DEPARTMENT OF BUILDING

FACULTY OF ARCHITECTURE, PLANNING AND SURVEYING

UNIVERSITI TEKNOLOGI MARA

(PERAK)

JANUARY 2019

It is recommended that the report of this practical training provided

By

MUHAMMAD HAFIZI BIN ROSIMAN

2017206698

Entitled

SUPERSTRUCTURE WORK OF ASTAKA

Accepted in partial fulfillment of requirement has for obtaining Diploma in Building.

Report Supervisor	: ____________________ En. Mohamad Hamdan Bin Othman
Practical Training Coordinator	: ____________________ En. Muhammad Naim Bin Mahyuddin
Programme Coordinator	: ____________________ Dr. Dzulkarnaen Bin Ismail

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STUDENT'S DECLARATION

I hereby declare that this report is my own work, except for extract and summaries for which the original references stated here in, prepared during a practical training session that I underwent at Kumpulan Prasarana Rakyat Johor (KPRJ) for 20 weeks starting from 5 August 2019 and ended on 20 December 2019. It is submitted as one of the prerequisite requirements of BGN 310 and accepted as a partial fulfillment of the requirements for obtaining the Diploma in Building.

……………………………………………………………

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UITM ID No : 2017206698

Date : 13 DECEMBER 2019

ACKNOWLEDGEMENT

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Last but not least, my special thanks to my beloved parents for their sacrifices over the years. Thank you so much

ABSTRACT

Superstructure is an important part in construction process, therefore this report will discuss about superstructure works in construction based on KPRJ BUILDERS Sdn. Bhd. Specification. This report was conducted for the superstructure at Cadangan Pembinaan Sebuah Stadium Beserta Kemudahan Berkaitan Di Atas Lot PTD 181003 (Tanah Kerajaan), Mukim Tebrau, Daerah Johor Bahru, Johor Darul Ta'zim. The purpose of this report is to study on the method used for constructing column, beam and slab at the construction. This report will focus on all the works related to concreting works and all the machines and equipment used that is prescribed by the requirements in the guideline of KPRJ BULDERS Sdn. Bhd. Specification. This report will also look at the type of defects occurred and their solutions on the superstructure as the method and equipment are describe in detail. A stable superstructure in a building are important for the long term and it plays a big role on the building structure as all load are transferred through it, a strong superstructure is indeed a must.

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CHAPTER 1.0

PREFACE

1.0 INTRODUCTION

Superstructure in Construction are defined as the portion of a building which is constructed above the ground level and it serves the purpose of structure's intended use. It includes columns, beams, slab upwards including all finishes, door and window schedules, flooring, roofing, lintels, and parapets.

It suggests that the function of the superstructure is 'to provide a full or partial system of structural support, where this is not provided by other elements.'includes:

- Frame: Load-bearing framework. Main floor and roof beams, ties and roof trusses of framed buildings; casing to stanchions and beams for structural or protective purposes.
- Upper floors: Suspended floors over, or in basements, service floors, balconies, sloping floors, walkaways and top landings, where part of the floor rather than part of the staircase.
- Roof: Roof structure, roof coverings, roof drainage, rooflights and roof features.
- Stair and ramps: Construction of ramps, stair, ladders, etc. Connecting floors at different levels.
- External walls: External enclosing walls including walls to basements but excluding walls to basements designed as retaining walls.
- Windows, doors and openings in external walls.
- Internal walls, partitions, balustrades, moveable room dividers, cubicles and the like.
- Doors, hatches and other openings in internal walls and partitions.

This a fairly narrower definition which excludes items such as; the substructure. Finishes, fittings, furnishings, equipment and services. Some broader definitions simply consider he superstructure to include all works above ground level, although clearly, this is a fairly ambiguous description (Baker, 2019).

In superstructure elements, column, beam and slab is the element of a structure which built on a layer of cement-sand mortar which sits in between substructure and superstructure to prevent ground floor dampness.

