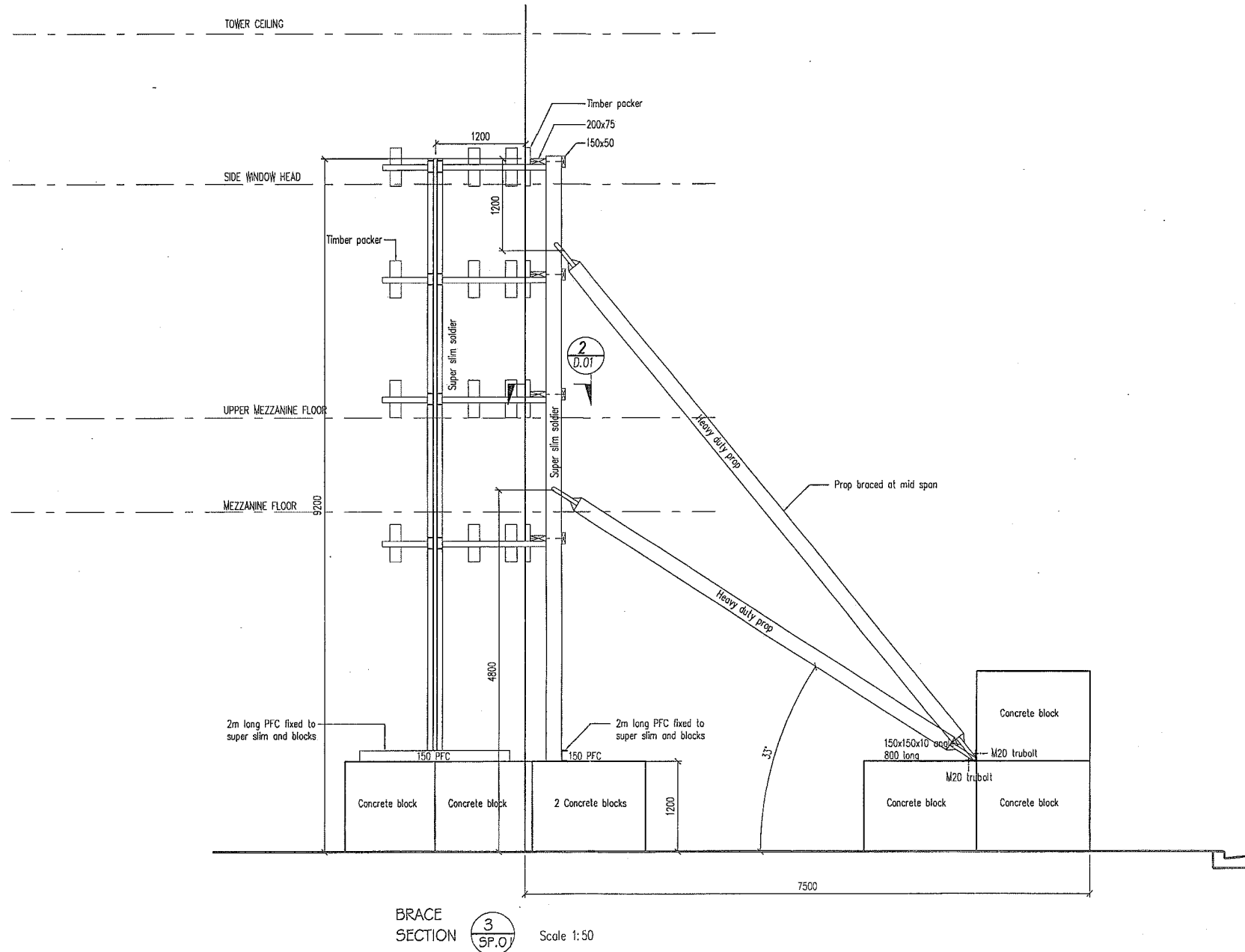
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BRACE SECTION 3
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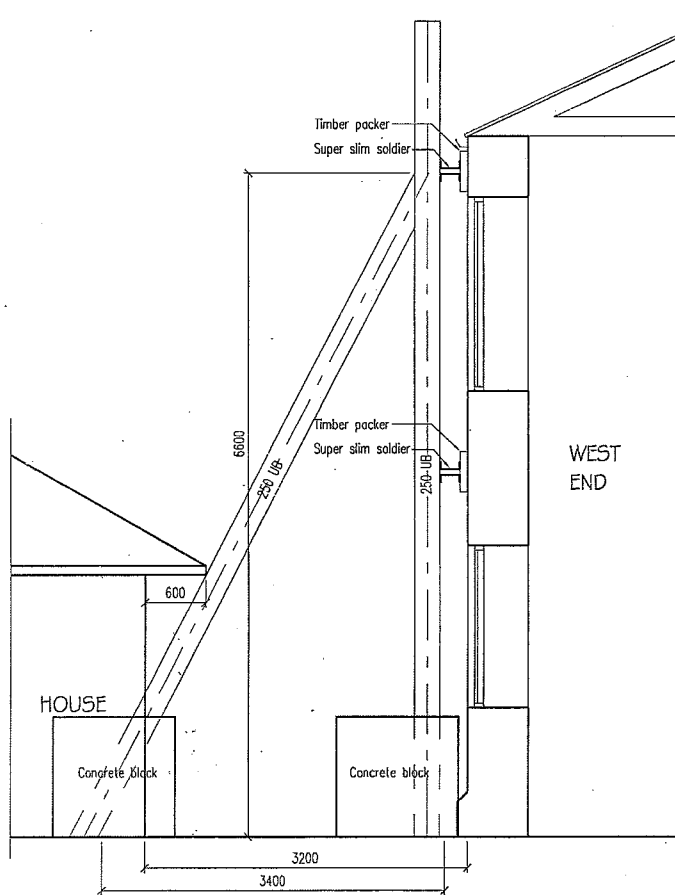
