THE USE OF AUTHENTIC ASSESSMENT IN CDIO PROJECT

Yina Chua

Singapore Polytechnic, Singapore

ABSTRACT

In engineering education, it is of great concern that students may not be capable of transferring the skills they have gained from their education to real-world problems. The industry is also encouraging the Polytechnics to expose students to multifaceted, complex problems where there are no fixed standard answers to one problem. These apprehensions have given rise to the use of authentic assessment in CDIO for the Year-3 module Structural BIM eSubmission in the Diploma in Civil Engineering with Business. These paper aims to discuss the use of authentic assessment in CDIO project in the module Structural BIM eSubmission and how it can help to prepare students for the industry by providing opportunities for them to use the knowledge gained from the 35 modules they learned over the last two years to work on a real-world project (three-storey high bungalow house), a CDIO project through the stages of Conceive-Design-Implement-Operate. Authentic assessment is infused into this project, aiming to achieve the four elements highlighted by Gulikers et al. (2004) as follows:
(a) product and performance produced in real-life
(b) making valid inferences
(c) a full array of tasks and multiple indicators of learning
(d) presentation of work
This paper also discussed the potential of the CDIO project with an authentic assessment to adequately assess all the capacities and outcomes we want to recognise and help in student's learning and its success factor for implementation. AA has the potential to adequately assess all the capacities and outcomes we want to recognise and helps in student's learning. We should work towards minimising the impact of the above-discussed problems because, at the polytechnic level, we have more valid reasons, resources, and support from the industry to drive AA.

KEYWORDS:

Civil Engineering, Authentic Assessment, Standards 2, 3, 7, 8, 9, 11

INTRODUCTION

In engineering education, it is of great concern that students may not be capable of transferring the skills they have gained from their education to real-world problems. The industry is also encouraging the polytechnics to exposed students to multifaceted, complex problems where there are no fixed standard answers to one problem. Exposure to real-world problems promotes critical thinking, problem-solving skills, and team working skills. These life-skills are a necessity in the industry. With the technological revolution, the availability of information online is also changing the way our students learn. It may no longer be adequate to just provide engineering students with a sound technical knowledge foundation in 21st-century engineering education. Schools need to foster effective, integrative learning of scientific knowledge and the development of professional skills and attitudes that may assist future engineers' practice. Archibald and Newmann (1998) acknowledged that "traditional tests" neglect the type of competencies required to deal with problems successfully beyond school. These apprehensions have pushed for the need to use of authentic assessment in CDIO for the Year-3 module Structural BIM eSubmission in the Diploma in Civil Engineering with Business.

The module Structural BIM eSubmission aims to prepare students for the industry by providing opportunities for them to use the knowledge gained from the 35 modules they learned over the last 2 years to work on a real-world project (three-storey high bungalow house), a CDIO project through the stages of Conceive-Design-Implement-Operate. Authentic assessment is infused into this project, aiming to achieve the four elements highlighted by Gulikers et al. (2004) as follows:

(a) product and performance produced in real-life
(b) making valid inferences
(c) full array of tasks and multiple indicators of learning
(d) presentation of work

LITERATURE REVIEW

An authentic assessment (AA) allows students to explore, discuss, and meaningfully construct concepts and relationships in contexts that involved real-world problems and projects that are relevant to the learner (Donovan, Bransford & Pellergino, 1999). This will allow the students to see the purposes of why they are learning certain modules and integrate what they have learned into use. More importantly, for Polytechnic education, AA should and can help in developing professional competencies, skills, and attitudes required for a particular discipline or industry, as highlighted by Newmann & Associates (1996) and Wiggins (1993). Furthermore, it is imperative for engineering education to expose students to complex, open-ended, and ill-structured real-life problems to encourage higher-order thinking processes. It is also critical that the AA is aligned with real-world expectations (Biggs, 1996; Linn, Baker & Betebenner, 2002). Gulikers, Bastiaens & Kirschner (2004) and Messick (1994) have also highlighted that when the assessment setting simulates the professional practice, students will innately cultivate professional competencies and skills which are relevant and prepare them for their future career. It can then be argued that AA can help to prepare them for the industry because as emphasized by Newmann & Associates, (1996) and Messick (1994) AA focus on simulating the real-world and will probably cover the relevant aspects of the required work performances and competencies of the particular profession.

Several theories and criteria have been proposed for AA; for example, Newmann, Marks, and Gamoran (1996) have defined the construction of knowledge, disciplined inquiry and value beyond school as the key criteria whereas Wiggins (1993) has identified 9 comprehensive criteria for AA which include perceivable performances.

In line with Newmann et al. (1996) and Wiggins (1993), Gulikers et al. (2004) stressed that the level of authenticity of AA depends greatly on the level of correspondence to the professional practice. Students are expected to employ and exhibit a similar kind of skills, competencies, attitudes, and construction of knowledge like a professional when AA is being adopted (Gulikers et al., 2004). In addition, Cronin (1993) and Newmann & Wehlage (1993) have emphasized that authenticity should be conceptualised as a continuum and a dimensional construct.

The other benefit of AA is the ability to actively involve students and touch their intrinsic motivation (Mehlinger, 1995). This is important for civil engineering students as most of the students did not choose this course as their first choice; hence motivating them intrinsically will enhance their learning. Furthermore, intrinsic motivation is one of the key pedagogy adopted by our course.

AA is multi-facets and the five-dimensional framework by Gulikers et al. (2004) which includes, tasks; physical context; social context; form and criteria is comprehensive and has been studied on vocational education, which yields positive results. Therefore, the proposed AA will be adopting the Gulikers et al. (2004) five-dimensional framework.

DESCRIPTION OF AA IN A CDIO PROJECT

Design of Task

Authentic Assessments are tasks that are either replica of or analogous to the kind of problems faced by adult citizens and consumers or professionals in the field, and these tasks simulate or replicate the diversity and richness of the context of performance (Wiggins, 1993). The high level of authenticity is achieved by adopting a real project in the industry. The set of architectural drawings given to the students is a bungalow house that has been built in Singapore. To increase the genuineness and reflecting the real-world, each group will be given a different set of architectural drawings of the same level of difficulty. Students are required to analyse, calculate, and design the structures of the bungalow house, which need to meet the Architectural, Building Construction & Authority, and the client's requirements. This ill-structured, complex and relatively open-ended tasks encourage diversification and a real-world feel which expose students to the messiness of real-life decision making, where there may not be a right or a wrong answer per se, although one solution may be better or worse than others depending on the particular context (Lombardi, 2007). Thus providing students the opportunity to perform structural design tasks akin to a design engineer where their performance represents the construction of knowledge through the use of disciplined inquiry that has some value or meaning beyond success in school (Newmann, 1997). The task requires them to go through the 4 stages of CDIO, which they need to tap on prior knowledge, established relationships by integrating and linking between fragments of knowledge, multiple concepts to construct intellectual comprehension of the task to create and devise a structural layout plan for the bungalow house. The students are given full ownership of the bungalow house design, where they have to interpret the set of architectural drawings to draw conclusions on the architectural requirements.