The System of Columns and Beams have been used in Construction since Ancient Egypt (Which lasted from about 3100BC until it was finally absorbed in to the Roman Empire in 30 BC) Ancient Greece and Ancient Rome (Figure 1.1). In modern day construction, Column-Beam-Slab System is been used in all superstructures with new technology, and construction materials. Generally, the load of the slab is transferred to the columns or walls through the

Figure 1.1 The columns during Roman Empire
(Source: Wikipedia)

beams, down to the foundation, and then to the supporting soil beneath. (Perrera, 2015)

According to (Perrera, 2015) , a column can be defined as a vertical structural member designed to transmit a compressive load (Figure 1.2). A Column transmits the load from ceiling/roof slab and beam, including its own weight to the foundation. Hence it should be realized that the failure of a column results in the collapse of the entire structure. The design of a column should therefore receive importance.

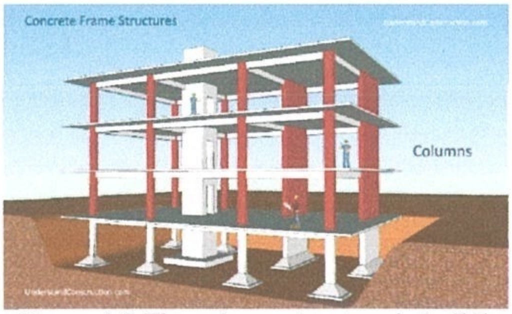


Figure 1.2 The column structure in building
(Source: UnderstandConstruction.com)

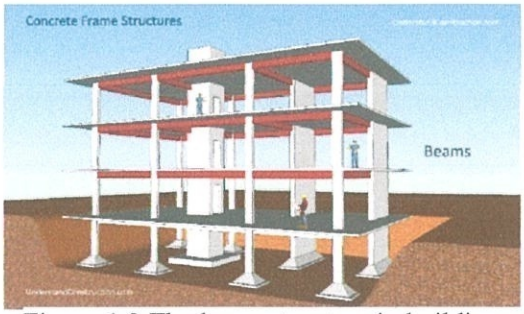


Figure 1.3 The beam structure in building
(Source: UnderstandConstruction.com)

Apart from column, she also defined a beam as a structural member which spans horizontally between supports and carries loads which act at right angles to the length of the beam (Figure 1.3). They are small in cross-section compared with their span. The width and depth of a typical beam are "small" compared with its span. Typically, the width and depth are less than span/10.

She added that generally a beam is subjected to two sets of external forces and two types of internal forces (Figure 1.4). The external loads are the loads applied to the beam and reactions to the loads from the supports. The two types of internal force are bending moments and shear forces. The internal shear force and the internal bending moment can be represented

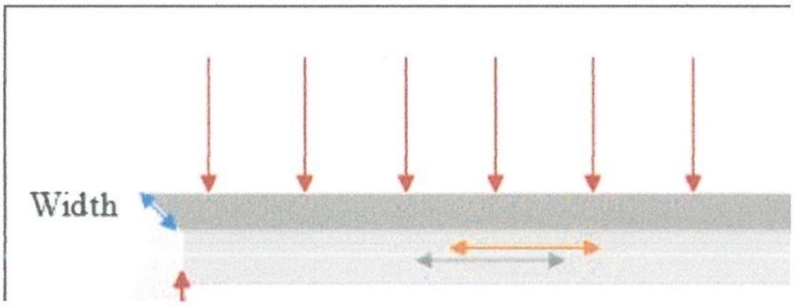


Figure 1.4 Beam with internal and external forces

as pairs of forces.