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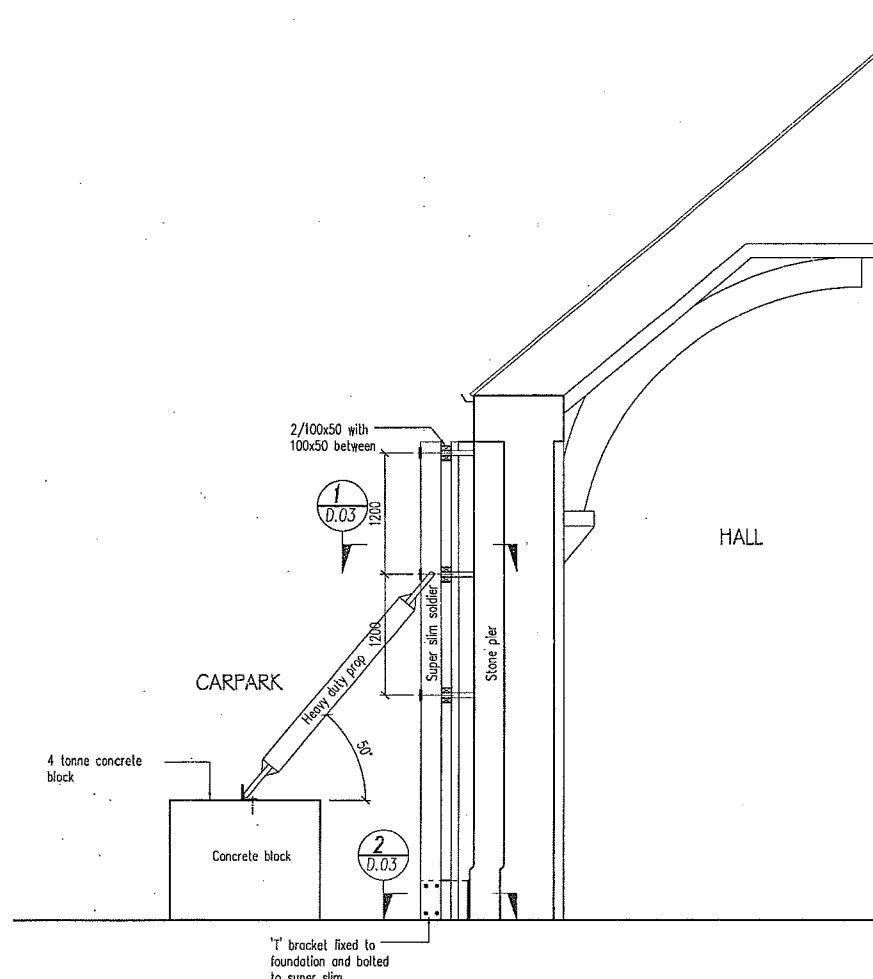
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SECTION 4
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SECTION 5