Task's Brief:

In a group of 4, students are given a set of architectural drawings (Appendix A). The set of drawings is an architectural floor plan which helps to convey the architectural ideas and concepts of the architectural design. The first and second storey floor plan shows the arrangement of spaces, walls and its material, windows, types of door and its openings, and other features of that particular level of the bungalow house. The elevations view of the bungalow house shows the profile of the side, the floor to ceiling height, wall height, staircase height, and design and other information not found on the floor plan. The students are required to design the structural elements of the house to meet the architecture, client, and authorities requirements. The task is split into three submissions, as shown in Appendix B. In this essay, only submission 1 will be used for discussion of rubrics.

CDIO Stages

For submission 1 (Conceive), the students are required to design and produce the structural floor plans for the bungalow house. They are required to submit both hardcopy and softcopy of their 2D drawings and Revit 3D-model for footing plan, 1st storey structural plan, 2nd storey structural plan, and structural roof plan. The main construct is house design, which is unpacked to the various criterion such as synchronizing architectural requirements in their structural floor plan, structural design, and compliance to authorities' requirements.

For submission 2 (Design & Implement), the students are required to exact information from their submission 1 in order to design and determine the sizes of the structural elements. They are required to submit the structural design and detailed calculations for the structural elements which must comply with the Eurocode 2 and Singapore code of practices.

For submission 3 (Implement & Operate), the students are required to model their structures into smart 3D using a BIM tool. This allows them to identify structural clashes and unrealistic structural sizes. The 3D model also serves as a preliminary form of operation as it can show if the building is visually safe.

Physical Context

The task requires them to design a structural layout plan which complies with the regulatory requirements by Building Construction Authority (BCA), the architectural requirements, and the client. The high contextual fidelity of the task offer students plenty of opportunities to perform like a design engineer where they have to engage structural analyse tools, Revit modeling software to model the bungalow house in 3D, and referencing to Singapore code of practices. The time given for them to finish the task is about 3 weeks. As pointed out by Wiggins (1993), the constraints need to be realistic, and hence we sufficient time was allocated for the students to complete the task, and the duration should be close enough to simulate what the real-world duration is like.

The objective is to provide an educative experience (bungalow house design principles and concepts) inherently valuable to students because they can see the relevance to their future life as an engineer and the purpose in learning and how the knowledge gained in Polytechnic is transferred into solutions for the real-world problem. This objective answers one of the important issues of AA raised by Baker & O'Neil (1994), which is authentic to whom?

Social Context

In reality, design engineers do work as a team and sometimes as an individual depending on the scale of the project. For this task, the students will work as a group comprising of 4 members. The rationale of choosing group work over individual work is due to the high complexity of the task. The group work may provide more opportunity for in-depth work which mimic a more real-world experience compared to typical course work. (McCorkle, Reardon, Alexander, Kling, Harris, & Iyer, 1999). Students working in groups will also engage in extended conversational exchanges with the lecturer or their peers about the subject matter in a way that builds an improved and shared understanding of ideas or topics (Newmann, 1996). Research by Johnson, Johnson & Smith (1998) and Springer & Donovan (1999) has also shown that collaborative learning improved learning relative to individual work for students in science, mathematics, engineering, and technology. Each group is required to meet the lecturer on a weekly basis for consultation – design review. In the real situation, the team of engineers usually are required to meet their professional engineer (PE) on a weekly or bi-weekly basis to review their design, which we termed as "design review" in the industry. During the consultation session, the lecturer will have to play multiple roles as "client" and "PE." The lecturers will only be providing his views, feedbacks, and needs as a client or as a PE and will not provide any answers and solutions to the students. The students are the designer of their learning, and the facilitator should not take power away from them. To further enhance the authenticity of a real consultation, an architect will be engaged to sit in the consultation sessions. The consultation session will also fit nicely with Wiggins's (1993) 6th criteria, where the interaction is important between the lecturer, architect, and the students. These consultation sessions serve as a platform for the assessee (students) to justify their choices with reasons and for the assessor (lecturer & architect) to ask questions and probe further to identify the student's depth of mastery and to enhance their learning.

Assessment Result or Form

The assessment result of the task consists of the four elements highlighted by Gulikers et al. (2004). The four elements are, (a) product and performance produced in real-life - the set of structural floor plans and the structural and architectural technical skills; (b) making valid inferences – the ability to do residential structural design; (c) a full array of tasks and multiple indicators of learning – students will demonstrate learning through the product of task and through inquiry during consultation sessions and (d) presentation of work – present set of structural floor plans to lecturer and architect through oral, 2D and 3D drawings.

Criteria and Standards

The major concern of authenticity is that nothing critical has been left out of the assessment of the focal construct (Messick, 1994). Therefore, the assessment has been designed with Messick's (1994) construct-driven approach to minimise construct-irrelevant variance and construct underrepresentation. The three criteria, synchronizing architectural requirement, structural design, and compliance of technical detailing for authority submission, are derived from the predominant construct, which is the structural design of a bungalow house. SOLO taxonomy has been adopted as an instrument to assess quality. As claimed by Biggs and Collis (1982), SOLO taxonomy is the only instrument that offered to assess quality in an objective and systematic manner. The levels are structured from concrete to abstract, which helps to assess the qualitative learning outcomes and is a good reflection of the complexity of learning. When compared to Bloom taxonomy, SOLO's ability to enable students to progress from uni structural to relational and abstract thinking is more suitable for assessing open-ended responses, and it is more accurate in making valid interference. On the other hand, Bloom taxonomy may be more suitable for setting questions rather than evaluating responses.

Table 1: Rubric for Submission 1 (15%)

Performance Criteria/Task	**1 (Unistructural)**	**2 (Multistructural)**	**3 (Relational)**	**4 (Extended Abstract)**
Synchronizing architectural requirement (30%)	• Did not consider and analyse client's and architectural requirements. • None of the architectural requirements have been synchronized into the structural plan.	• Consider and analyse some (limited) client's and architectural requirements • Some of the architectural requirements have been synchronized into the structural plan.	• Consider and analyse majority of client's and architectural requirements. • Majority of the architectural requirements have been synchronized into the structural plan.	• Consider and analyse majority of client's and architectural requirements. • All of the architectural requirements have been synchronized into the structural plan.
Structural Design (40%)	• Structural design shows basic logical structural layout without efficiency consideration resulting in not being a cost-effective design.	• Structural design shows an intermediate logical structural layout with some efficiency consideration resulting in being a minimal cost-effective design	• Structural design shows a good logical structural layout with good efficiency consideration resulting in being a cost-effective design.	• Structural design shows an excellent logical structural layout with excellent efficiency consideration resulting in being a very cost-effective design.
Compliance of technical detailing for authority submission (30%)	• Do not comply with BCA authority submission requirement • Incorrect technical format used. (e.g., incorrect line types, incorrect line weight, etc.) • No technical symbols used to communicate structural details	• Comply with some of BCA authority submission requirement • Some of the technical format used is correct. (e.g., correct line types, incorrect line weight, etc.) • Minimal technical symbols used to communicate structural details	• Comply with the majority of BCA authority submission requirement • Majority of the technical format used is correct. (e.g., correct line types, correct line weight, etc.) • Extensive use of technical symbols used to communicate a majority of structural details	• Comply with all of BCA authority submission requirement • All technical format used is correct. (e.g., correct block layer, correct font type used, correct lines types used, etc.) • Complete usage of technical symbols were used to communicate all structural details

DISCUSSION

Even though there are many benefits of AA for our civil engineering students and the push from industry to expose students to real-world problems, many lecturers are not comfortable in adopting AA as the lecturers are not ready to accept those open-ended responses. As highlighted by Hargreaves, Earl & Schmidt (2002), the predominant cultural perspective is one of the biggest challenges for AA. Can the lecturer be comfortable as collaborators in the student's learning? For the longest time, our engineering education has been adopting convergent assessment where exams and tests dominate. The lecturers hold power in decision making, and they feel safe and secure when armed with a solution script. The solution script seems to give them that extra boost of confidence and power over the students. However, in the form of AA, the lecturer may feel insecure without an absolute answer to safeguard their ego and authority, or they may feel powerless. It can also be a big challenge to their confidence level in relation to their depth of knowledge, skills, and competencies of that particular domain. Are the lecturers ready to accept alternative solutions and students challenging their opinions? Lecturers need to know that their roles will have to change when AA is adopted. They are collaborators of learning and not the sole provider of knowledge. They need to have the kind of openness and confidence to facilitate students and co-learn in an AA setting.

