CIVIL & STRUCTURAL

DESIGN REPORT

3.0

HYD/F/081

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SPRINGFIELD ACADEMY

CIVIL & STRUCTURAL STAGE D DESIGN REPORT

Purpose:

For cost planning sign off

Revision 0: Initial draft issue
Date: 24/5/13

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1.0 INTRODUCTION

Hydrock Consultants have been engaged by Kier Western & Wales to work with architects Band Architects providing multi-disciplinary design consultancy services in respect of structural, civil, mechanical, geotechnical, highway and traffic engineering and flood risk assessment.

This report describes the civil and structural engineering design, and is to be read in conjunction with design sketches C13267/SK02, 03, 04, all revision P2.

2.0 EXECUTIVE SUMMARY

- Proposed building is located on a level part of the existing school grounds away from any other permanent buildings (although some temporary classrooms will be demolished to make way for the building).
- Proposed building will be braced steel frame with concrete planks and in situ structural topping first floor.
- Structural ties are required between planks and roof structure and beams to resist disproportionate collapse (Class 2B).
- Roofs are duo-pitched with a flat central section. There are options for proprietary timber or steel trusses where ceilings exist. Alternatively tied roof frames supporting purlins and roof deck where no ceiling. Flat roof to be "eco-joists" (lattice web between top and bottom timber chords). Roof decking to be a structural diaphragm stabilizing the building.
- All walling, internal and external, will be cold formed steel stud partitioning system (eg Metsec SFS). This would be let as a specialist sub-contractor package. Secondary hot rolled steel members may be required as wind posts to trim large openings, and these should be part of the design package in order to ensure coordination of detailing.
- Further secondary steel members may be needed to restrain curtain walling.
- Steelwork estimated from initial design work as being 35-40kg/m^2 of floor area (based on minimum weight section sizes rather than minimum depth) giving a tonnage of 66T, including connections, contingency and feature trusses. Proprietary trusses, secondary steelwork and cold formed steel not included.
- Ground conditions comprise limestone "brash" at shallow depth, with good bearing properties.
- Foundations to be shallow bearing pads and strips.
- Ground floor to be ground bearing slab.
- Drainage designs not progressed pending further review / investigations.

3.0 SUPERSTRUCTURE DESIGN

The building is approximately 30m square, two-storey, with an arrangement of duo-pitched roofs with a central flat roofed area incorporating rooflight. It has been conceived as a steel frame with precast concrete planks spanning between. Walling to be kept as lightweight studwork. The grid of the building has been kept quite large at 7-8m to keep columns on partition lines, without internal columns.

Salient points of the first floor design are as follows.

- Primary structural frame is hot rolled steelwork with vertical bracing for stability.
- Floor plate is of precast concrete planks spanning onto tops of beams (ie beam downstands throughout) with an insitu power floated concrete topping. No raised floor or screed.
- The drama area is required to have a floor matting finish, of up to 20mm thick. It is proposed to step the structural topping to suit FFL's, ie over the rest of the building the topping will be 20mm thicker than structurally required in order to keep FFL's the same.
- Some transfer beams are required to transfer column positions through the building.
- Steel sizes are given on accompanying sketches, options are provided for minimum depth beams (costlier / heavy) and minimum weight beams (lighter / deeper).

- Given the large grid some beams are of significant size: the largest is 533x210x92 UB (min weight) or 305x305x198 UC (min depth).
- Building is Class 2B in respect of disproportionate collapse (as defined in Part A3 of Building Regulations). This means planks and trusses will require to be positively tied to all edge floor beams. Planks could be tied via in situ RC edge strips joining rebar cast into slots in the planks to shear studs on the beams. Roof structure to be bolted at regular centres to steelwork.

The roof comprises an arrangement of duo-pitched wings surrounding a flat roofed central area. Pitched roof finishes are to be traditional alumminium deck warm roof system (Euroclad). Flat roofs to be finished in roofing felt. Options have been provided for internal pitched roof spaces with ceilings and without.

