structex

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17 December 2013

Mr Stephen Brown-Thomas
Airways Nominees Limited
C/- KCL Property
PO Box 44
New Plymouth 4340

Dear Stephen

**Re: Airways Corporation, ADC2 Seismic Strengthening Concept and Quantitative DEE Update**

Structex has been engaged to complete seismic strengthening concepts for the three buildings currently tenanted by Airways Corporation on Sir William Pickering Drive, Christchurch. This letter and its attachments cover the strengthening concept for the ADC2 building to a level sufficient for initial pricing along with updated information relating to the Quantitative Detailed Engineering Evaluation.

**Seismic Strengthening Concept to 100% NBS:**

As requested, we have assessed the seismic strengthening concept at Importance Level 2 with a target of 100%NBS (refer Appendix B for sketches).

100% NBS Roof bracing strengthening:

- Install a new bay of roof bracing between grids 3 and 4;
- Add new steel SHS struts at each end of the roof bracing and use epoxy bolts to connect the strut to the concrete shear walls;
- Retrofit double purlin cleats at selected roof locations to drag the lateral load into the roof bracing system and internal shear walls;
- Retrofit roof bracing cleats by increasing the thickness;
- Retrofit the Reidbrace32 connection details to meet the latest Reid specification.

100% NBS General strengthening:

- Four new concentrically braced steel frames in the across direction at ground floor (310UC96.8 frame) and one at first floor level (250x9.0 SHS frame);
- Three new concentrically braced steel frames in the along direction (250x9.0 SHS frame);
- Three new steel PFC tension ties to be installed to the underside of the suspended floor in the along direction.

Please refer to Appendix A 'Reference Plan' for along and across directions as well as grid lines.

This strengthening is required to reduce the load on the existing internal shear walls by transferring load to the new bracing.

Further recommendations:

To increase robustness during an earthquake larger than design level, you may wish to consider strengthening the first floor diaphragm connection to the façade panels. This could be achieved relatively easily with a bolted steel angle within the ground floor ceiling space. This connection is critical to the seismic performance of the building. The current connection provides a strength >100%NBS but falls short of the current concrete code requirements for robustness.

Note this is an optional item to increase robustness for an earthquake greater than the 100% NBS design level.

**Quantitative DEE Update:**

A Quantitative DEE has previously been completed for ADC2, which was issued to Airways Nominees Ltd on 21 October 2013. During the process of conceptual strengthening design, it was identified that there are isolated components of the structure with a capacity less than the overall assessed building capacity stated in the previous report. These are:

- Suspended floor diaphragm-mesh tension tie capacity near panels 39 and 37 (refer appendix A for panel locations);
- Roof bracing to concrete shear wall connections at grid A4-5 and D4-5 (critical structural weakness).

The suspended floor diaphragm is required to drag earthquake load into the concrete shear walls. The evaluation of 38% and 52% NBS at two walls is governed by the ability of the mesh to drag seismic load into panels 39 and 37 at each location during an earthquake in the one direction.

With regards to roof bracing, two different types of connections between the roof bracing and the concrete shear walls at grids A4-5 and D4-5 have been evaluated. These connections have a capacity of 24%NBS (four trubolts) and 18%NBS (two chemsets) under the roof bracing load induced by the design level earthquake. As this has a brittle failure mechanism, it is considered to be a critical structural weakness (CSW). The remaining steel roof bracing system is evaluated at 48%NBS governed by the steel brace cleat capacity. The pin connecting the reidbrace banana end to the steel rafter is anticipated to slog out the hole in the cleat, eventually leading to a tension tear-out failure of the cleat. Refer to the attached 'roof bracing system capacities' in Appendix A for other roof bracing components strength. In addition, secondary load paths within the roof are present, therefore the connection strength does not directly impact the overall seismic %NBS of the structure. This secondary load path consists of a plywood roof structure which will distribute the seismic load between the steel rafters (by bending), which in turn transfers the load into the concrete shear walls. This load path has not been considered as a primary load path as it was not specifically detailed as a diaphragm.

**Minimum strengthening recommendation:**

Should you not wish to strengthen the building to 100% NBS, we would recommend at least strengthening the following items to maintain robust primary load paths.

- Tension tie capacity of the diaphragm near panels 37 and 39;
- Roof bracing elements (purlin cleats, brace cleats and connections to shear walls).

This would involve using a steel member running parallel to panels 37 and 39 underneath the suspended floor, retrofitting brace and some purlin cleats and installing an additional strut along grid lines A and D, between grids 4 and 5 only and epoxy anchoring it to the concrete shear walls. Strengthening to a minimum of 67%NBS is recommended on these elements. Refer to the Appendix C for further details.

We trust that you find the above information useful. If you wish to discuss further, we would be happy to meet with you at your convenience.

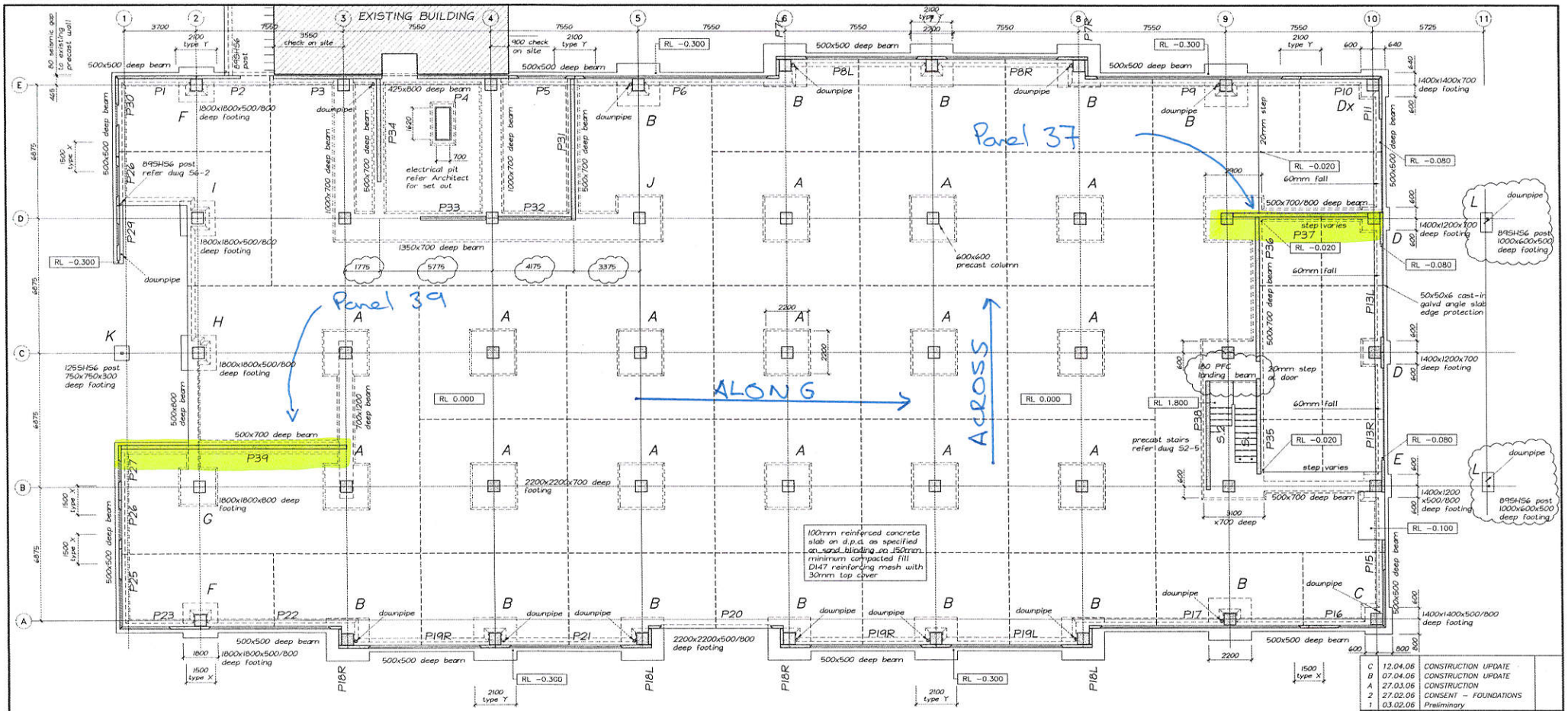
Yours sincerely
**Structex Harvard Ltd**