Another potential problem to the power struggle posed by Hargreaves et al. (2002) is that lecturer may intentionally craft an AA task to have only one possible solution or intentionally guide students to the solution he/she preferred which did not comply with what Newmann et al. (1996), Wiggins (1993) and Gulikers et al. (2004) have highlighted that an AA task is open-ended and ill-structured. This intention is to fend off any scrutiny from the students. When a task is open-ended, the strategy for assessment changes and assessment may move in multi-directions. Are our lecturers ready to receive feedback on their practice to make improvements and enhance learning?

One other key factor that plays a critical role in the success of AA is the facilitation skills of the lecturer. If lecturers perceive AA as "the window into learning" (Earl & Lemahieu, 1997; Wiggins & McTighe; 1998, Broadfoot, 1996), they make positive use of the consultation session to give constructive feedback and identifying professional trades in student's performance to track the depth of their learning and stimulate them to be critical thinkers. However, assessment is more often used to categorise them rather than for learning. Some lecturers may fear inflation of grades when they facilitate their learning. This is especially true if the AA project weighting is more than 50% of the module. Therefore, when the assessment is perceived to categorize them into different grades, the lecturer may hold back in giving constructive feedbacks, which may hinder their learning.

Interaction between the assessor and assessee is one of the key criteria for AA highlighted by Wiggin (1993) to provide opportunities for the assessor to probe and inquire student's responses and for the assessee to justify their responses. In order to facilitate these during the consultation sessions, the lecturers need to spend a substantial time (about 30 minutes) with each group, and the lecturer must ensure each member of the group is given sufficient attention and time to respond and justify. This requires good time and group management from the lecturer to prevent anyone from dominating the session and to ensure each student is given equal opportunities for learning.

AA has the potential to adequately assess all the capacities and outcomes we want to recognise and helps in student's learning. We should work towards minimising the impact of the above-discussed problems because, at the polytechnic level, we have more valid reasons, resources, and support from the industry to drive AA.

CONCLUSION

The use of AA in the CDIO project in this module increases the richness of the context of the project, which allows students to dive deeper and explore beyond the superficial layer. The richness of the tasks enables the educator to play with the level of diversity and complexity. Instructions to the students should not be strict and complex as this will restrict exploration and promote spoon-feeding. Educators must encourage and accept various solutions. What educators usually overlook when designing the projects is that the project is too difficult, and the scope is too wide. Consider breaking up one big project into many goldilocks tasks. This will help to increase student's confidence because the tasks are attainable and not seem as impossible. During the enactment curriculum, the facilitators need to use inquiry-based techniques and avoid giving students the answers. To better facilitate, guide the students with guiding questions. Maybe some of our students may be frustrated because they only want the answers from us, but we give them a list of questions instead. Changing their mindset does take time; ultimately, they have been trained in the traditional education culture since their primary school days. Educators need to also take note of how to give effective feedback to the students during the consultation sessions, and feedbacks must also be given after each task has been assessed. This will help to minimise any missing gaps between students' learning. The consultation sessions are carried out in small groups; hence it will be more effective to be conducted during a three hours tutorial. The students thus far have been motivated because they are able to apply what they have learned to solve real-world problems. Educators can also explore the possibility of inviting external professionals to sit in the consultation sessions and give critique to their work. The next phase of the research could potentially study the effect of an external professional's critique on our student's motivation. In tertiary education, we are preparing students to be work-ready, and hence authentic learning approach can be one of the pedagogy to adopt to engage and motivate the students. Eventually, we are preparing them to be future engineers.

A survey has also been carried out at the end of the module to gather the student's feedback on the effectiveness of authentic learning implementation and their enjoyment level. Both quantitative & qualitative data were collected to analyse their experience on the use of AA in the CDIO project.

100% of the students have either agreed (25.8%) or strongly agreed (74.2%) that the project tasks have given them the opportunities to apply and integrate their prior knowledge rather than the reproduction of knowledge. Students are able to see the purpose of each module learned previously and how it can be applied to real-world problems.

100% of the students have either agreed (28.8%) or strongly agreed (71.2%) that the role they played as an engineer has allowed them to see the relevance with the industry. 97% of the students have either agreed (33.3%) or strongly agreed (63.7%) that the consultation session has helped to simulate a real-world working environment. 97% of the students have also either agreed (28.8%) or strongly agreed (68.2%) that the project tasks have prepared them for the industry and to be work-ready.

100% of the students have either agree (15.2%) or strongly agreed (84.8%) that the consultation session has provided them with effective support, guidance and have helped them scaffold their tasks. 98.4% of the students have either agreed (24.2%) or strongly agreed (74.2%) that the way the module is being conducted allows them to see the relevance with the industry and appreciate civil engineering and the building profession. 100% of the students have also either agreed (22.7%) or strongly agreed (77.3%) that the tasks they did in this module are important and beneficial to them. The students are able to see the purposes of the tasks that are being assigned to them. All of the students have either agreed (30.3%) or strongly agreed (69.7%) that through consultation sessions, they have managed to gain technical knowledge as well as teamwork and communication skills. 98.4% of the students have either agreed (27.3%) or strongly agreed (71.1%) that the consultation sessions have trained them to ask the correct questions rather than reply to the lecturer. In order for the students to ask the correct questions, they have to think through the solutions process and identify any queries that they have. 92.4% of the students have also either agreed (42.4%) or strongly agreed (50%) that they have participated actively during the consultation sessions by asking questions. Only 7.6% of the students felt that they did not ask a lot of questions. This could be due to the organization of the group where they consolidated the questions and was asked by one person in the group, or this can also mean that the students have thought through the solutions process and clearly understood what is required to be done.