The word cement is interpreted in a wide sense, including not only Portland cement but also blended cements and other binding materials. In addition to novel aspects of conventional concrete materials, the journal covers a wide range of composite materials such as fiber-reinforced cement composites, polymer cement composites, polymer impregnated composites, ferrocement, and cement composites containing special aggregate inclusions or waste materials. (Banthia, 2019)

Apart from that, (Meo, 2015) said that the conventional composite materials could experience extensive damage under impact loading due to the poor through-the-thickness mechanical properties. The impact damage, being difficult to detect, may cause a serious reduction of the structural performance, e.g., the residual compressive strength.

The concrete is a relatively easy material to manage. However, you can run into huge problems if it is not worked on properly. Concrete problems vary but could include discolorations, shrinkage, scaling, and various other problems.

He also added that a number of solutions have been proposed over the years to improve impact resistance and damage tolerance of composite materials, such as use of selective interlayers and hybrids, fiber and/or matrix toughening, interface toughening, and through-the-thickness reinforcements.

Beyond that, the precast concrete is an alternative to *cast-in-situ* concrete. While cast-in-situ concrete is cast in its actual location, precast concrete is cast at another location, either at the building site or in a factory, and is then lifted to its final resting place and fixed securely. This means that unlike cast-in-situ construction, which is monolithic or continuous, precast concrete buildings are made of separate pieces that are bolted or connected together. Figure 1.5, 1.6 and 1.7 shows the installation work of precast concrete for seating area. (En. Ungku Ahmad, 2019)

Figure 1.5 The precast concrete of seating area

Figure 1.6 The installing work of precast concrete at seating area

Figure 1.7 The precast concrete for seating area is installed

Since it is done in a purpose-built precasting yard or factory, it makes construction easier for the following reasons:

- The construction is done on the ground rather than at a height

- It can be done inside a climate-controlled structure, eliminating problems of rain, dust, cold, or heat
- Specialised formwork (moulds) can be built for doing many repetitions of the same component
- Specialised equipment can be used to make, move, and pour the liquid concrete
- Curing of the concrete can be done in a controlled environment

1.1 Background and Scope of study

This study focusses on the superstructure work as it was conducted to understand the method of frame structure choose for all the buildings and also their installation method which consists of several types of structures and all according to KPRJ Builder's specifications. This study mainly focuses on the construction of superstructure which comprise on concrete works and installation work such as precast concrete at "Cadangan Pembinaan Sebuah Stadium Beserta Kemudahan Berkaitan Di Atas Lot PTD 181003 (Tanah Kerajaan), Mukim Tebrau, Daerah Johor Bahru, Johor Darul Ta'zim".

In addition, this study pursues to describe all related process required to be applied on the superstructure. This stage includes all the progress activities associated with

i. Determining the type of machineries, equipment and materials used in concreting superstructure
ii. Identifying the problem and method required for the defects on concrete

1.2 Objectives

Based on the practical training session, following are the objectives of this study:

i. To study the method for concreting superstructure
ii. To identify the construction of column, beam and slab
iii. To determine the problem and solution on superstructure

1.3 Method of Study

The research of case study on superstructure of the building has been carried out by using several methods in gaining more information.

i. Observation

Observation method is the most frequent method use as it has been done throughout the whole practical training directly by daily site visit for the whole period. The information collected are based on all the activities occurred at site construction with guidance by site supervisors. All the information is collected using mobile device by taking photos and recording videos of site activities such as work progress, equipment and machineries used in any process.

ii. Interview

Interview method also plays a big role as it has been carried out by having interview sessions with Site Supervisor both from Main Contractor and BUILDERS KPRJ. Many information and new knowledge on construction were gained from the interview.

iii. Book

Book also have been one of the sources of information as books are made as a reference to understand better about substructure works and other construction works related to building scope. Books additionally demonstrates the correlation of how theory are not quite the same as what really occur on construction site.

iv. Internet

There are many internet websites that have been referred to as a secondary source in gaining more information about frame structure and method of concrete and installation works. Internet have been a great helper in achieving more knowledge related to construction of superstructure in context of articles and visuals.

v. Research

Based on all drawings provided, there are many information achieve by doing studies on structural plans and drawings of related process of construction. Architectural drawings also help a lot to foresee on the outcome of all the construction process related to the case study.