Option 1 – roof trusses with ceiling

- Sketches indicate proprietary timber trussed rafters at 600mm centres of various types: simple spans of about 8.5 and 9m, and one of 9m span, but supported at 6.5m centres with a 2.5m cantilevering overhang. This forms the column-free entrance canopy. Bottom truss chords raised up from eaves slightly.
- Timber truss manufacturers have confirmed this is possible and indicative designs are awaited from them.
- Alternatively any form of proprietary metal truss would be equally applicable.

Option 2 – no ceiling

- Roof frames on grid positions comprising hot rolled steel cranked frames with Detan proprietary feature tie and anti-sag rods and connection discs. These would be fairly cheap and easy to fabricate but would have some aesthetic quality.
- Purlins as required – either hot rolled steel beams supporting timber joists (as drawn) or more closely spaced cold formed metal purlins supporting a metal deck.

Flat roofs to be structured with eco-joists (metal lattice web between timber chords).

All roof decking (ply or metal) to act as diaphragms to stabilize the building against lateral wind and notional forces. Connections need to be formed between supporting beams and decking via many small diameter fixings (eg tek-screws) at closely spaced centres.

All internal and external walling is to be formed of cold formed metal stud partitioning. Allow for 150mm deep studs for external walls at 600mm centres (designs to be checked). In some areas wind posts may be needed around large openings, or secondary steelwork to curtain walling.

Internal walls will likely be 100mm studs at 600mm centres, subject to design checks.

Based on current outline designs, steel weight is working out at 35-40kg/m^2 of floor area, generally based on minimum weight (deep) beam section sizes. If minimum depth beams are used this may increase. Based on total floor area of 2No floors x 840m^2, gives total steel tonnage approx. 60T. Contractor to add on another 10% contingency to allow for detailing, connections etc.

This figure does not include any secondary steel nor any cold formed steelwork for purlins, studwork or lattice trusses (although does include for the tied roof frames that have been schemed).

4.0 SUBSTRUCTURE DESIGN

Hydrock geotechnical have just completed the site investigation survey (23rd May 2013) which comprised trial pitting, soakaways and contamination sampling and testing.

The final report will not be due for some time, but initial feedback is as follows:

- Topsoil and made ground generally to about 0.5m
- Clayey/cobbly limestone, becoming very stiff at about 1m (essentially “brash” material)
- Limestone became too stiff to dig with a JCB at about 1.2m depth.
- Soakaway tests were done but did not work at all due to the clayey component to the brash.
- No obvious signs of ground contamination noted, although test results are awaited.

The implications on the substructure design are likely to be as follows.

- Building foundations will be shallow spread footings. There will be good bearing properties at fairly shallow depths, but quite large foundation loads. Say for example, if bearing capacity is 200kN/m^2 and column load is about 500kN, then pad would be about 1.6m square. To minimize a difficult dig through the limestone, it is suggested that pads are kept shallow and thin, ie 0.45-0.6m thick, in which case they would be reinforced with a cage of cut/bent loose reinforcement (which could be pre-fabricated).
- Ground floor can be a ground bearing slab.
- Requirement for radon protection is not yet known. Advice will be included within the final report.
- It is hoped that ACEC class will be low in regard to grade of concrete required in the ground. Testing is however awaited.
- Soil will likely exhibit low volume change potential.

5.0 BELOW GROUND DRAINAGE DESIGN

Some limited initial review work has been undertaken in so far as held information will allow. Points to note are as follows.

- A site topographical survey has been received with only partial information relating to below ground drainage levels. Many invert levels and pipe information has not been given.
- Topographical surveyors were not able to prove all connections, and some blocked manholes were discovered with outfall pipes not identified
- Drainage that was surveyed around the proposed buildings was generally found to be quite shallow.
- There are suspected foul and surface water pumped rising mains shown.
- An adopted sewer is located across the large lawn in front of the existing main building, which is lower in level than the location of new building (by about 1-1.5m). However topographical survey has not picked up invert levels of adopted drainage, so it is not known if it will provide a gravity outfall connection in the absence of a nearer existing run at convenient level.
- Apparently the adopted sewer crossing the site in front of the school was installed as enabling works for a possible housing development that never happened. It therefore has a large capacity, although depth is not known.