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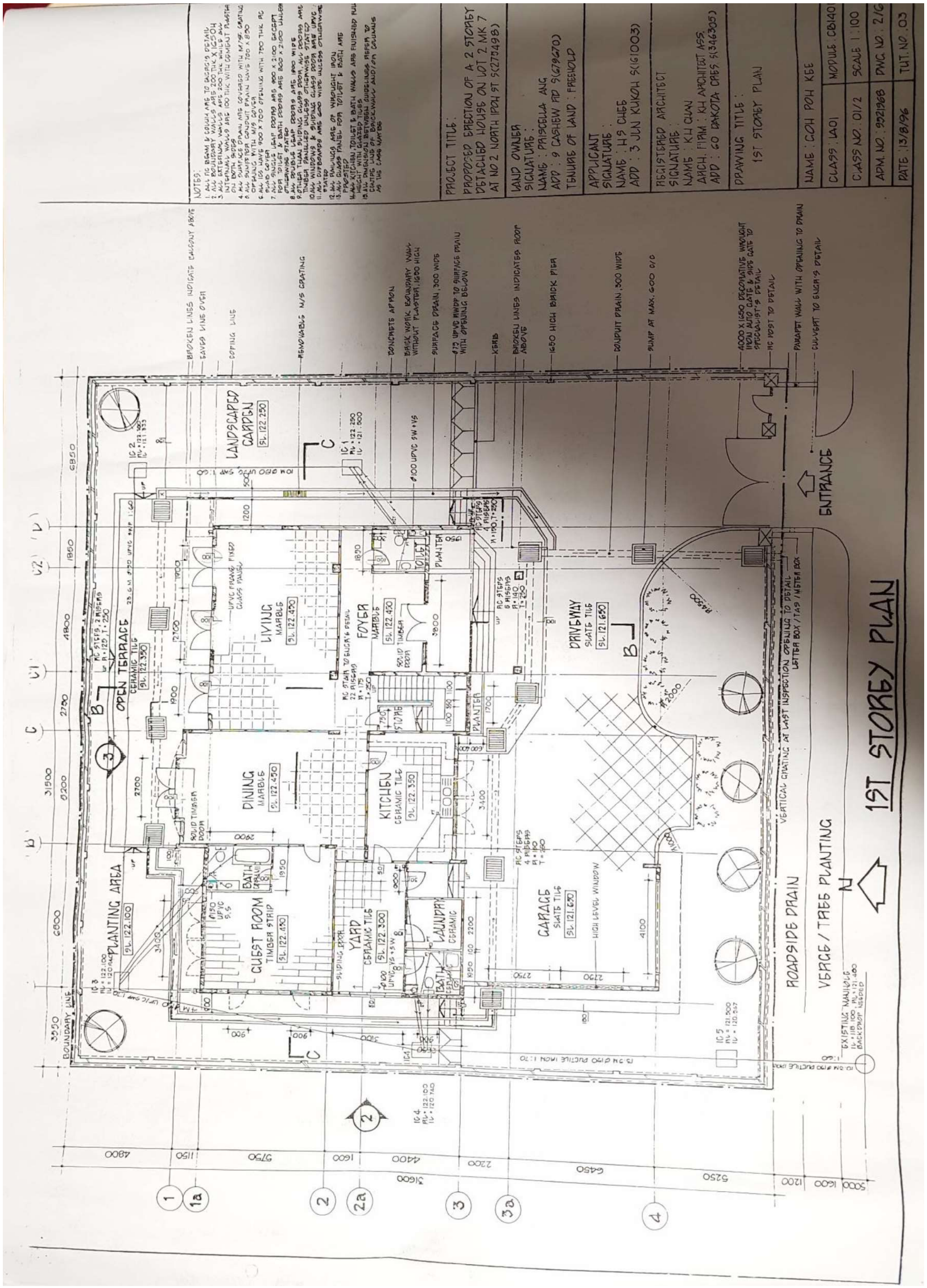
BIOGRAPHICAL INFORMATION

Yina Chua is a Lecturer of Civil Engineering, School of Architecture & the Built Environment, Singapore Polytechnic. Her expertise covers structural design, green buildings, and sustainability. Yina is also a Young Leader under the Built Environment Young Leaders Programme set up by the Building and Construction Authority (BCA). She has had actively involved and contributed significantly as a nominated attendee for the Built Environment Cluster Sub-committee. Yina has also won various teaching awards awarded by Singapore Polytechnic. As part of the teaching team of Civil engineering, She has actively contributed to the curriculum design, pedagogy, and the adoption of CDIO in the curriculum.