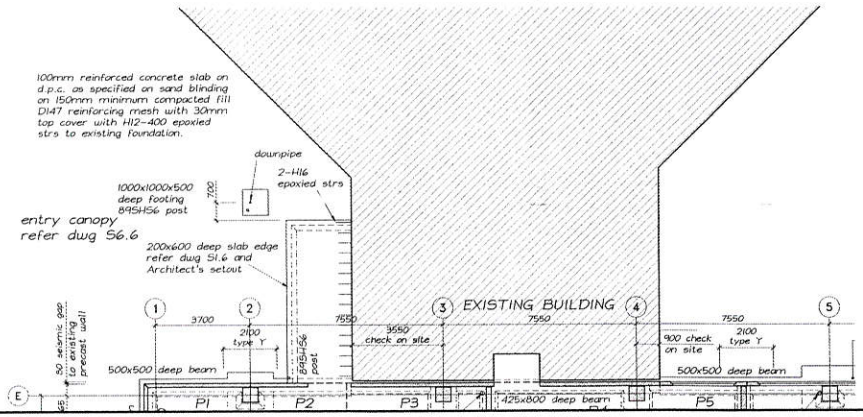
Blair Ramsay
Structural Engineer
BE(Hons), GIPENZ

Geoff Banks
Managing Director
BE(Hons), MIPENZ, CPEng, IntPE

## Appendix A: Report information

- Panel Locations
- Roof bracing capacities




Ground Floor RL 0.000 = RL 33.000 on Architectural drawings.

refer dwg S1-2 for footing reinforcing

refer Architectural drawings for all downpipe and sewer pipe details

---------- denotes 3x30mm deep slab saucut located mid-grid as shown, grout fill prior to placing floor coverings

Reference Plan

BR #3740

16/12/2013

| ISSUE | DATE | AMENDMENT | CHECKED |
|---|---|---|---|
| C | 12.04.06 | CONSTRUCTION UPDATE | |
| B | 07.04.06 | CONSTRUCTION UPDATE | |
| A | 27.03.06 | CONSTRUCTION | |
| 2 | 27.02.06 | CONSENT - FOUNDATIONS | |
| 1 | 03.02.06 | Preliminary | |

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IAN KRAUSE ARCHITECTS LIMITED

# AIRWAYS NEW ZEALAND TECHNOLOGY PARK
CHRISTCHURCH

## GROUND FLOOR PLAN

CONTRACTOR MUST VERIFY ALL DIMENSIONS ON SITE

| SCALES: | | DESIGNED | | |
|---|---|---|---|---|
| 1:100 | | DRAWN | KD | 01/06 |
| | | CHECKED | | |

| SET | JOB NO. | SHEET NO. | ISSUE |
|---|---|---|---|
| | 050818 | S1-1 OF - SHEETS | C |



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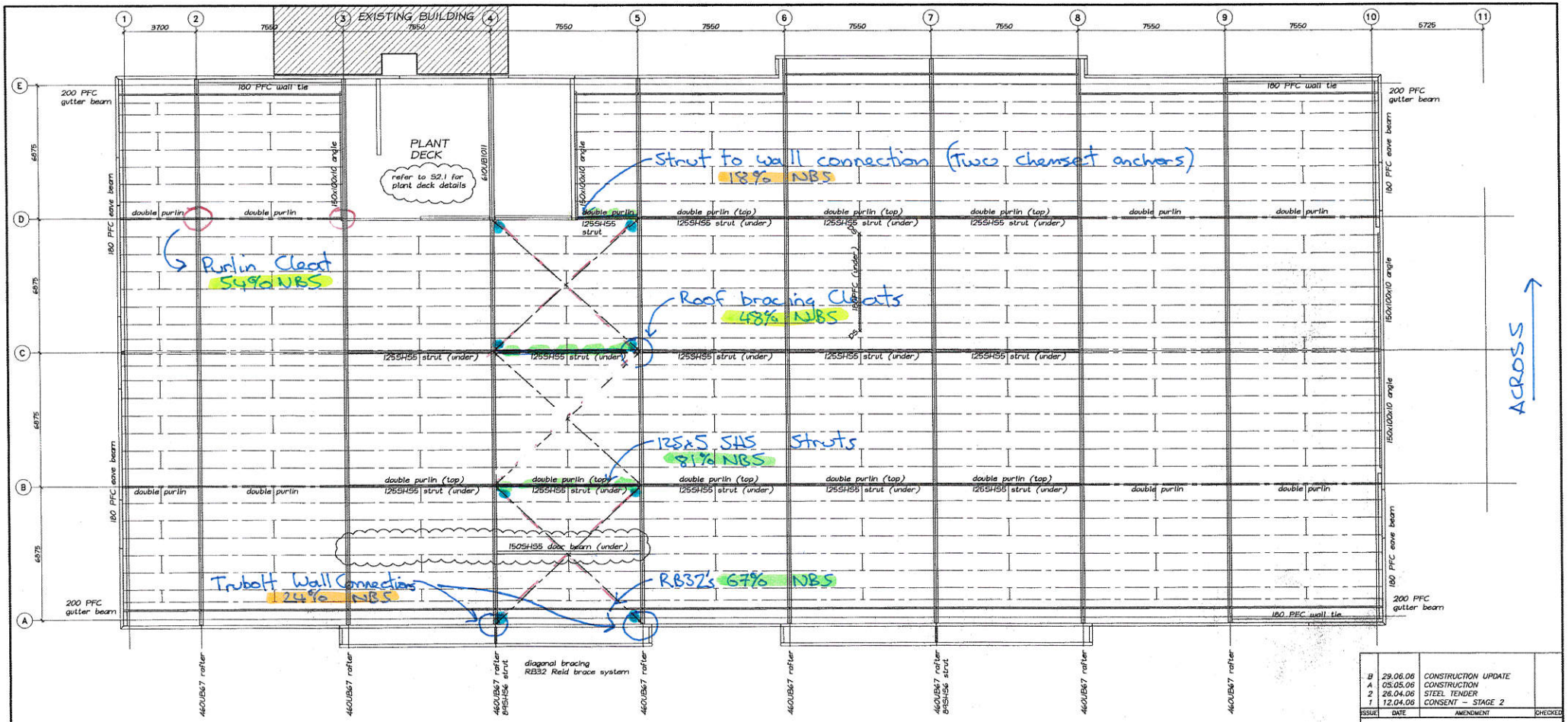
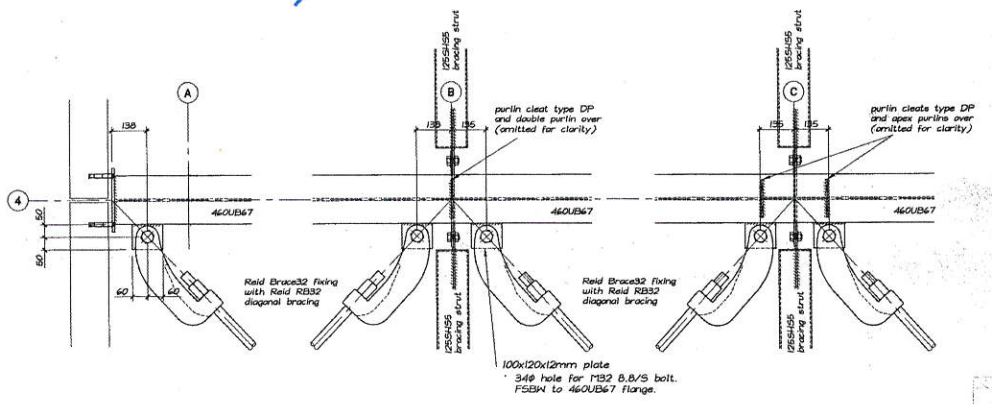



ROOF FRAMING PLAN
Scale: 1:100

all purlins to be DHS 250-13 steel purlins with 1 row of bracing channels.