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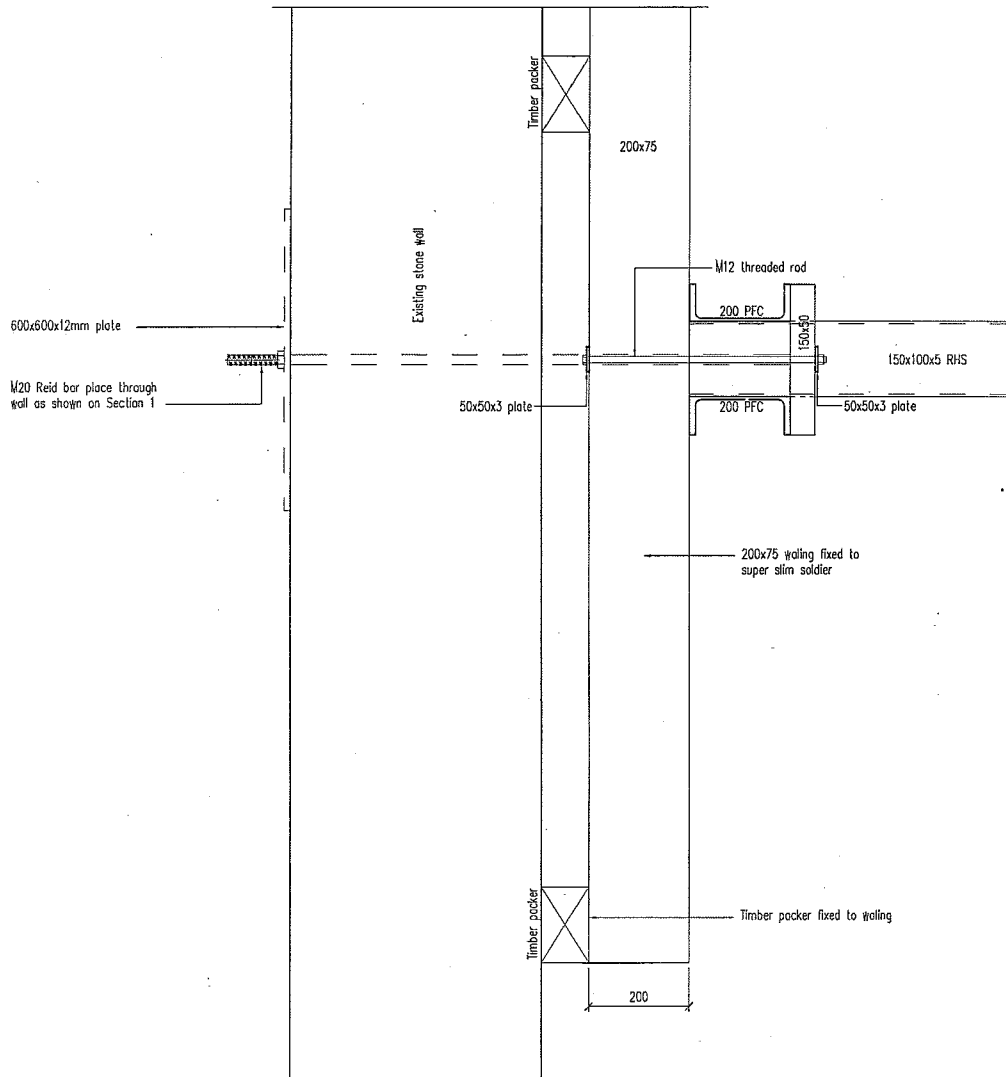
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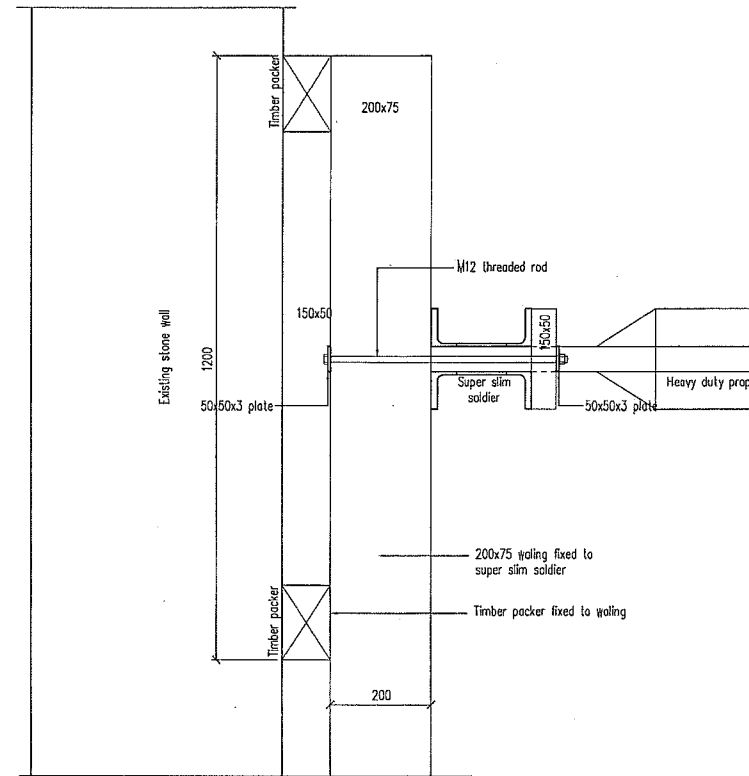