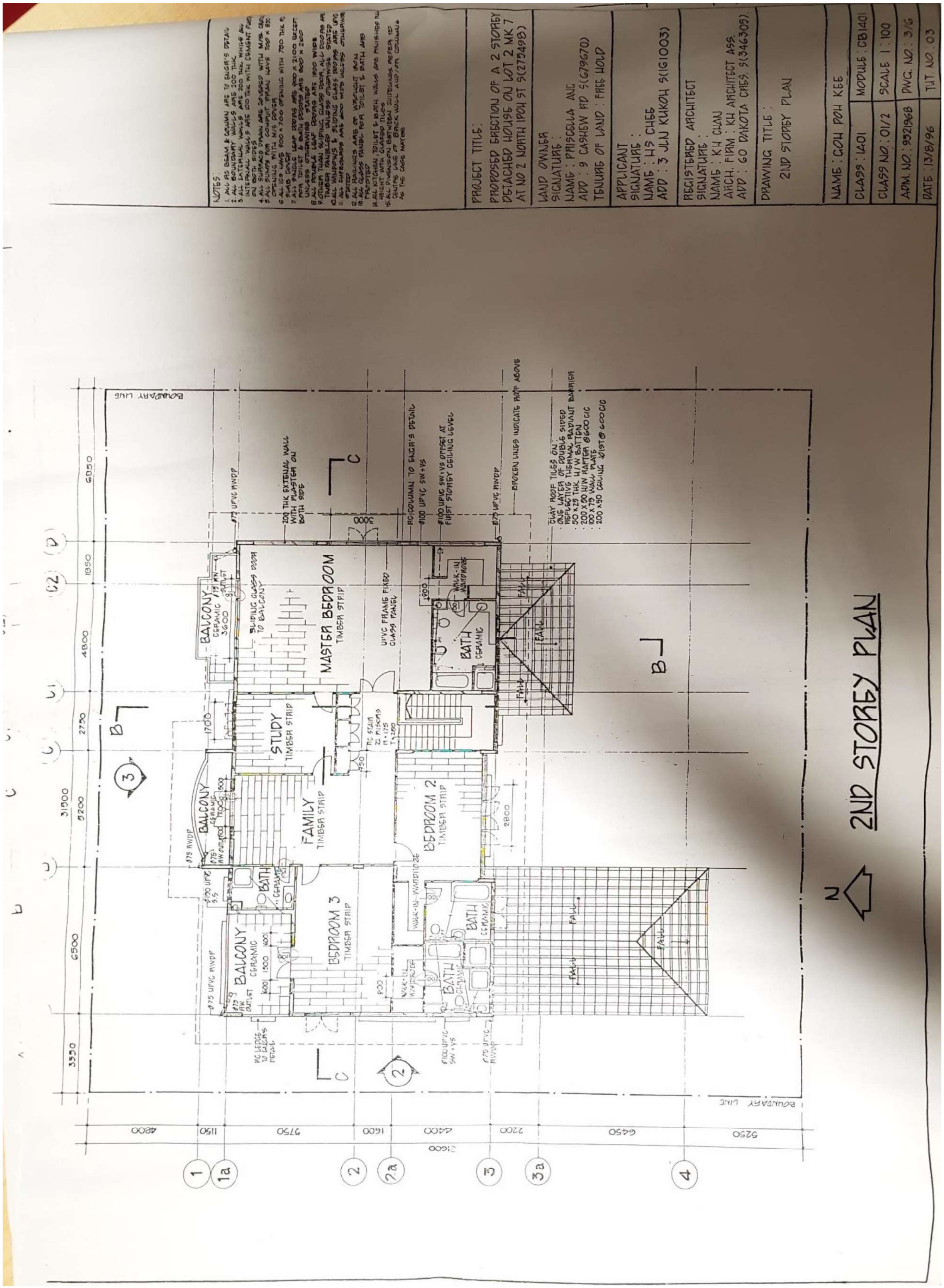
Corresponding author

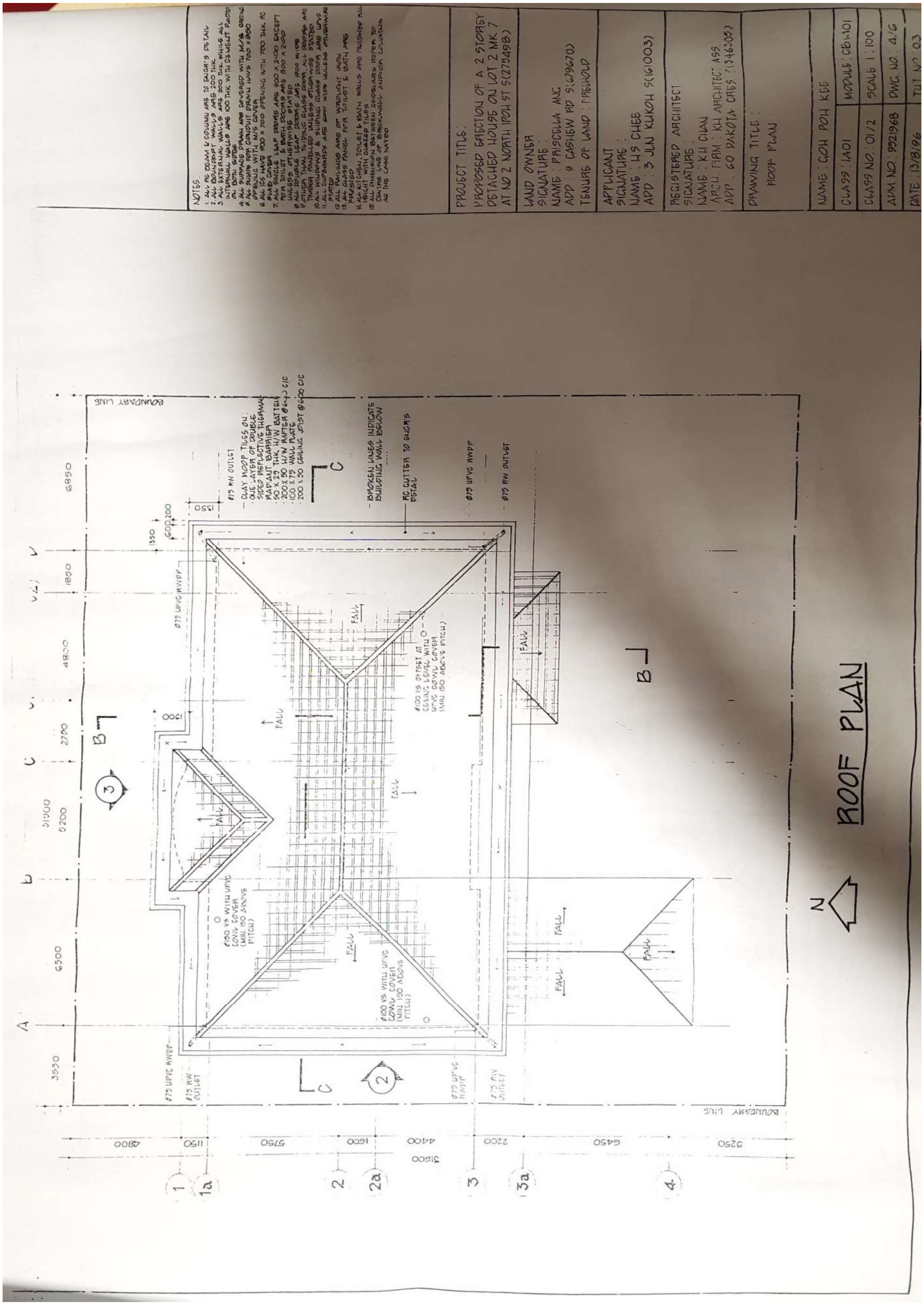
Yina Chua
Singapore Polytechnic
School of Architecture & the Built Environment
500 Dover Road Singapore 139651
+65 6772 1171
Yina_chua@sp.edu.sg
linkedin.com/in/yina-chua-9b8b54151

Appendix A



1ST STOREY PLAN
ENTRANCE
LIVING
DINING
FOYER
KITCHEN
GUEST ROOM
YARD
LAUNDRY
GARAGE
DRIVEWAY
OPEN TERRACE
PLANTING AREA
LANDSCAPED GARDEN
ROADSIDE DRAIN
VERGE / TREE PLANTING


2ND STOREY PLAN
MASTER BEDROOM
TIMBER STRIP
STUDY
FAMILY
BEDROOM 2
BEDROOM 3
BALCONY
BATH
CERAMIC
PROJECT TITLE:
PROPOSED ERECTION OF A 2 STOREY DETACHED HOUSE ON LOT 2 MK 7 AT NO 2 NORTH IPOH ST S(275498)
LAND OWNER
NAME : PRISCELLA ANG
ADD : 9 CASHEW RD S(679670)
TENURE OF LAND : FREE HOLD
APPLICANT
NAME : HS CHEE
ADD : 3 JLN KUKOH S(161003)
REGISTERED ARCHITECT
NAME : KH CHAN
ARCH. FIRM : KH ARCHITECT ASS.
ADD : 60 DAKOTA CHES S(346305)
DRAWING TITLE :
2ND STOREY PLAN
NAME : GOH POH KEE
CLASS : 1A01
MODULE : CB1401
CLASS NO : 01/2
SCALE 1 : 100
ADM. NO : 9521968
DWG. NO : 3/6
DATE : 13/8/96
TUT NO : 03