Roof bracing system capacities
BR #3740
16/12/2013




DIAGONAL BRACING DETAILS

| ISSUE | DATE | AMENDMENT | CHECKED |
|---|---|---|---|
| B | 29.06.06 | CONSTRUCTION UPDATE | |
| A | 05.05.06 | CONSTRUCTION | |
| 2 | 26.04.06 | STEEL TENDER | |
| 1 | 12.04.06 | CONSENT – STAGE 2 | |

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AIRWAYS NEW ZEALAND TECHNOLOGY PARK
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STRUCTURAL STEEL
ROOF FRAMING PLAN

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| 1:100,1:10 | DRAWN | KD | 04/06 |
| | CHECKED | | |

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|---|---|---|---|
| | 050818 | S6-1 OF – SHEETS | B |

30 JUN 2006



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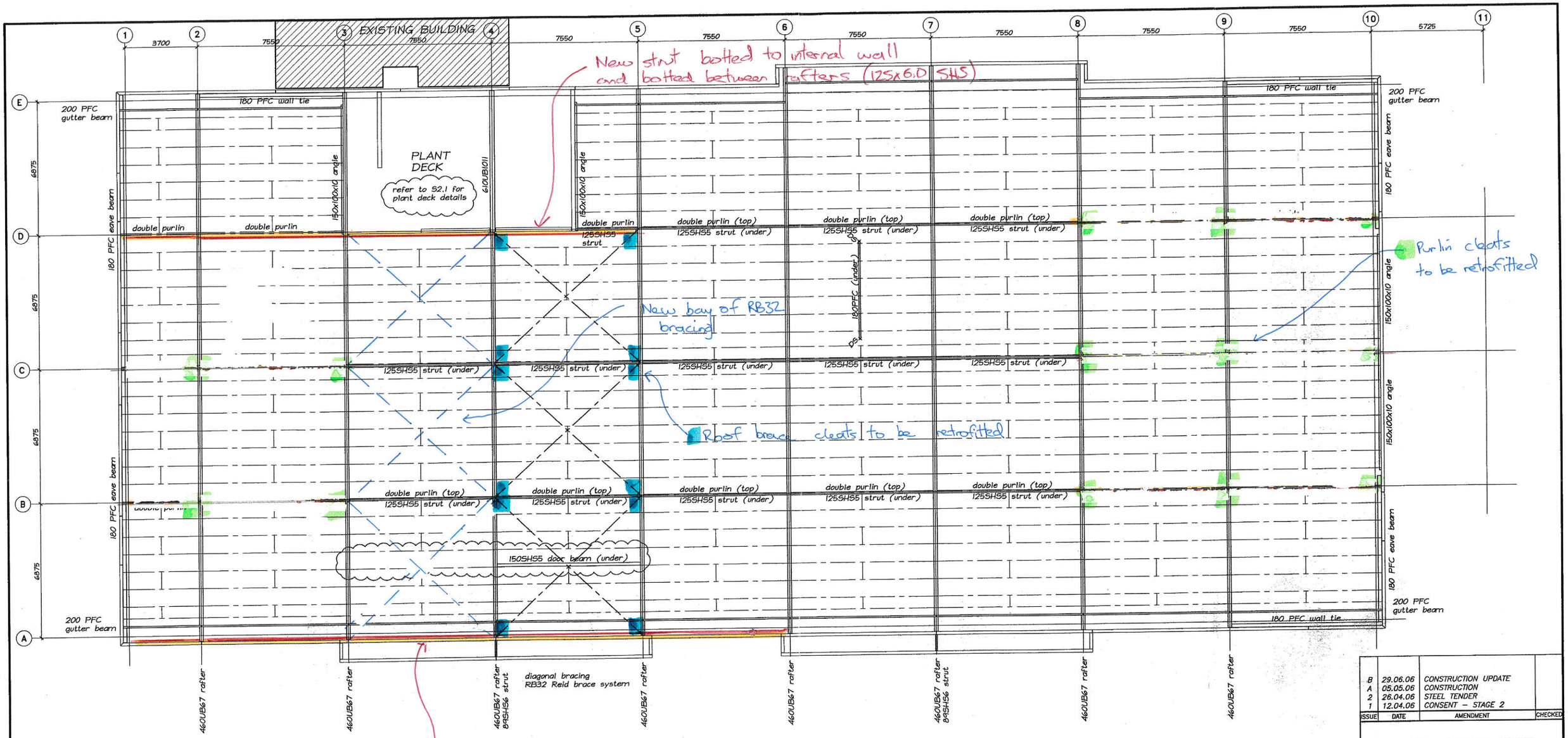
## Appendix B: Strengthening to 100%NBS

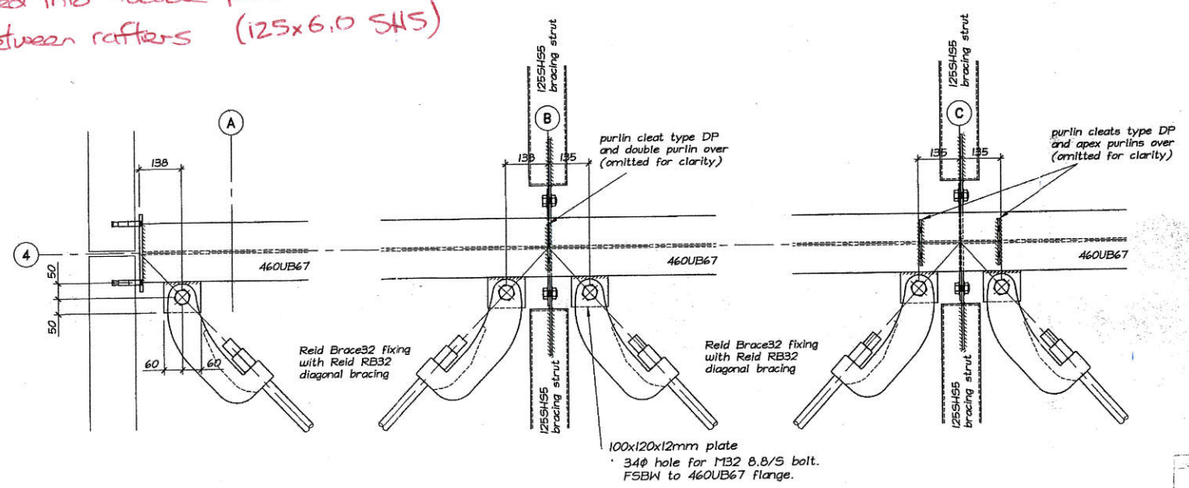



ROOF FRAMING PLAN
Scale: 1:100

all purlins to be DHS 250-13 steel purlins with 1 row of bracing channels.

New strut bolted into facade panels and bolted between rafters (125x6.0 SHS)

ADC2 Strengthening Option (Roof)
#3740
BR SK01




DIAGONAL BRACING DETAILS

| ISSUE | DATE | AMENDMENT | CHECKED |
|---|---|---|---|
| B | 29.06.06 | CONSTRUCTION UPDATE | |
| A | 05.05.06 | CONSTRUCTION | |
| 2 | 26.04.06 | STEEL TENDER | |
| 1 | 12.04.06 | CONSENT – STAGE 2 | |