Since survey work has identified that soakaways are unlikely to work at the site there remains a risk that so far existing connectivity to outfall has not been proven. Clearly further survey and review work will need to be undertaken by Hydrock/Kier.

6.0 DESIGN LOADINGS

The following loadings have been assumed in the structural design.

	D (kN/m^2)	L (kN/m^2)
ROOF		
EuroClad	0.20	

Battens / Insulation		0.02	
Timber truss		0.30	
Services		0.25	
Ceiling		0.15	
Live			0.60
Total		**0.92**	**0.60**
Total working	**1.5 kN/m^2**		
Total ultimate	**2.3 kN/m^2**		

Flatroof felt finish		0.25	
Battens / Insulation		0.02	
Timber rafters		0.25	
Services		0.25	
Ceiling		0.15	
Live			0.75
Total		**0.92**	**0.75**
Total working	**1.7 kN/m^2**		
Total ultimate	**2.5 kN/m^2**		

FIRST FLOOR

Classroom

Finishes/Raised flr		0.10	
Structural Slab inc. topping		4.50	
Services		0.25	
Acoustic panels		0.01	
Live			3.0
Partitions (TBC)			1.0
Total		**4.86**	**4.0**
Total working	**8.9 kN/m^2**		
Total ultimate	**13.2 kN/m^2**		

Circulation

Finishes/Raised flr		0.10	
Structural Slab inc. topping		4.50	
Services		0.25	
Acoustic panels		0.01	
Live			4.0
Total		**4.86**	**4.0**
Total working	**8.9 kN/m^2**		
Total ultimate	**13.2 kN/m^2**		

Dance/Drama

Finishes/Raised flr		0.10
Structural Slab inc. topping		4.50
Services		0.25
Acoustic panels		0.01