ROOF PLAN

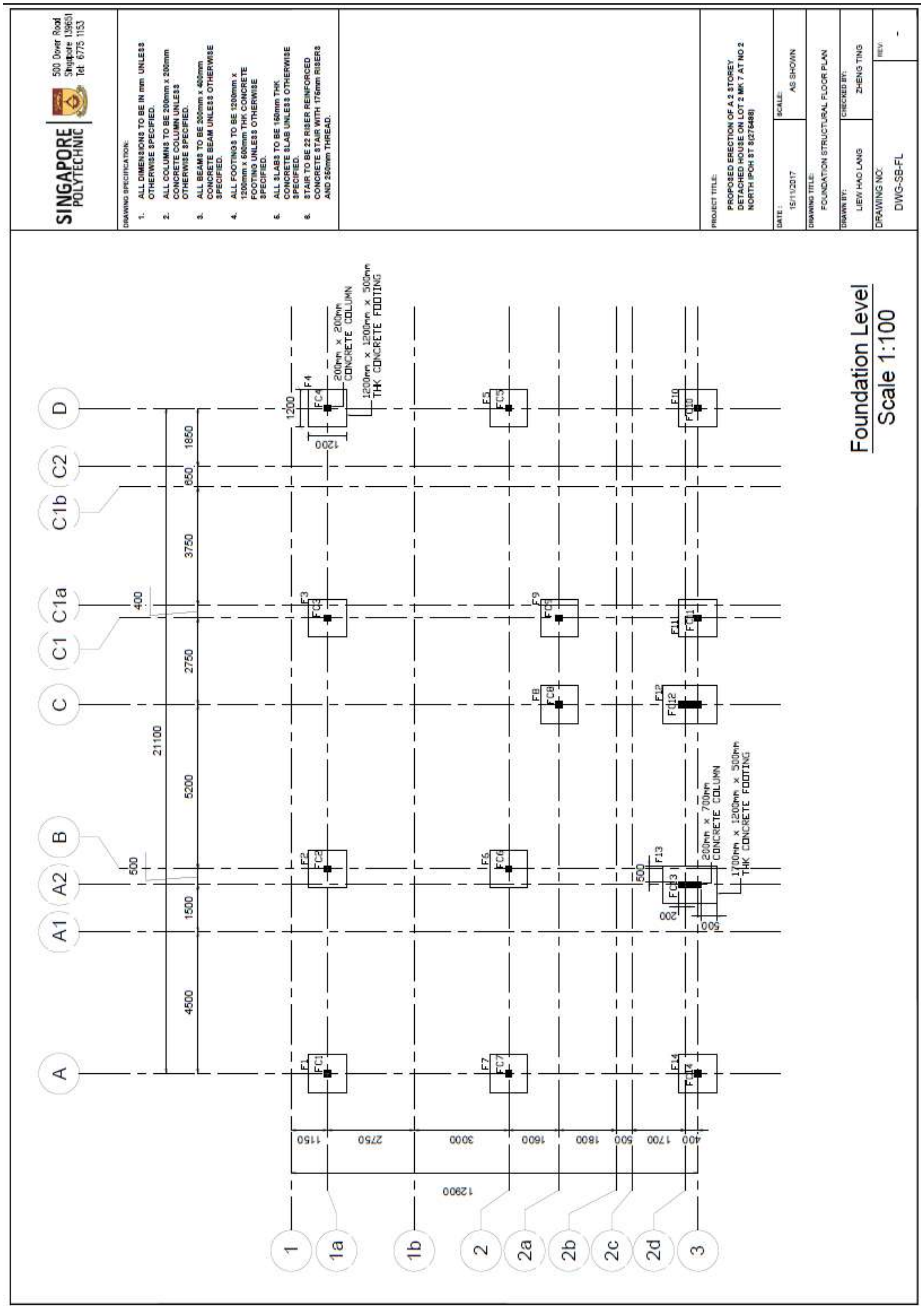
Appendix B

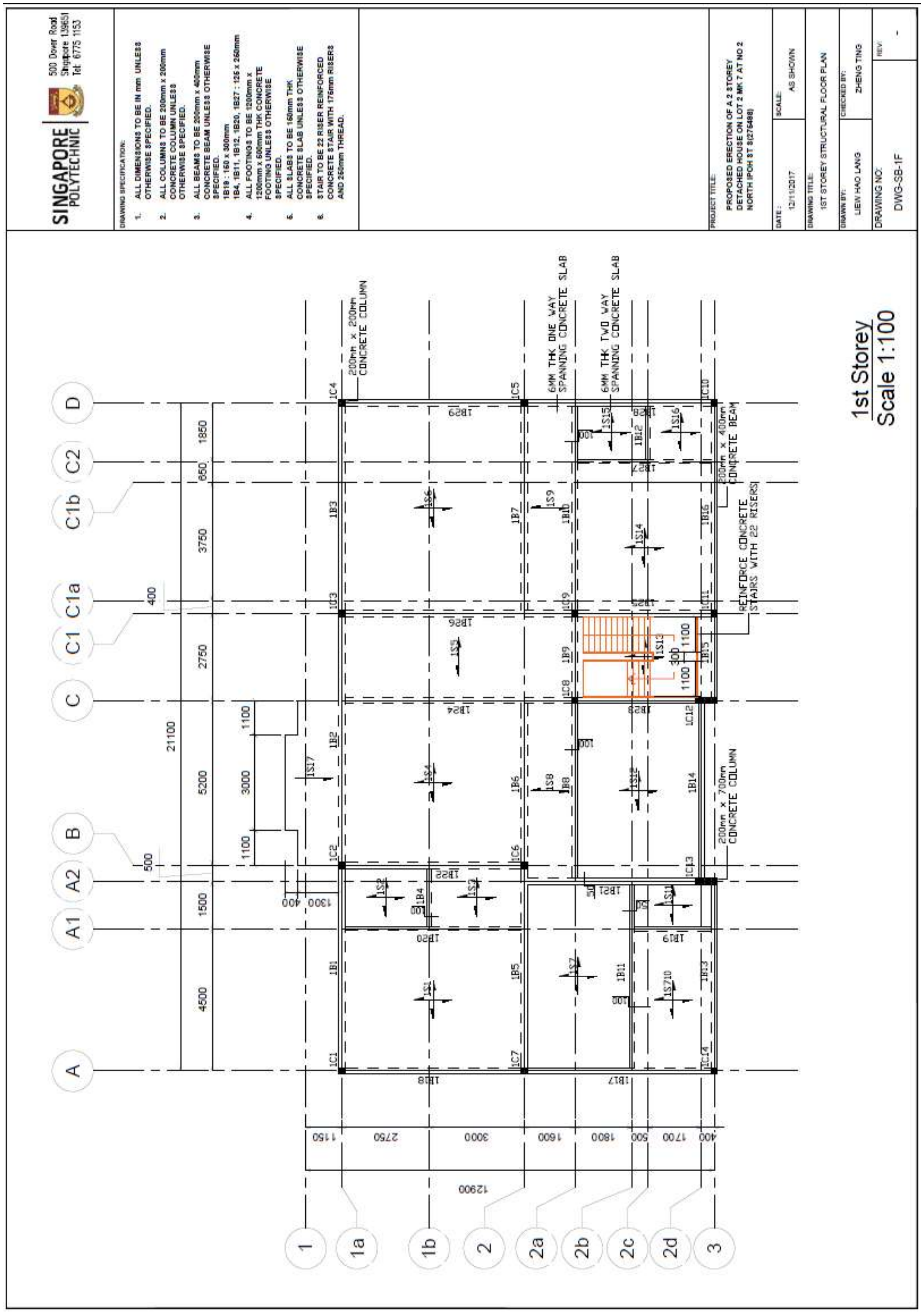
Project Tasks	Learning Outcomes	Learning Outcomes Rationale
Submission 1 (15%): Students are given a set of architectural drawings of a real bungalow house and are required to design and produce the structural floor plans for the bungalow house. They are required to submit both hardcopy and softcopy of their 2D drawings and Revit 3D-model : • Footing Plan, • 1st Storey structural plan • 2nd Storey structural plan • Roof structural plan	• To study the architectural drawing plan in order to understand what are the spaces used for and determine the position to place the structural elements such as columns and beams. • To configure the structural support system for their proposed structural plan.	• Students will have to view the tasks beyond their own discipline as a structural engineer. They must adopt different roles in order to think in cross-disciplines perspective. They must understand the perspective of an architect in order to ensure they meet the architect's requirements, and the structural elements do not pose any aesthetic issues. They must also understand the end-users needs of the bungalow. • Integrate prior knowledge and new resources and apply higher-order thinking by synthesising, hypothesising, and analysing to generate solutions.
Submission 2 (20%): Students are required to exact information from their submission 1 in order to design and determine the sizes of the structural elements. They are required to submit the structural design and calculations for: • Area method of load taking for 1 column • 1-way spanning span • 2-way spanning slab	• To analyse the structural floor plans submitted in submission 1 and to know what information to extract. • To design and determine the sizes and thickness of the structural elements and to ensure it meets all the requirements and code of practices for all relevant authorities.	• Students are required to apply and integrate knowledge gained in other modules from year 1 to year 3. • Students have to break down the task into sub-tasks before deriving the solutions.