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|---|---|---|---|
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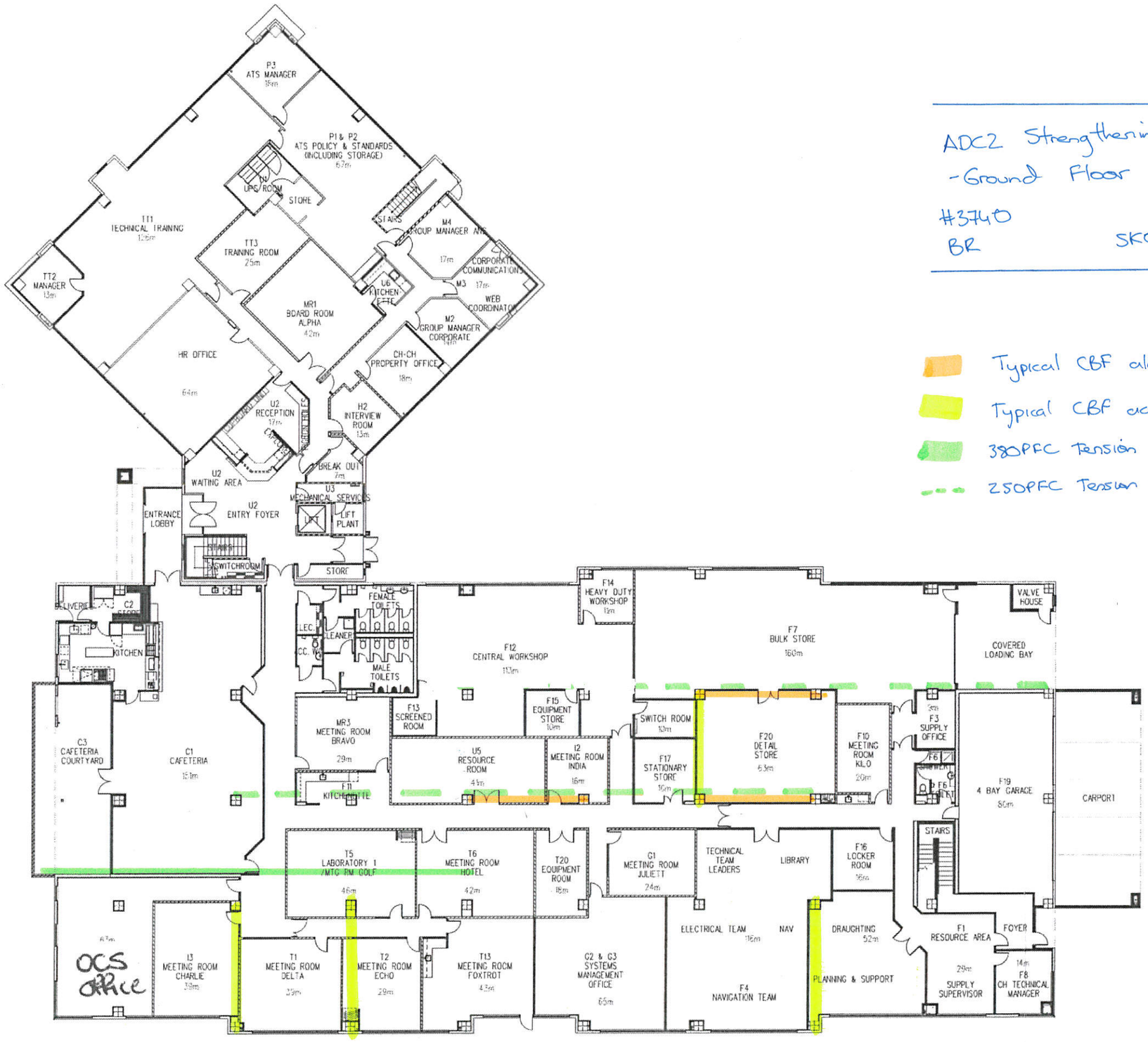
ADC2 Strengthening Option
-Ground Floor

#3740
BR SK02

Typical CBF along direction (SK04)
Typical CBF across direction (SK05)
380PFC Tension tie underneath suspended floor
250PFC Tension tie underneath suspended floor




| Issue | Amendment | Origin, Date | Drawn, Date | Origin Chk, Date | Design Chk, Date | Approved, Date |
|---|---|---|---|---|---|---|
| A | Layout Update. | JP, 26.7.07 | DC, 26.7.07 | . | . | . |
| B | Layout Update. | PDS, 11.6.08 | DC, 11.6.08 | . | . | . |
| C | Room areas added. | RJ, 17.10.08 | DC, 17.10.08 | . | . | . |
| D | Layout updated | DC, 26.08.09 | DC, 27.08.09 | . | . | . |
| E | Base Plan and Room Layouts on separate sheets. | DC, 04.09.09 | DC, 04.09.09 | . | . | . |

| | Name | Date |
|---|---|---|
| Origin | PDS | 30.04.07 |
| Drawn | DC | 02.05.07 |
| Origin Chk | | |
| Design Chk | | |

Approved:
Date:

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# Airways Development Centre
## Building Layout
## Ground Floor Base Plan

Sheet 1 of – Sheets
Scale: 1 : 200
Drg. No. 31693
Issue E

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2

9122011

ADC2 Strengthening Option (Walls) - First floor

#3740

BR SK03

Typical CBF along direction


| Issue | Amendment | Origin, Date | Drawn, Date | Origin Chk, Date | Design Chk, Date | Approved, Date |
|---|---|---|---|---|---|---|
| D | Com and Network Engineering areas updated. | AF, 6.8.08 | DC, 7.8.08 | . | . | . |
| E | Room updates | MD, 10.9.08 | DC, 10.9.08 | . | . | . |
| F | Layout updates. | RJ, 26.02.09 | DC, 26.02.09 | . | . | . |
| G | Layout updates. | DC, 26.08.09 | DC, 27.08.09 | . | . | . |
| H | Base Plan and Room Layouts on separate sheets. | DC, 04.09.09 | DC, 04.09.09 | . | . | . |

| | Name | Date |
|---|---|---|
| Origin | PDS | 30.04.07 |
| Drawn | DC | 02.05.07 |
| Origin Chk | | |
| Design Chk | | |

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# Airways Development Centre
## Building Layout
## First Floor Room Layouts