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PLAN 1
S.01 Scale 1:10



PLAN 2
S.02 Scale 1:10

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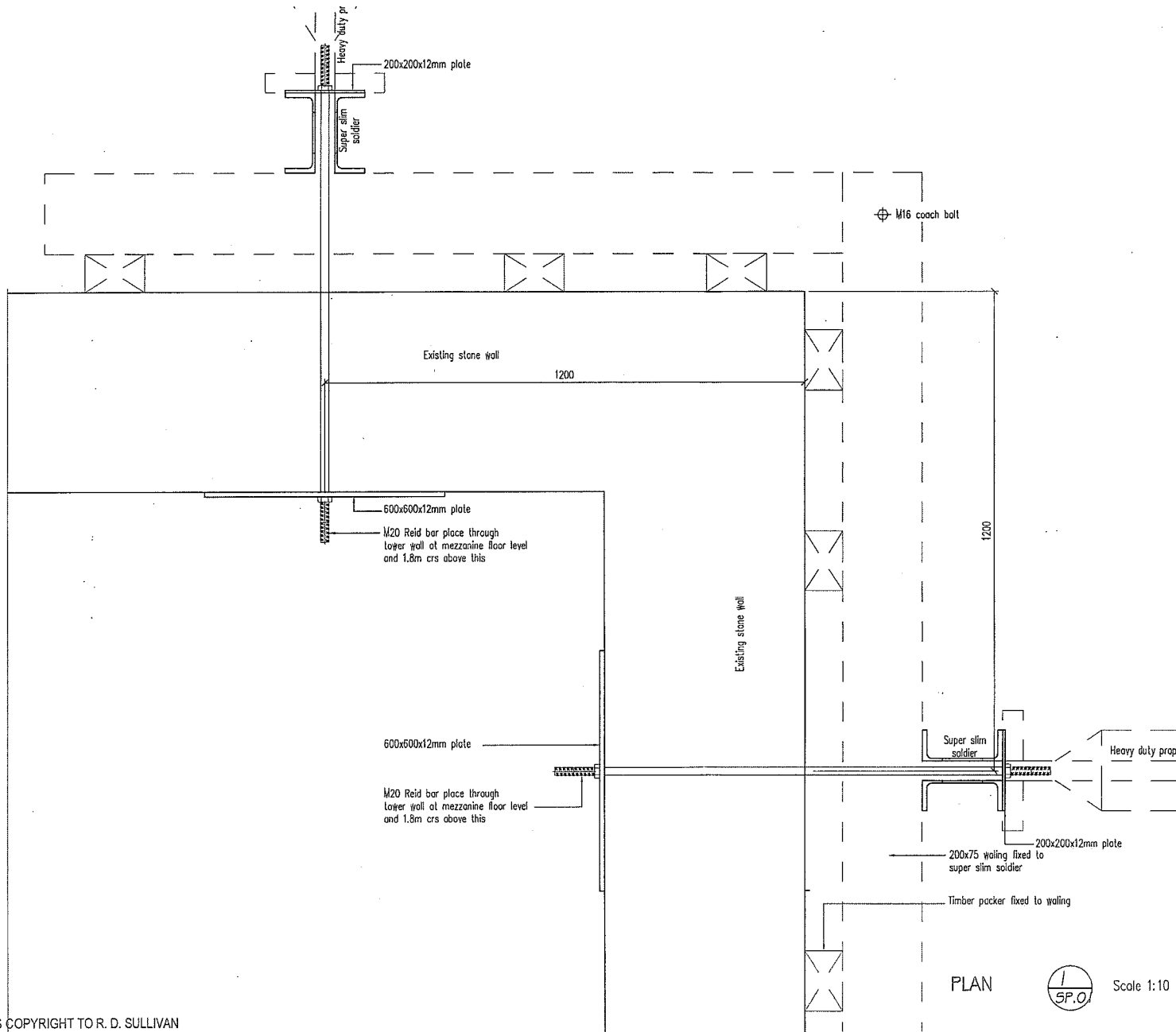
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