Live		5.0
Partitions (TBC)		1.0
Total	**4.86**	**6.0**

Total working **10.9 kN/m^2**
Total ultimate **16.4 kN/m^2**

WALLS

Internal:	
Metsec SFS	0.50
Plaster board	0.30

Total working **0.8 kN/m^2 elevation**
Total ultimate **1.1 kN/m^2 elevation**

7.0 HEALTH AND SAFETY RISKS

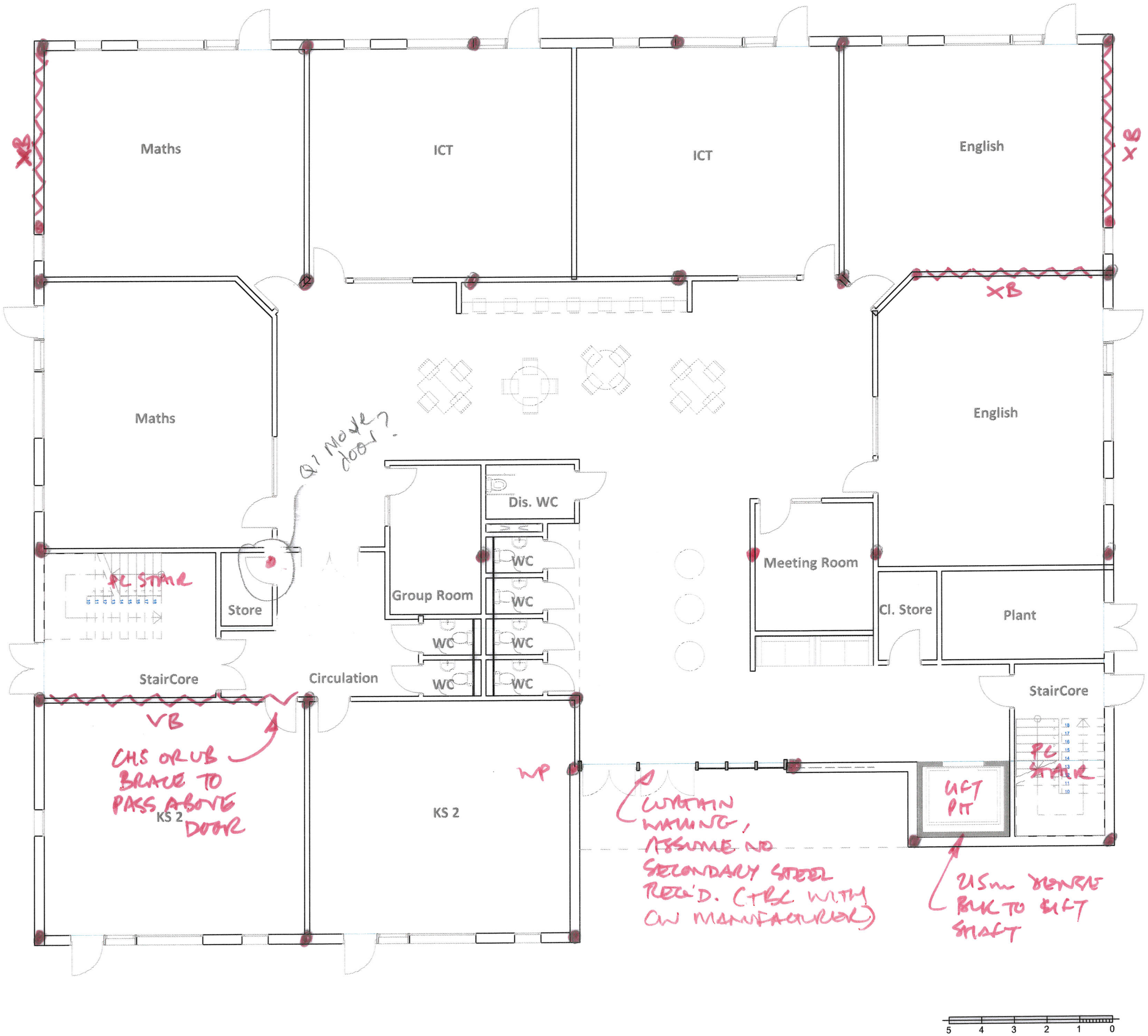
- Heavy beams – the largest min depth option is 305x305x198 UC x 9m = 1.8T
- Heavy planks – typical worst case 7m span x 1.2m wide x 150mm thick unit @ 300kg/m^2 = 2.5T
- Working within live school
- Traffic management – existing traffic will conflict with construction traffic and pupils/staff. Circulation to be amended to make safe.

8.0 FINANCIAL RISKS

- Shallow drainage nearby, deeper adopted sewer further away: this may mean drainage options may involve pumping or long runs. Further investigations required.
- Ground contamination – awaiting test results
- Designs to be progressed through the planning process in order to meet start on site of Autumn 2013. Risk of abortive work if changes are required.

9.0 FURTHER SURVEYS

- Further leveling of drainage and connectivity required to inform designs.
- Final geotechnical / geoenvironmental site investigation report awaited
- Possibly WAC testing



XB - VERTICAL CROSS BRACING FLAT PLATES

VB - VERTICAL SINGLE BRACING UB OR UC OR CHS.

WP WIND POST

● COLS - ASSUME 203 UC / 152 UC - AVE 45 kg/m.

B1	-	305 x 165 x 40	UB	OR
		203 x 203 x 71	UC	
B2	-	305 x 165 x 54	UB	OR
		205 x 203 x 86	UC	
B3	-	200 x 200 x 6.3	SHS	
B4	-	356 x 171 x 51	UB	OR
		254 x 254 x 89	UC	
B5	-	254 x 146 x 37	UB	
B6	-	305 x 127 x 37	UB	OR
		203 x 203 x 52	UC	
B7	-	203 x 133 x 25	UB	
B8	-	457 x 191 x 82	UB	OR
		305 x 305 x 137	UC	
B9	-	533 x 210 x 92	UB	OR
		305 x 305 x 198	UC	
B10	-	406 x 178 x 54	UB	OR
		254 x 254 x 107	UC	