Sheet 4 of – Sheets

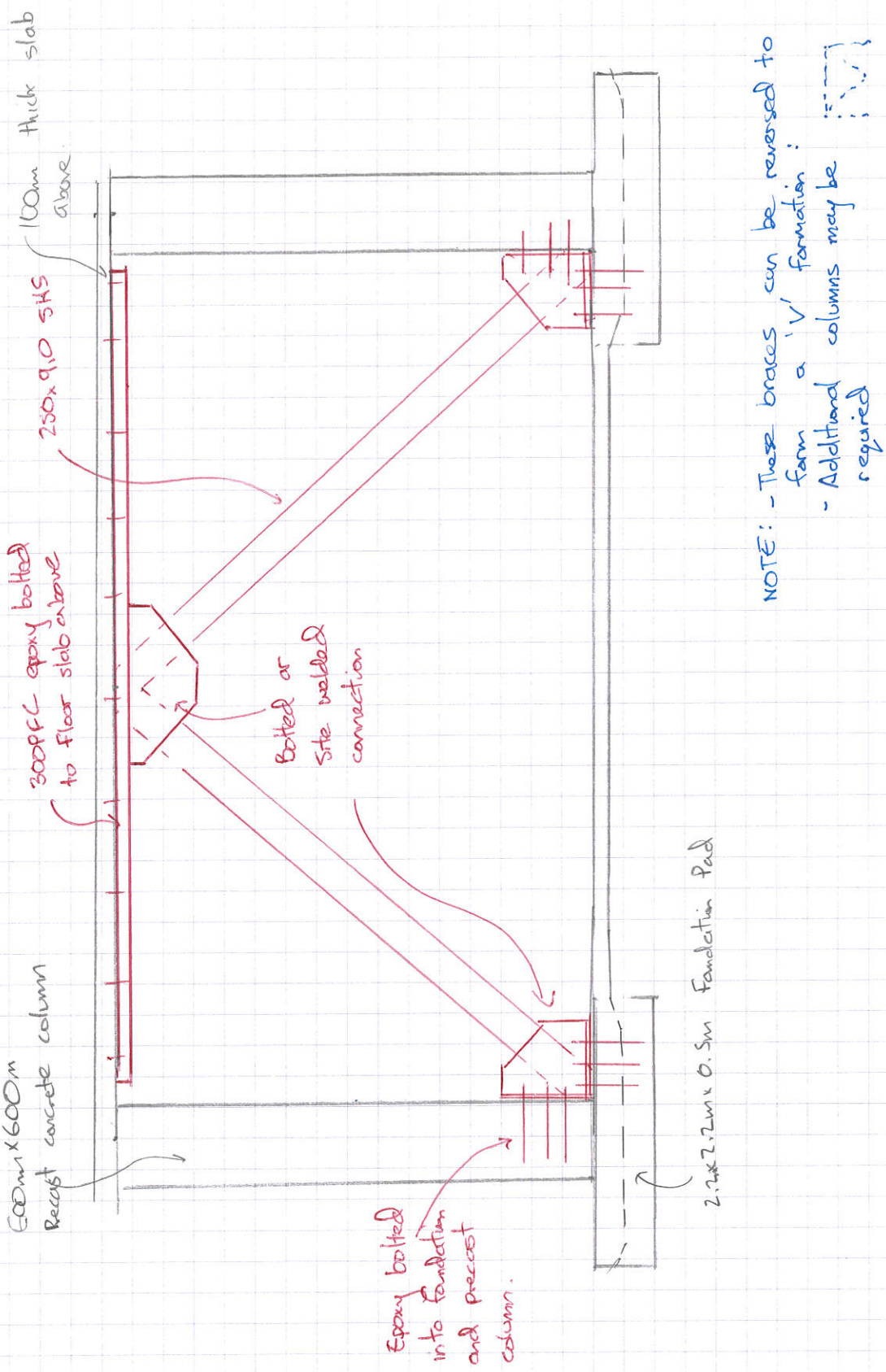
Scale: 1 : 200

Drg. No. 31693

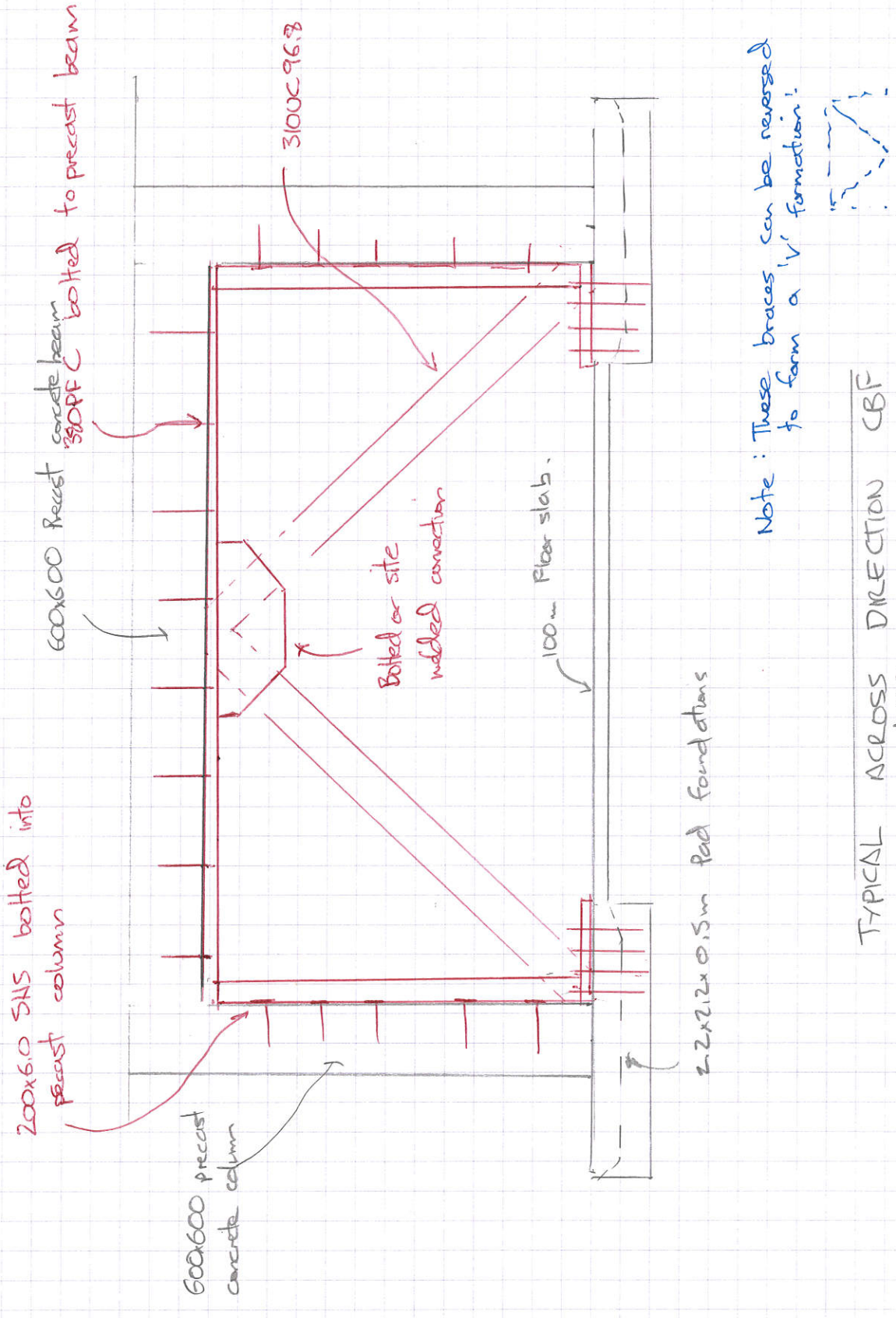
Issue H

A2

METRIC




TYPICAL ALONG DIRECTION CBF
1:50




TYPICAL ACROSS DIRECTION CBF
1:50

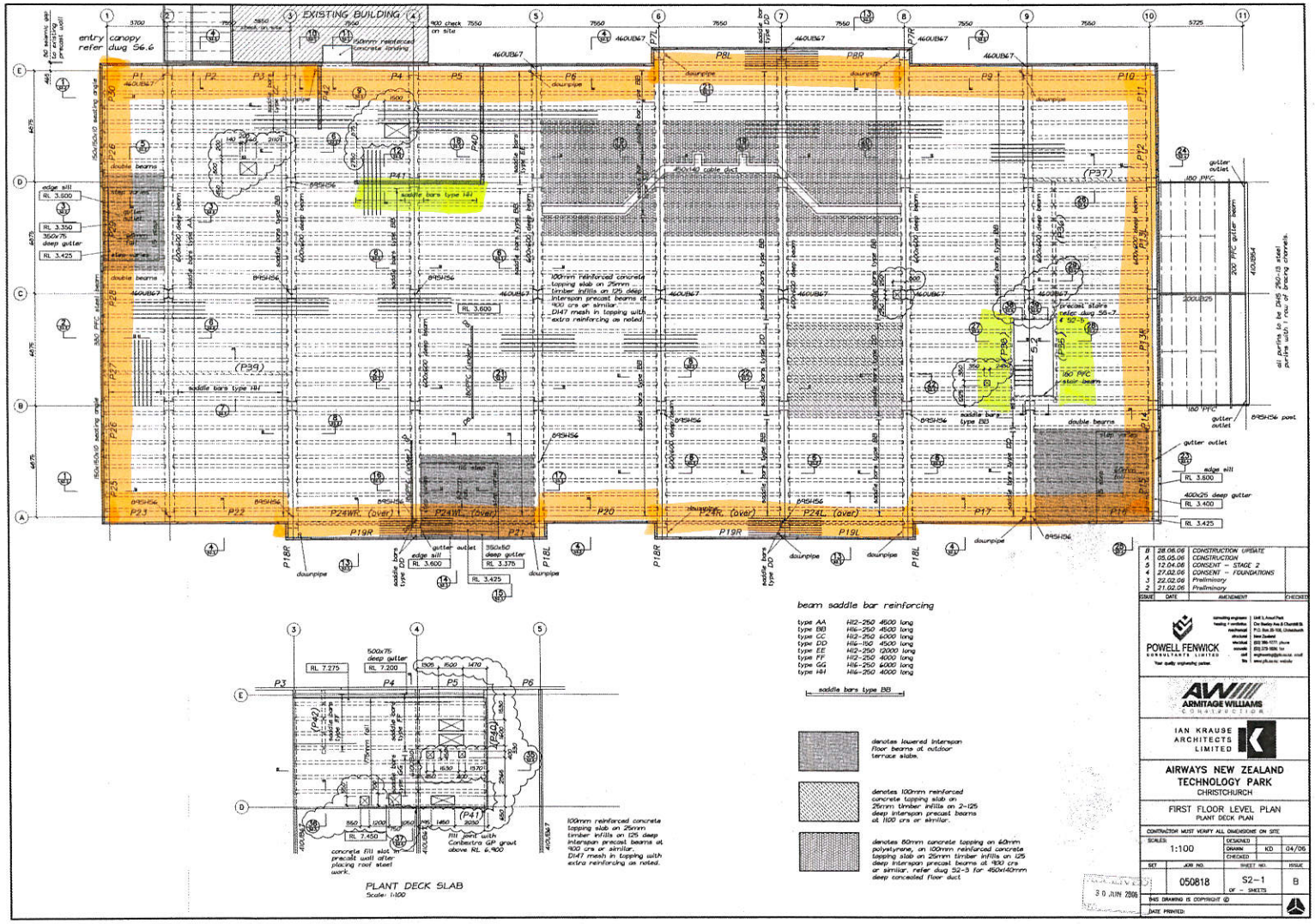
Ø60 Rods through floor beam
3 Ø60 MS rods welded to PFC (Site weld)
350PFC Tension Tie
Bolted to floor slab
Sepaded Floor Slab
A
A
ELEVATION 1:50
600x600mm
100mm Floor slab
600mm Beam
SECTION A-A
END ELEVATION 1:5
- TENSION TIE CONNECTION THROUGH BEAM
1:5 or 1:50