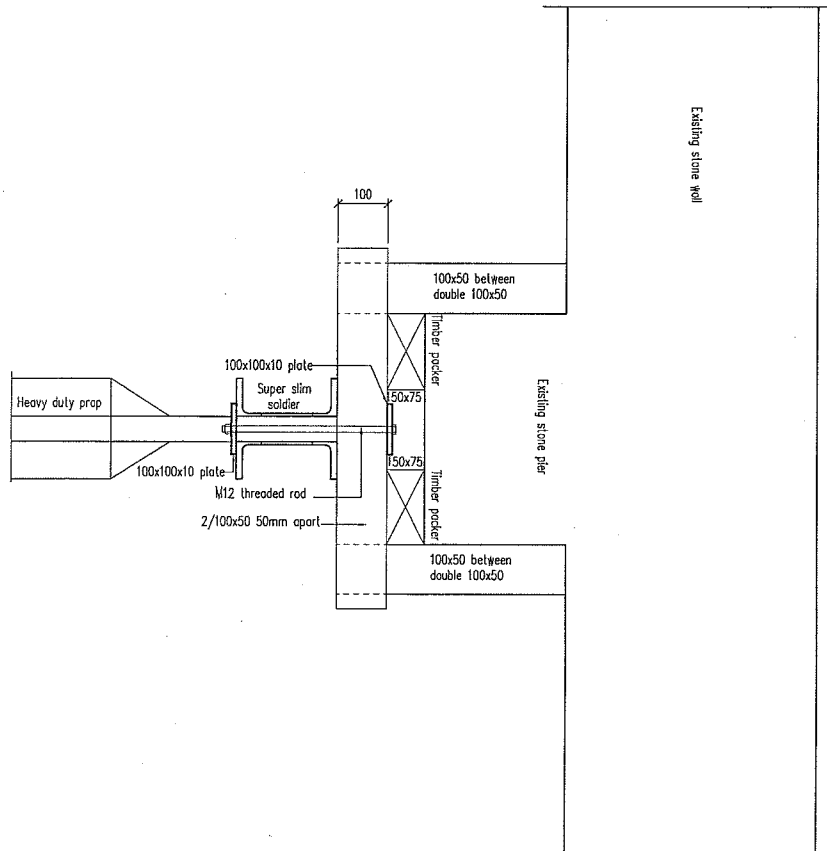
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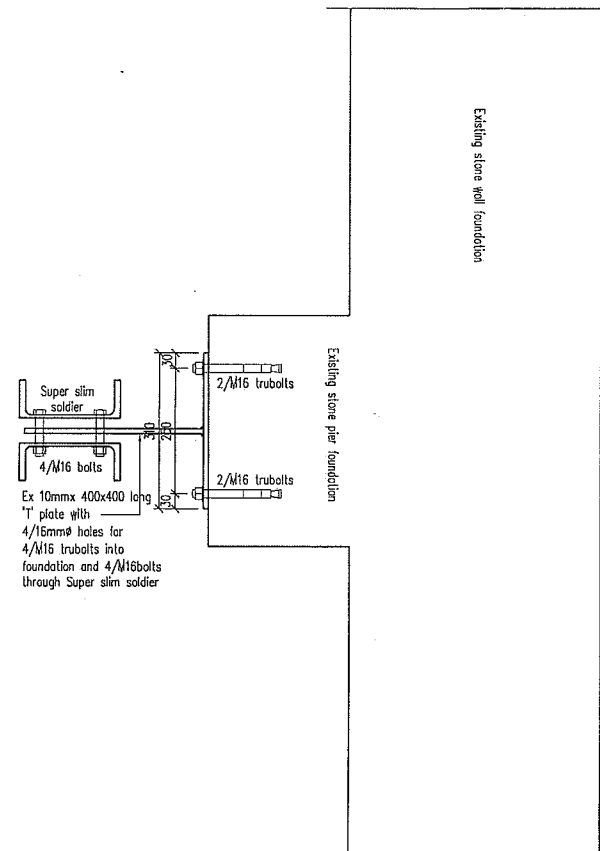
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PLAN