CHAPTER 2.0

ORGANIZATION BACKGROUND

2.1 Introduction of Organization

KPRJ Builders Sdn. Bhd. (formerly known as Julung Cipta Sdn Bhd) is a wholly owned subsidiary of **Kumpulan Prasarana Rakyat Johor Sdn. Bhd.** (KPRJ) whereas KPRJ is a company wholly owned by the State of Johor. JCSB was incorporated on 28th October 1996. The paid-up capital of JCSB at 28th May 1997 is RM 600,000.00.

In the beginning, KPRJ BUILDERS was set up for maintaining and building new mosques in several district of the Johor State for KPRJ. A total 32 other mosques had been successfully completed in several districts of Johor under this programmed.

On 26th March 2004, KPRJ BUILDERS has been made the wholly own subsidiary of KPRJ and appointed new board of directors with a new management team. KPRJ had increased the paid-up capital for KPRJ BUILDERS to RM 1, 500,000.00. KPRJ BUILDERS had been successfully obtained Grade G7 with Construction Industry Development Board (CIDB) on 5th April 2004 and PK License, Bumiputera Status Class A on 17th Jun 2004, ISO 9001:2008 on 10th March 2008.

KPRJ BUILDERS had been successfully completed the prestigious projects Johore State New Administrative Centre (JSNAC) Phase 1 for RM 170 million in 2012. KPRJ BUILDERS is actively involved with the current development within Nusajaya and Iskandar Development Region. Some of KPRJ BUILDERS's main clients are Nusajaya Development Sdn. Bhd., Iskandar Investment Bhd, YPJ Holdings Sdn. Bhd., Island & Peninsular Group, IDR Assets Sdn Bhd and Johore State Government.

With the new term on board KPRJ BUILDERS has been awarded construction of 95 nos. abandoned projects Sekolah Agama Kerajaan Johor (SAKJ) with contract sum of RM 168 million and expected to be completed in 2017.

2.2 Organization Profile

Figure 2.1 Logo of KPRJ Sdn. Bhd.

COMPANY'S NAME	: **KPRJ BUILDERS SDN. BHD.** (formerly known as at Julung Cipta Sdn Bhd)
REGISTRATION NO.	: **407977-M**
ESTABLISHED DATE	: **28th OCTOBER 1996**
ADDRESS	: **G-07 & 08, BLOK 4 DANGA BAY, JALAN SKUDAI 80200 JOHOR BAHRU, JOHOR**
TELEPHONE NO.	:
FAX NO.	:
WEBSITE	: **www.julung.com.my**
BUSINESS TYPE	: **CONSTRUCTION / PROJECT MANAGEMENT**
AUTHORIZED CAPITAL	: **RM 5,000,000.00**
PAID-UP CAPITAL	: **RM 1,500,000.00**
SHARE HOLDER	: **100% WHOLLY OWNED SUBSIDIARY OF KUMPULAN PRASARANA RAKYAT JOHOR SDN. BHD. (KPRJ)**

LICENSE : **CLASS A – BUMIPUTERA STATUS (PUSAT KHIDMAT KONTRAKTOR)**

GRADE 7 (LEMBAGA PEMBANGUNAN INDUSTRI PEMBINAAN MALAYSIA- CIDB)

MS ISO 9001: 2008 (APPROVED BY LLOYD'S REGISTER QUALITY ASSURANCE)

BANK : **1) CIMB BANK BERHAD**
8005757670

2) AMISLAMIC BANK BHD
151-202-200108-7

Vision of Organization

"To deliver maximum returns to the State of Johor and to continuously benefit the Rakyat"

Mission of Organization

- To accomplish innovative and high-quality projects in order to maximize returns.
- To conduct various CSR programs that bring added value to the community.
- To develop human capital of high potential and value.