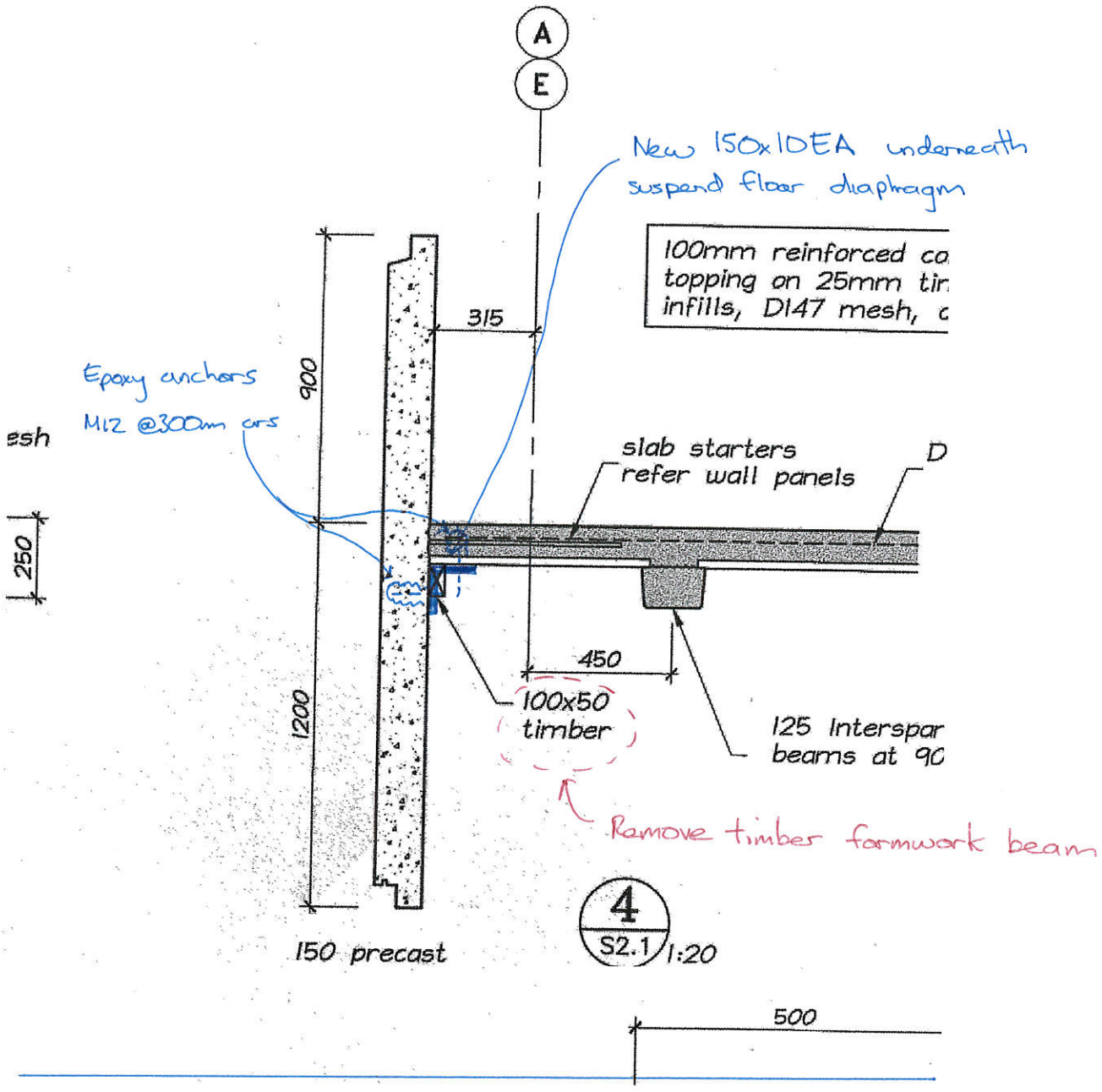
Recommended Strengthening of Diaphragm connection

16/12/2013 BR #3740 SK07

150x10 EA M12 epoxy anchors @300 centres.

150x10 EA M12 epoxy anchors @300 centres






Typical Strengthening of Diaphragm to wall connection

#3740 BR

16/12/2013

# REIDBRACE BRACING SYSTEM

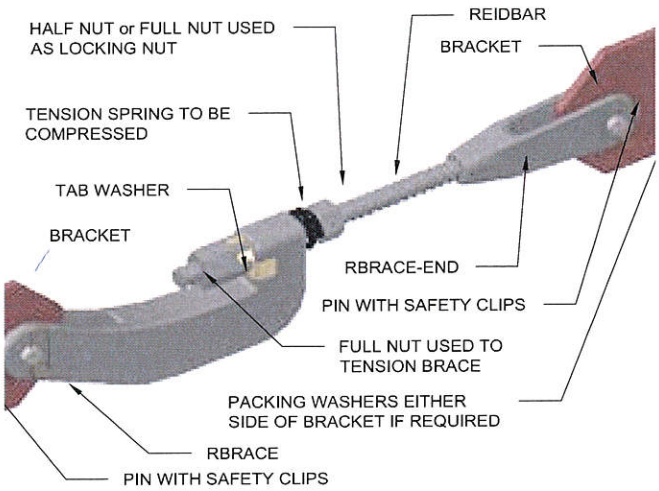
PRODUCT DATA SHEET

## DESCRIPTION

Reidbrace™ is rapidly becoming the preferred option for tension tie bracing and provides an economic off-the-shelf solution for bracing structures, tie-back applications and temporary bracing.

## FEATURES

- Eliminates expensive threaded rods. Reidbrace™ uses seismic grade 500E Reidbar™ for tendons.
- Eliminates welding and threading. Reidbar™ is available in either black or galvanised bar in standard 6 metre lengths and can be joined using standard couplers and locking nuts. (Longer Reidbar™ lengths by order).
- Over length bar can be cut without dismantling the bracing assembly.
- Substantial cost savings in labour and materials.
- All components sold as kits or separately.
- Engineered design - tested and certified to exceed the yield capacity of the 500E grade Reidbar™ (with the exception of RBRACE32, refer to Table1.)
- Designed to fit over structural steel flanges or cleats to provide double shear connection. The bracket thickness will influence the strength of system. Refer to Reid for design advice.
- Supplied with pin and clip for connection to structure - no need to source separate HS bolt.
- Reidbrace is galvanised for added corrosion protection.




## APPLICATIONS

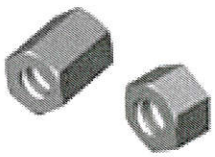
- Wall and roof bracing
- Retro fitted seismic bracing
- Retaining wall tie backs
- Cross ties
- Temporary Bracing
- Beam Strengthening

## REIDBRACE KITS & PRODUCT CODES

The Reidbrace Kits comprise of six major components and includes all the pins and safety clips for ease of ordering and installation. The kits are available in 12, 16, 20. 25 and 32mm sizes.