Scale 1:10



PLAN



Scale 1:10

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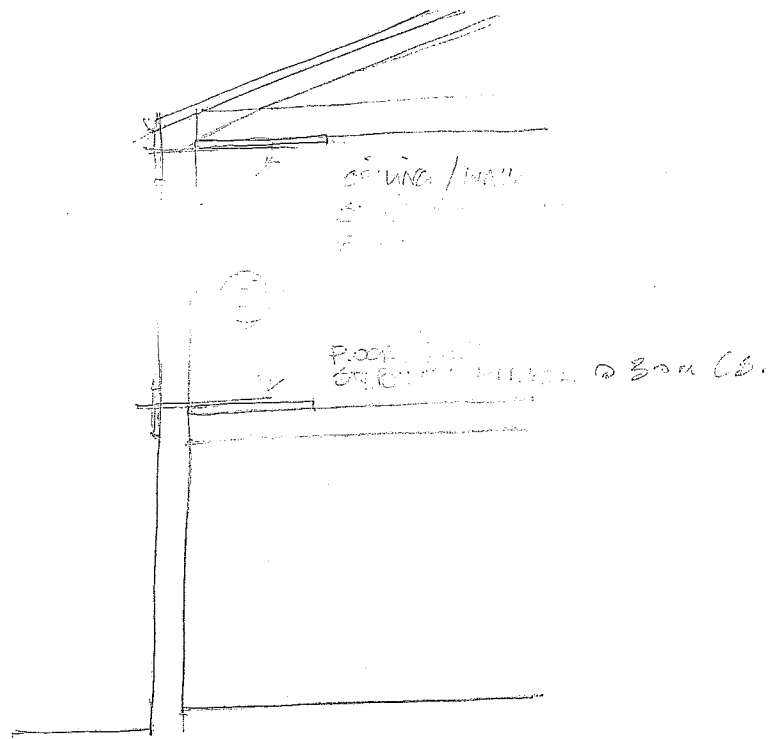
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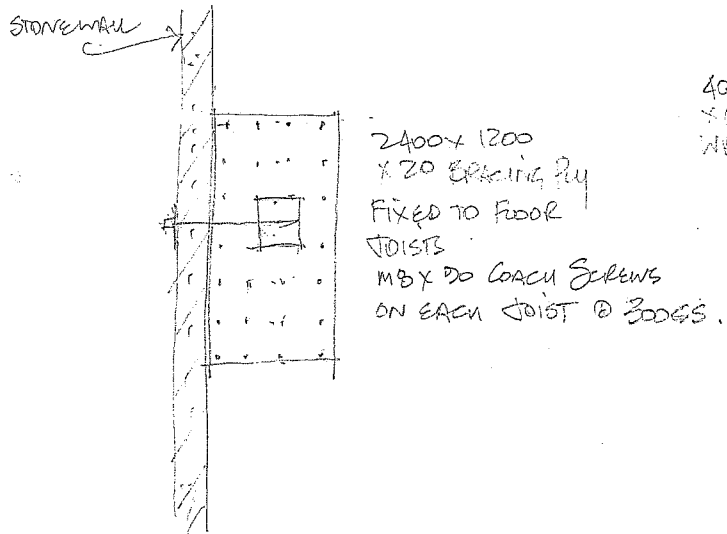