GROUND FLOOR PLAN

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t 0117 945 9225

Drawn : RB
Job : SPRINGFIELD ACADEMY
Sketch No : C13267 / SK02
Date : MAY 13
Rev : P2

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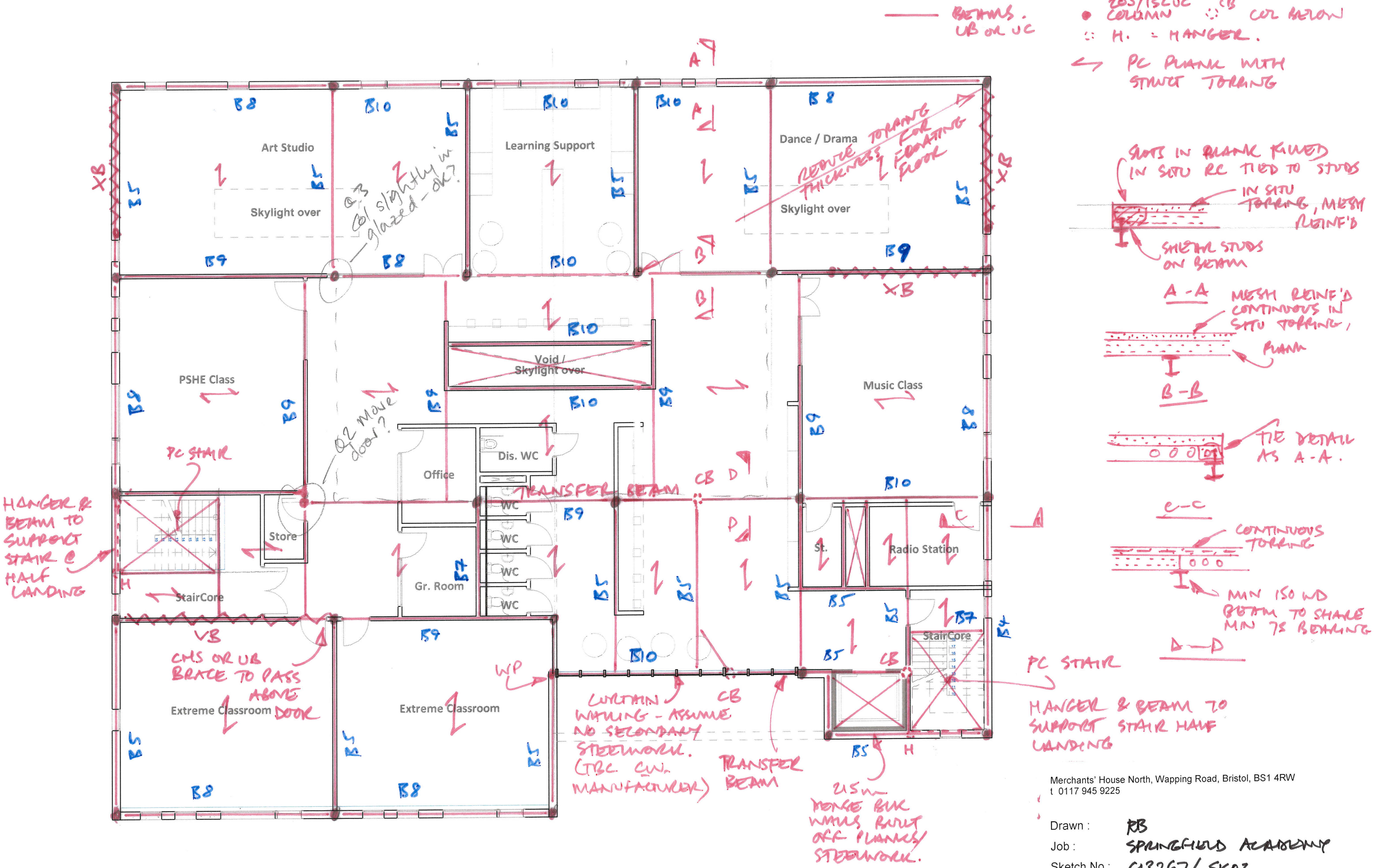
P2 22/5/13 MEMBER SIZES ADDED
Rev. P1 17/5/13 Indicative for comment.