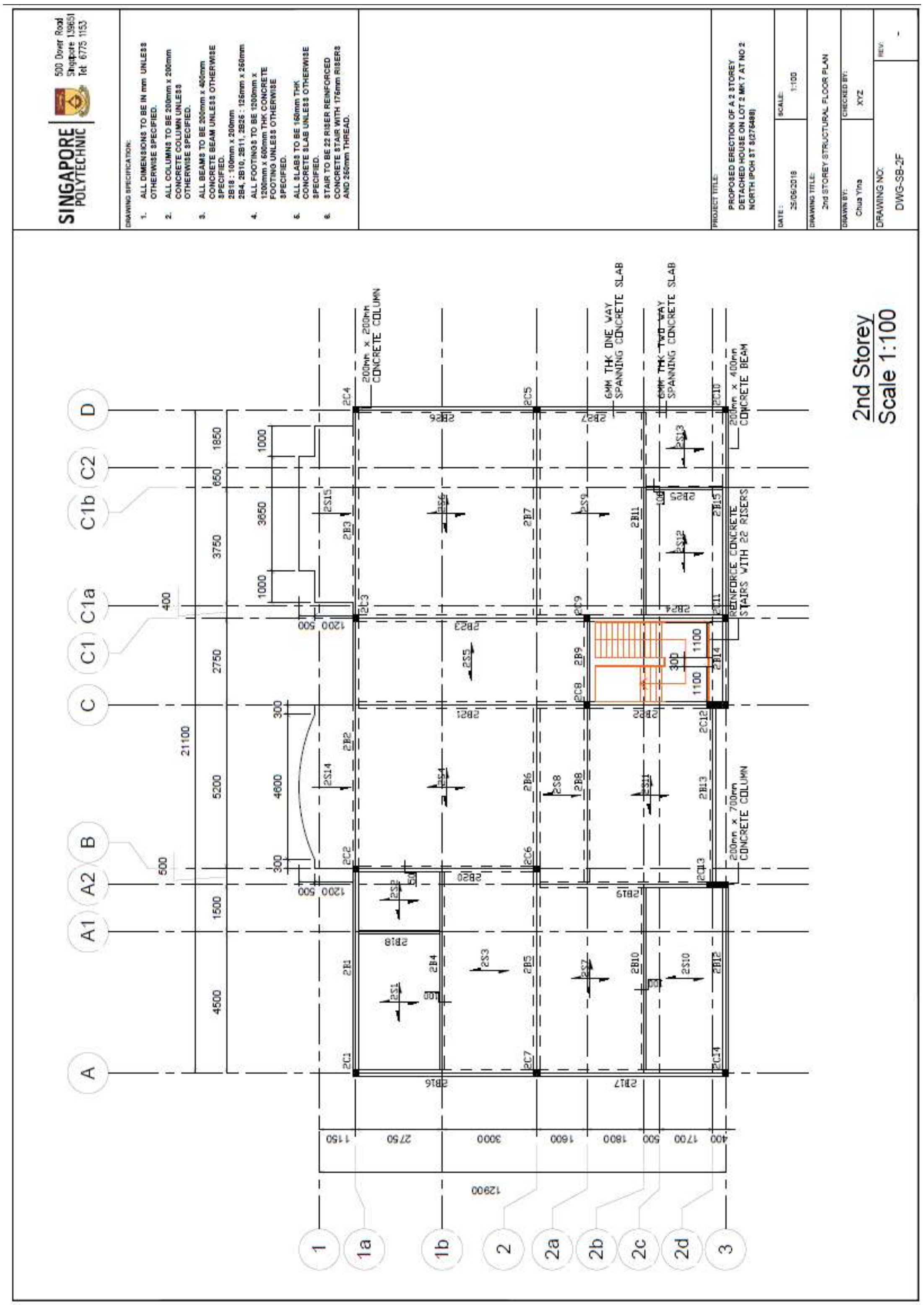
• staircase.		
Submission 3 (20%): Students are required to exact information from their submission 1 in order to design and determine the sizes of the structural elements. They are required to submit the structural design and calculations for: • Continuous beam • Single span beam • timber rafters • footing	Same as submission 2	Same as submission 2