2.3 Organization Chart

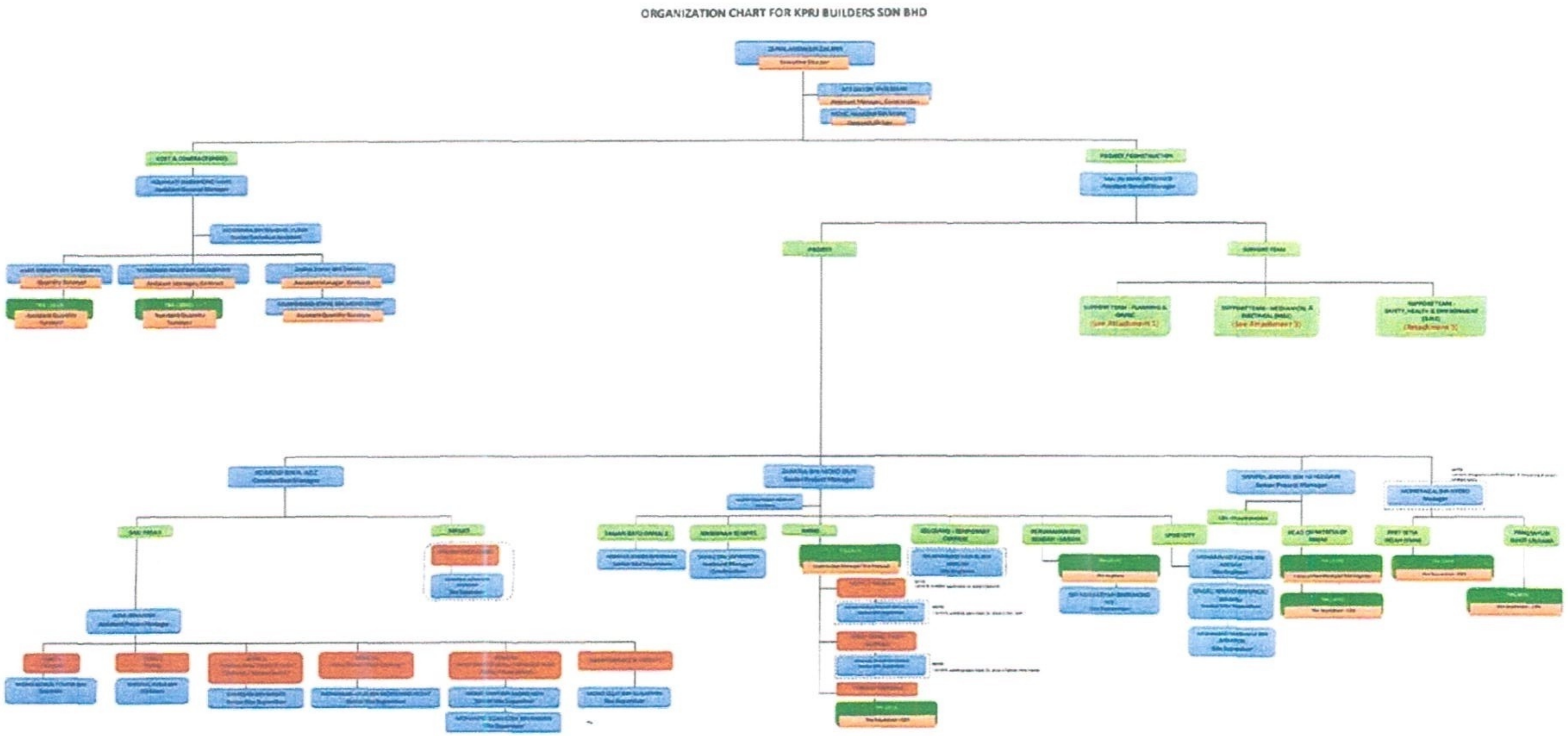


Figure 2.2 Organizational Chart of Kumpulan Prasarana Rakyat Johor (KPRJ)