Merchants' House North, Wapping Road, Bristol, BS1 4RW
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Drawn : RB
Job : SPRINGFIELD ACADEMY
Sketch No : C13267/ SK03
Date : MAY '13
Rev : P2

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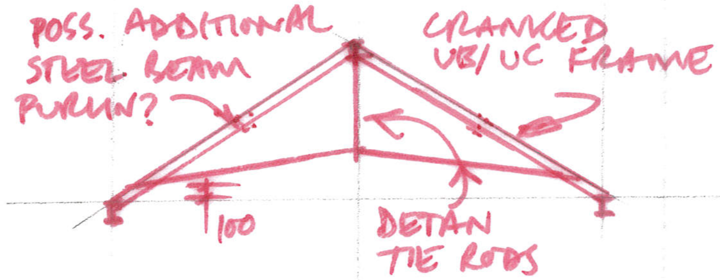
FIRST FLOOR PLAN

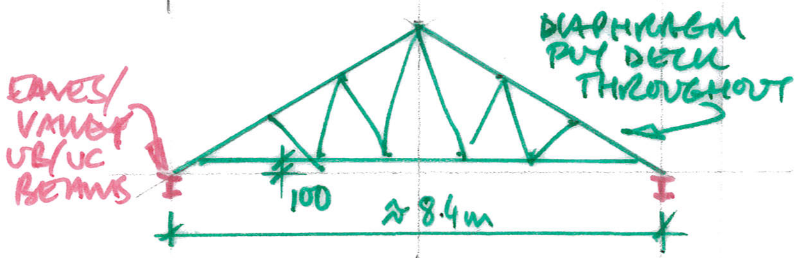
P2 23/5/13 MEMBER SIZES ADDED
Rev. P1 17/5/13 Indicative for comment

↔ SPANNING ROOF STRUCTURE OPTIONS:

- S.W. SQUARE CUT RAFTERS
- COMPOSITE PANELS

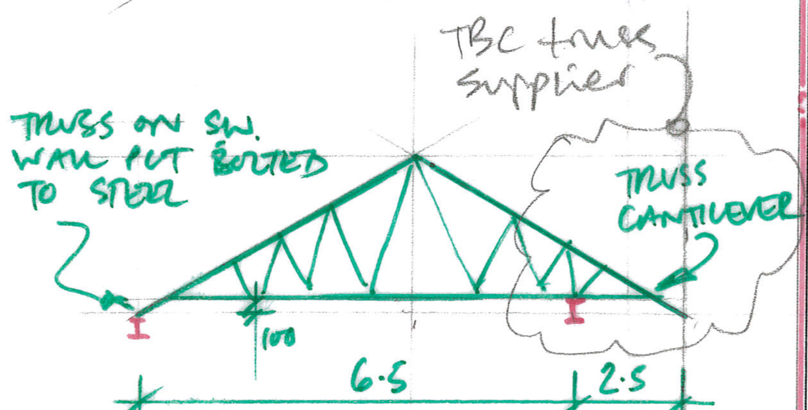


ROOF FRAME 'RF'
FEATURE FRAME



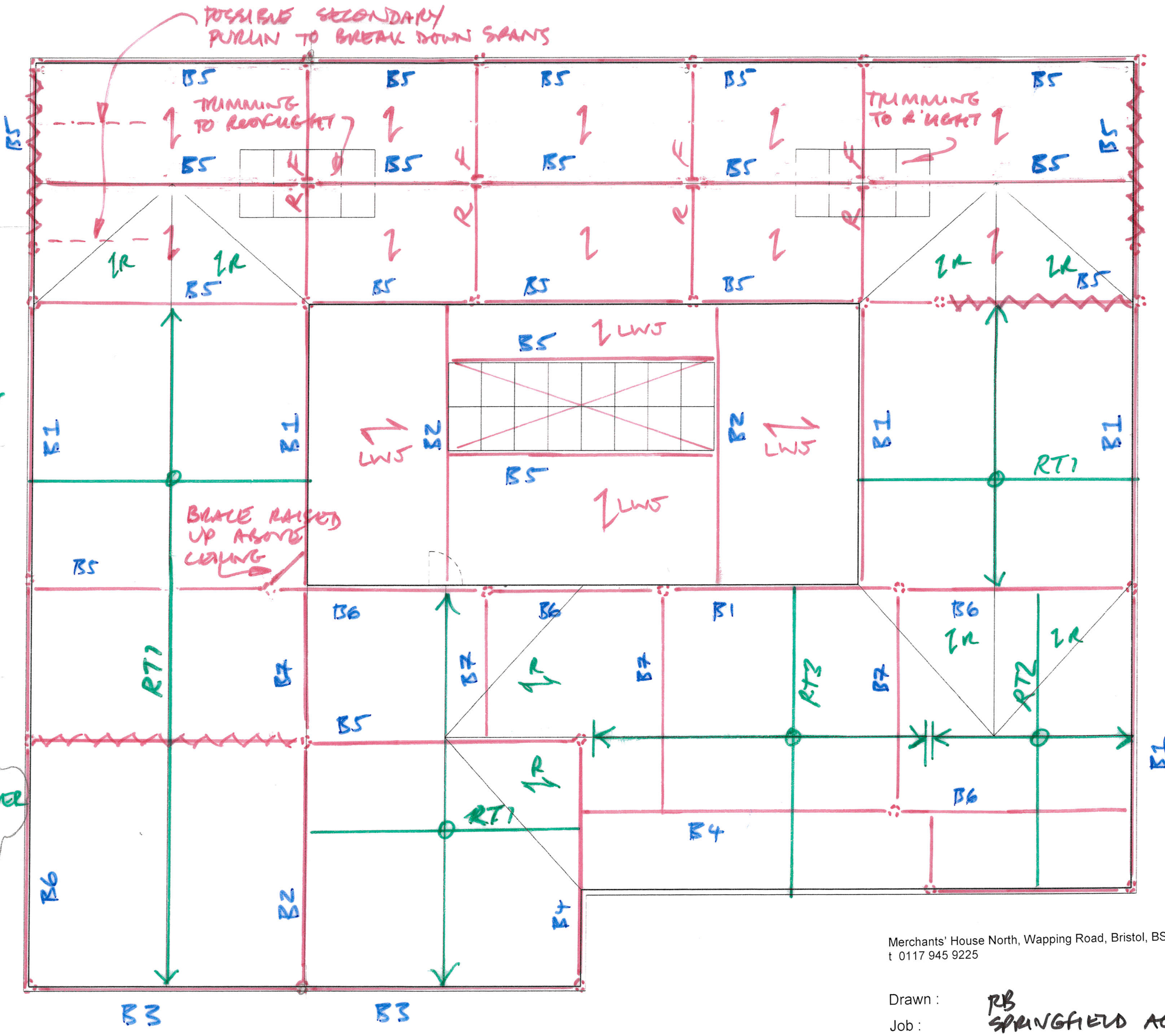
ROOF TRUSS RT1

ROOF TRUSS RT2 SIMILAR, BUT SPAN APPROX 9m.
TRUSSES @ 600mm c/c
TIMBER PROPRIETARY TRUSSES



ROOF TRUSS RT3

↔ LWJ LATTICE WEB JOISTS WITH PLY DECK DIAPHRAGM



ROOF PLAN

Merchants' House North, Wapping Road, Bristol, BS1 4RW
t 0117 945 9225

Drawn : RB
Job : SPRINGFIELD ACADEMY
Sketch No : 43267 /SK04
Date : MAY 13
Rev : P2

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P2 22/5/13 MEMBER SIZES ADDED
Rev. P1 17/5/13 Indicative - for comment