RBRACE Banana End plus pins and safety clips

RBRACE-END plus pins and safety clips



Reid Full Nut and Half Nut

Reid Tension Spring

Reid Tab Washer

| Bar Size | Kit Code (includes all fittings including pins) |
|---|---|
| 12mm | RBRACE12-SET |
| 16mm | RBRACE16-SET |
| 20mm | RBRACE20-SET |
| 25mm | RBRACE25-SET |
| 32mm | RBRACE32-SET |

Ph 0800 88 22 12 | www.reids.co.nz

PRODUCT DATA SHEET

## REIDBRACE SPECIFICATION

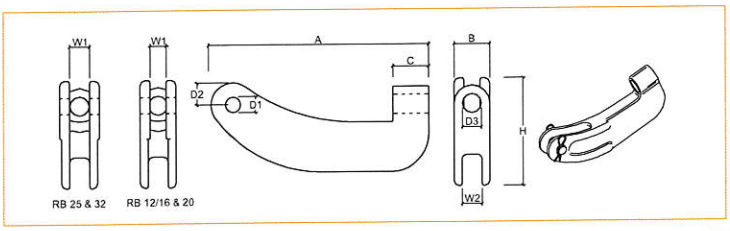
Table 1: CHARACTERISTIC STRENGTHS - min ultimate strength in kN

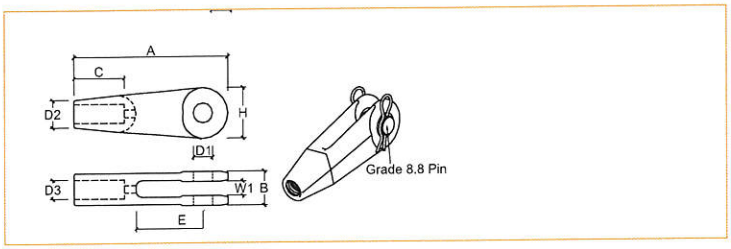
| RBRACE Size | RBRACE Banana | RBRACE End | Reidbar FULL NUT | Reidbar HALF NUT | Reidbar Min Yield | Reidbar Min UTS |
|---|---|---|---|---|---|---|
| 12mm | >116 | >65 | 79 | 34 | 56.5 | 65.0 |
| 16mm | >116 | >116 | 141 | 60 | 100.6 | 115.6 |
| 20mm | >181 | >181 | 220 | 94 | 157.0 | 180.6 |
| 25mm | >282 | >282 | 344 | 147 | 245.5 | 282.3 |
| 32mm | >430 | >462 | 462 | 241 | 402.0 | 462.3 |

Table 2: PRODUCT SPECIFICATION - DIMENSIONS OF RBRACE BANANA AND RBRACE END

| Reidbrace Banana | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Size | A | B | C | D1 | D2 | D3 | E | H | W1 | W2 |
| 12/16 | 276 | 36 | 46 | 17 | 25 | 19 | - | 107 | 16 | 20 |
| 20 | 345 | 45 | 58 | 21 | 32 | 24 | - | 134 | 21 | 25 |
| 25 | 382 | 53 | 73 | 31 | 40 | 29 | - | 149 | 26 | 29 |
| 32 | 436 | 68 | 72 | 31 | 44 | 38 | - | 170 | 36 | 36 |

| RB-End | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Size | A | B | C | D1 | D2 | Pin ø | E | H | W1 | |
| 12 | 145 | 32 | 50 | 17 | - | 16 | 50 | 40 | 16 | - |
| 16 | 160 | 36 | 55 | 17 | 30 | 16 | 67 | 50 | 1o | - |
| 20 | 195 | 45 | 60 | 21 | 35 | 20 | 88 | 60 | 21 | - |
| 25 | 247 | 50 | 80 | 31 | 43 | 30 | 108 | 80 | 26 | - |
| 32 | 265 | 62 | 85 | 31 | 55 | 30 | 120 | 88 | 32 | - |




### INSTALLATION SPECIAL CAUTION:

The Reidbrace must be centralised on the bracket to ensure central loading forces.

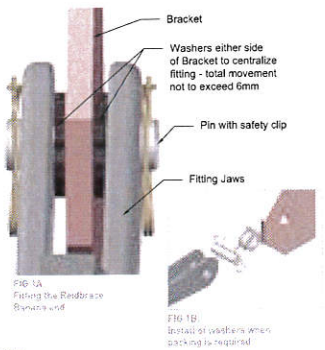
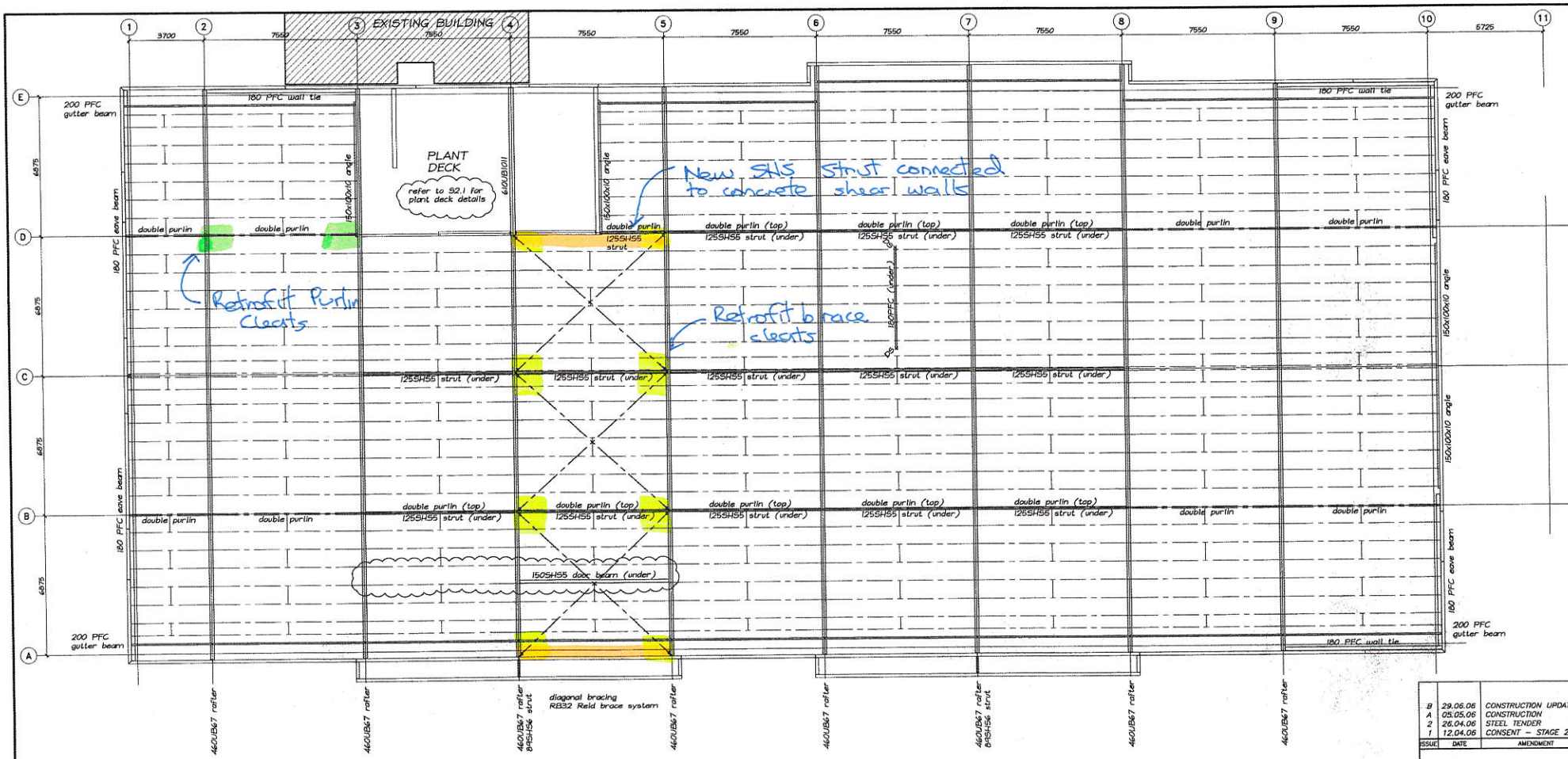



FIG 1A
Fitting the Reidbrace Bracket end

FIG 1B
Install of washers when packing is required

For further technical information and CAD drawings, please refer to the Reid website www.reids.co.nz or call 0800 88 22 12. All specification information is also contained in the Reidbar Technical Catalogue.

## Appendix C: Minimum Strengthening Recommendation




ROOF FRAMING PLAN
Scale: 1:100

all purlins to be DHS 250-13 steel purlins with 1 row of bracing channels.