2.4 List of Projects

2.4.1 Completed Projects

Table 2.1 The list of KPRJ Completed Projects

NO.	PRO	CLIENT	CONSULTANT	CONTRACT VALUE (RM)	DATE OF COMMENCEMENT	DATE OF COMPLETION
1.	STATE SECRETARY COMPLEX FOR JOHOR STATE NEW ADMINISTRATIVE CENTRE, BANDAR NUSAJAYA, JOHOR *SUB-PACKAGES*	27 & 29, Jalan Indah 15/3, Bukit Indah, 79100 Nusajaya, Johor Darul Ta'zim	5th Floor, Menara 2, Faber Towers, Jalan Desa Bahagia, Taman Desa, 58100 Kuala Lumpur			
	Earthworks					
	Piling, Pile cap And Foundation Works			2,265,000.00	26-DEC-05	28-FEB-06
	Structural And Associated Works			10,50,000.00	29-NOV-05	15-NOV-07
	Main Building Works, M&E Services And Local Infrastructure Works			30,611,230.00	05-APR-06	16-APR-09
	Interior Design, Landscape And M&E Services			34,650,000.00	22-AUG-06	16-APR-09
	Supply, Fabricate, Installation, Testing And Comissioning of Office System Furniture of Workstation			4,817,031.53	23-MAY-08	22-AUG-08
	Interior Design Works			5,245,947.00	24-NOV-08	24-FEB-09
	Proposed Enhancement To Existing Landscaping Works			264,600.00	6-JAN-09	2-FEB-09
	TOTAL			**89,514,968.53**		

N0.	PRO	CLIENT	CONSULTANT	CONTRACT VALUE (RM)	DATE OF COMMENCEMENT	DATE OF COMPLETION
2.	PROPOSED STATE COMPLEX (PARCEL C3S) FOR JOHOR STATE NEW ADMINISTRATIVE CENTRE, BANDAR NUSAJAYA, JOHOR	Cahaya Jauhar Sdn Bhd, 27 &29, Jalan Indah 15/3, Bukit Indah, 79100 Nusajaya, Johor Darul Ta'zim	Kinta Samudra Sdn Bhd, 5th Floor, Menara 2, Faber Towers, Jalan Desa Bahagia, Taman Desa, 58100 Kuala Lumpur			
	SUB-PACKAGES					
	Earthwork					
	Piling works			1,820,000.00	22-FEB-06	17-MAY-06
	Pile Caps, Sub-Structure, Super Structure And Associated Works			6,558,000.00	05-APR-06	24-JAN-07
	Main Building Works, M&E Services, Local Infrastructure and Landscape Works			31,445,000.00	12-SEP-06	14-AUG-07
	Supply, Fabricate, Installation, Testing and Comissioning of Office System Furniture of Workstation			3,075,269.00	23-MAY-08	22-AUG-08
	Interior Design Works			3,101,089.00	24-NOV-08	01-MAR-09
	Proposed enhancement to Existing Landscaping Works			322,212.45	6-JAN-09	2-FEB-09
TOTAL				**46,936,570.45**		