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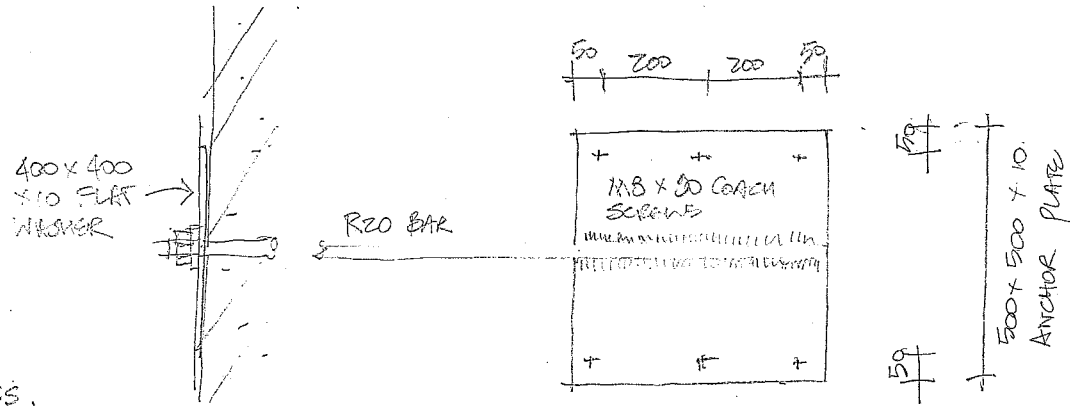
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ANNEX SECTION



PLAN DETAIL A.



DETAIL A
SCALE 1:10.