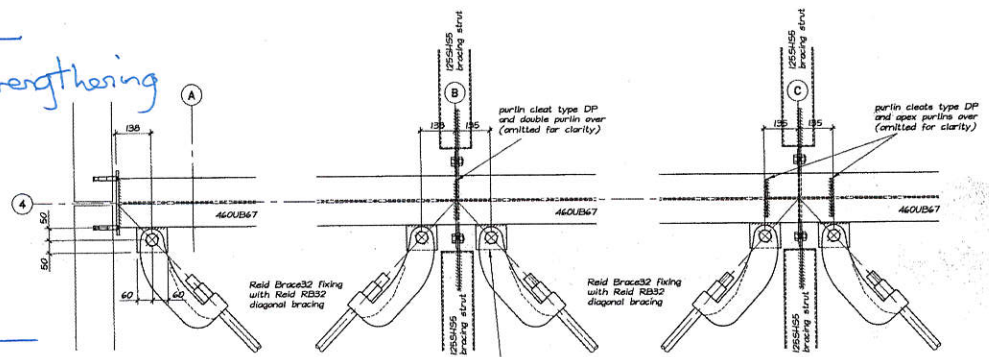
Roof bracing element minimums strengthening recommendation

BR

16/12/2013

#3740

SK09




DIAGONAL BRACING DETAILS

| ISSUE | DATE | AMENDMENT | CHECKED |
|---|---|---|---|
| B | 29.06.06 | CONSTRUCTION UPDATE | |
| A | 05.05.06 | CONSTRUCTION | |
| 2 | 26.04.06 | STEEL TENDER | |
| 1 | 12.04.06 | CONSENT – STAGE 2 | |

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AIRWAYS NEW ZEALAND TECHNOLOGY PARK
CHRISTCHURCH

STRUCTURAL STEEL
ROOF FRAMING PLAN

CONTRACTOR MUST VERIFY ALL DIMENSIONS ON SITE

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30 JUN 2006



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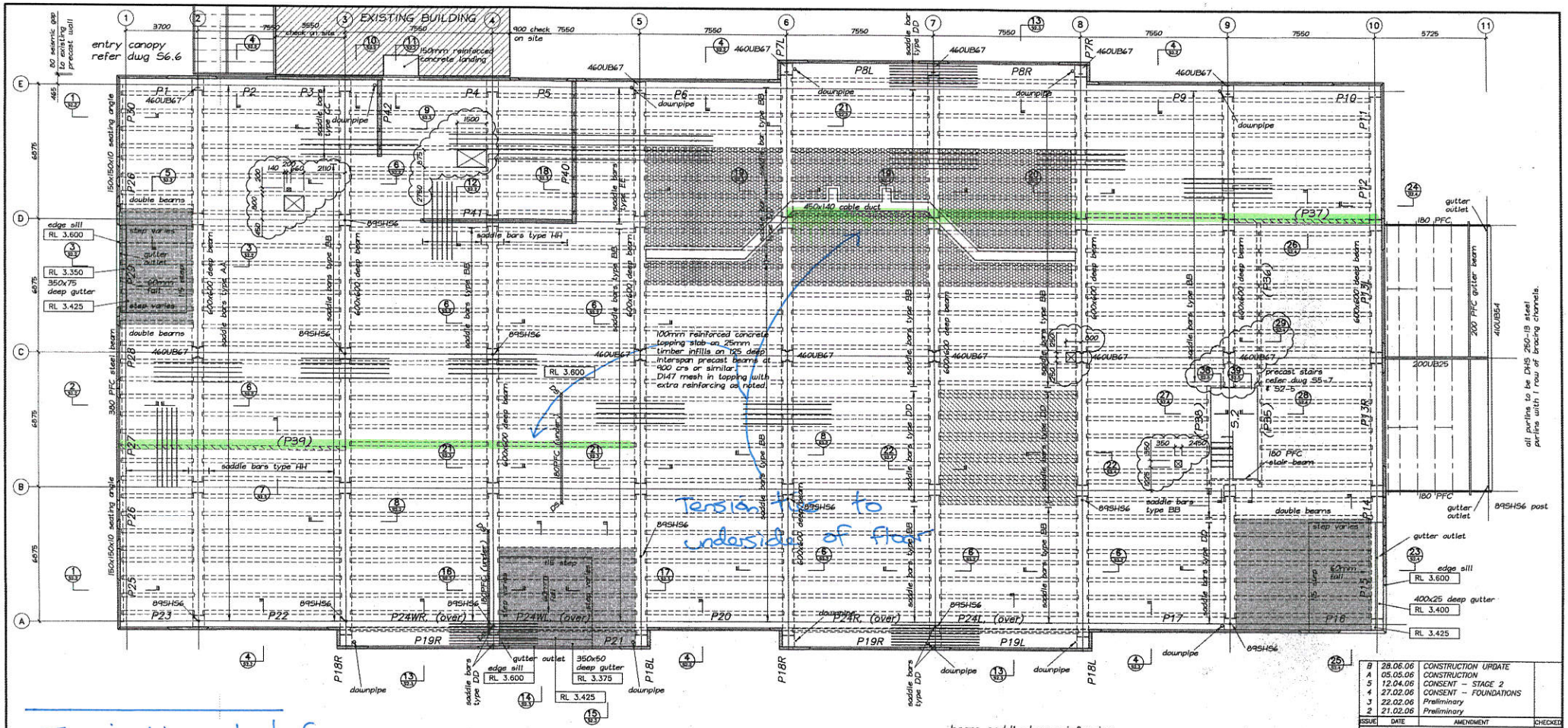
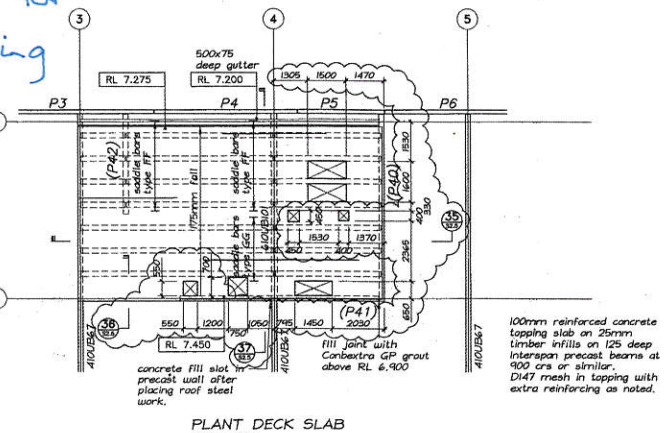



Tension tie extent for minimum strengthening recommendation
BR
16/12/2013
#3740 SK10




PLANT DECK SLAB
Scale: 1:100

beam saddle bar reinforcing

| | | |
|---|---|---|
| type AA | H12-250 | 4500 long |
| type BB | H16-250 | 4500 long |
| type CC | H12-250 | 6000 long |
| type DD | H16-150 | 4500 long |
| type EE | H12-250 | 12000 long |
| type FF | H12-250 | 4000 long |
| type GG | H16-250 | 6000 long |
| type HH | H16-250 | 4000 long |

saddle bars type BB

denotes lowered Interspan floor beams at outdoor terrace slabs.

denotes 100mm reinforced concrete topping slab on 25mm timber infills on 2-125 deep Interspan precast beams at 1100 crs or similar.

denotes 80mm concrete topping on 60mm polystyrene, on 100mm reinforced concrete topping slab on 25mm timber infills on 125 deep Interspan precast beams at 900 crs or similar. refer dwg S2-3 for 450x140mm deep concealed floor duct

| ISSUE | DATE | AMENDMENT | CHECKED |
|---|---|---|---|
| B | 28.06.06 | CONSTRUCTION UPDATE | |
| A | 05.05.06 | CONSTRUCTION | |
| 5 | 12.04.06 | CONSENT – STAGE 2 | |
| 4 | 27.02.06 | CONSENT – FOUNDATIONS | |
| 3 | 22.02.06 | Preliminary | |
| 2 | 21.02.06 | Preliminary | |

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CHRISTCHURCH

FIRST FLOOR LEVEL PLAN
PLANT DECK PLAN

CONTRACTOR MUST VERIFY ALL DIMENSIONS ON SITE

| SCALES: | | DESIGNED | | |
|---|---|---|---|---|
| 1:100 | | DRAWN | KD | 04/06 |
| | | CHECKED | | |
| SET | JOB NO. | SHEET NO. | | ISSUE |
| | 050818 | S2-1 OF – SHEETS | | B |


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