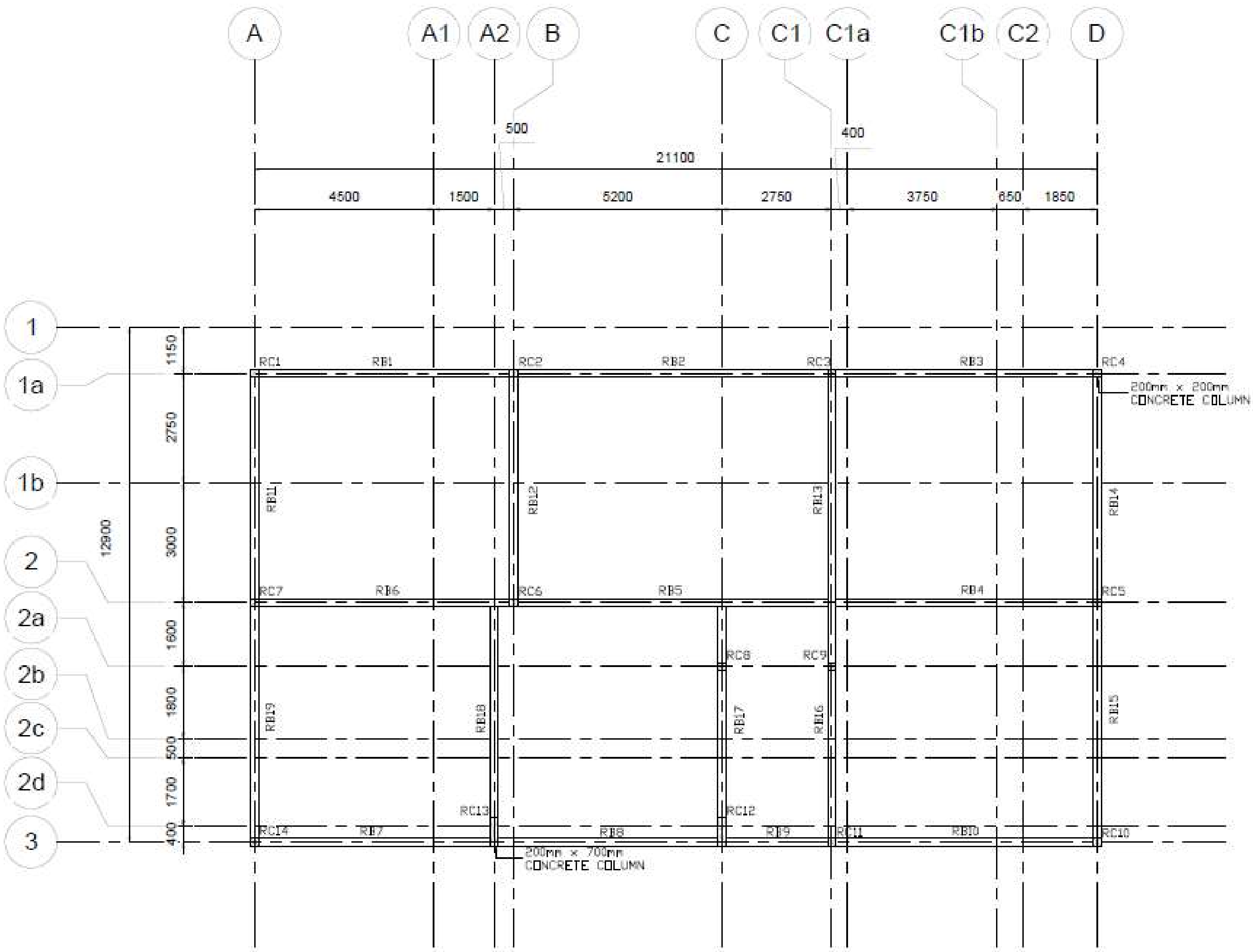
Appendix C

Possible solutions




SINGAPORE POLYTECHNIC
500 Dover Road
Singapore 139651
Tel: 6775 1153
PROPOSED ERECTION OF A 2 STOREY DETACHED HOUSE ON LOT 2 MK 7 AT NO 2 NORTH IPOH ST 8(276488)
AS SHOWN
1ST STOREY STRUCTURAL FLOOR PLAN
LIEW HAO LANG
ZHENG TING
DWG-SB-1F
1st Storey
Scale 1:100
200mm x 200mm CONCRETE COLUMN
6MM THK ONE WAY SPANNING CONCRETE SLAB
6MM THK TWO WAY SPANNING CONCRETE SLAB
200mm x 400mm CONCRETE BEAM
REINFORCE CONCRETE STAIRS WITH 22 RISERS
200mm x 700mm CONCRETE COLUMN


SINGAPORE POLYTECHNIC
500 Dover Road Singapore 139651 Tel: 6775 1153
2nd Storey
Scale 1:100
DWG-SB-2F



Roof Level
Scale 1:100

SINGAPORE POLYTECHNIC
500 Dover Road
Singapore 139651
Tel: 6775 1153

DRAWING SPECIFICATION:

1. ALL DIMENSIONS TO BE IN mm UNLESS OTHERWISE SPECIFIED.
2. ALL COLUMNS TO BE 200mm x 200mm CONCRETE COLUMN UNLESS OTHERWISE SPECIFIED.
3. ALL BEAMS TO BE 200mm x 400mm CONCRETE BEAM UNLESS OTHERWISE SPECIFIED.
4. ALL FOOTINGS TO BE 1200mm x 1200mm x 500mm THK CONCRETE FOOTING UNLESS OTHERWISE SPECIFIED.
5. ALL SLABS TO BE 150mm THK CONCRETE SLAB UNLESS OTHERWISE SPECIFIED.
6. STAIR TO BE 22 RISER REINFORCED CONCRETE STAIR WITH 175mm RISERS AND 250mm THREAD.

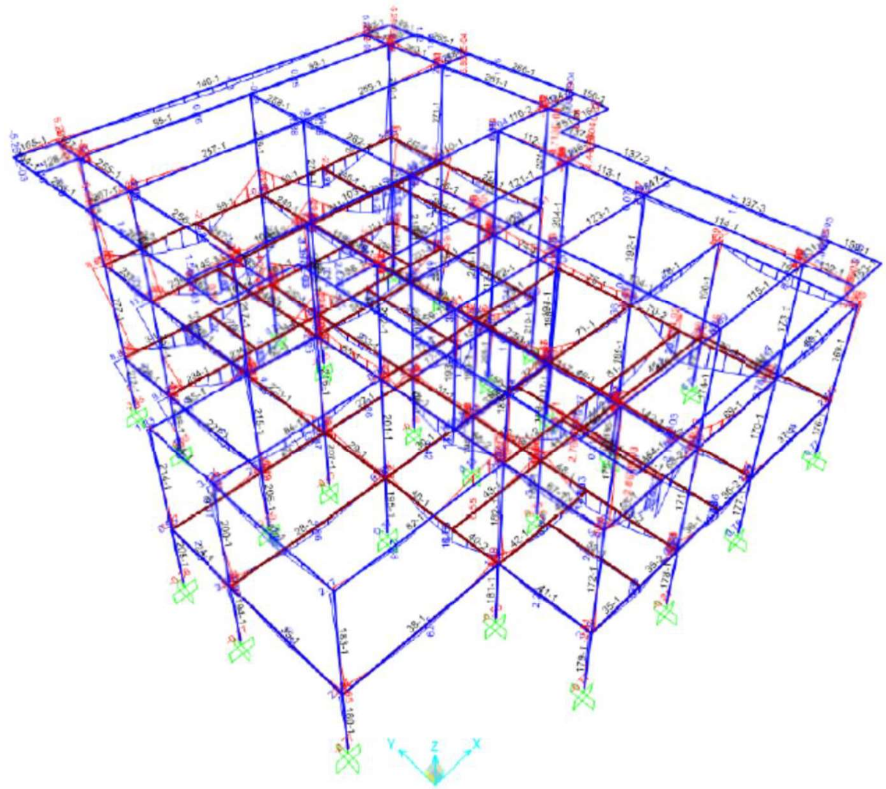
PROJECT TITLE:
PROPOSED ERECTION OF A 2 STOREY DETACHED HOUSE ON LOT 2 MK 7 AT NO 2 NORTH IPOH ST 8(275498)

DATE :	SCALE:
25/06/2018	1:100

DRAWING TITLE:
ROOF STRUCTURAL FLOOR PLAN

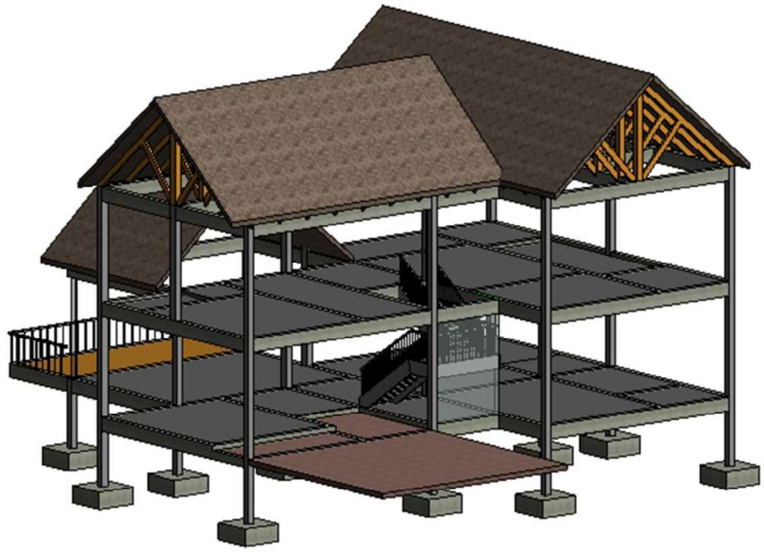
DRAWN BY:	CHECKED BY:
Chua Yina	XYZ

DRAWING NO:	REV:
DWG-SB-RL	-



Submission 2: Bugalow Structural Analysis

Submission 3: Bungalow Revit Model with Architecture finishes



Submission 3: Bungalow structural Revit model