N0.	PRO	CLIENT	CONSULTANT	CONTRACT VALUE (RM)	DATE OF COMMENCEMENT	DATE OF COMPLETION
3.	Cadangan Pembangunan 752 Unit Pangsapuri Mampu Milik 5 Tingkat Beserta Kemudahan Awam dDi Atas Sebahagian Lot 39889, Di Kampung Setanggi, Jalan Tebrau, Johor Bahru	Syarikat Perumahan Negara Berhad Tingkat 10, Bangunan MAS, Jalan Sultan Ismail, 50250 Kuala Lumpur	Architect Abdul Rahman Akil 11 A-C, Jalan SS 6/12, Kelana Jaya, 47301 Petaling Jaya , Selangor Darul Ehsan	48,500,000.00	1-MAR-05	30-OCT-09
4.	Proposed Sewerage Reticulation, Sewerage Treatment, Road, Electrical Infrastructure And Landscaping Works For Johor State New Administrative Centre	Cahaya Jauhar Sdn Bhd, 27 &29, Jalan Indah 15/3, Bukit Indah, 79100 Nusajaya, Johor Darul Ta'zim	Kinta Samudra Sdn Bhd, 5th Floor, Menara 2, Faber Towers, Jalan Desa Bahagia, Taman Desa, 58100 Kuala Lumpur	28,600,000.00	18-JUL-05	31-MAY-08
5.	Proposed Construction and Completion of Infrastructure Works (Phase 1) for Educity on Lot PTD 71074 Mukim Pulai, At Iskandar, Johor Darul Ta'zim	Iskandar Investment Berhad G-12, Block 8, Jalan Skudai, 80200 Johor Bahru, Johor	ACE Vector Sdn. Bhd. No. 11-2, Jalan 3/109E, Desa Business Park, Jalan Desa, Taman Desa, 58100 Kuala Lumpur	15,830,110.00	27-AUG-08	15-JUL-09
6.	The Execution and Completion of Environmental Mitigation, Earthworks, Road & Drains And Electrical Infrastructure Works For Proposed Federal Administrative Centre (FAC)	Cahaya Jauhar Sdn Bhd, 27 &29, Jalan Indah 15/3, Bukit Indah, 79100 Nusajaya, Johor Darul Ta'zim	Kinta Samudra Sdn Bhd, 5th Floor, Menara 2, Faber Towers, Jalan Desa Bahagia, Taman Desa, 58100 Kuala Lumpur	6,524,770.50	27-FEB-08	15-DEC-08

Source:Kumpulan Prasarana Rakyat Johor, Johor Darul Takzim

2.4.2 Project in Progress

Table 2.2 The list of KPRJ on-going projects

NO.	PRO	CLIENT	CONSULTANT	CONTRACT VALUE (RM)	DATE OF COMMENCEMENT	DATE OF COMPLETION
1.	Cadangan Pembinaan Sebuah Stadium Beserta Kemudahan Berkaitan Di Atas Lot Ptd 181003 (Tanah Kerajaan), Mukim Tebrau, Daerah Johor Bahru, Johor Darul Takzim – Pakej 1 Kerja tanah	KPRJ Development Sdn Bhd	Farik Ghaffar Architect	14,082,039.45	26-OCT-16	24-APR-17
2.	Cadangan Merekabentuk, Membina dan Menyiapkan Sekolah Agama Kerajaan Negeri Johor (SAKJ), Di Atas Sebahagian Lot 77603 (PTD 84033), Jalan Tualang 1, Bandar Putra, 81000 Kuali Johor Darul Ta'zim, Untuk Tetuan Jabatan Agama Islam Negeri Johor	Jabatan Agama Islam Johor	Mrh Rashidi Architect	8,750,000.00	12-OCT-16	11-OCT-18
3.	Cadangan Pembangunan Perumahan Yang Mengandungi 50 Unit Rumah Semi-D 1 Tingkat - 40'×75' Dan 182 Unit Rumah Teres 2 Tingkat – 18'×65' (Untuk Bekas Pemegang Lesen Pendudukan sementara (Tol) Dan Golongan Generasi Kedua Yang Terlibat Dengan Pembangunan HUB Industri Minyak dan Gas Di Pengerang) Di Atas Sebahagian Tanah Milik Kerajaan Negeri Johor (Lot PTD 7123), Mukim Pantai Timur, Daerah Kota Tinggi, Johor Darul Ta'zim.	KPRJ Development Sdn Bhd	Azman Bilaji Architect	41,340,000.00	10-OCT-16	4-DEC-17
4.	Cadangan Merekabentuk, Membina Dan Menyiapkan Kerja Pengambil alihan Projek Sekolah Agama Negeri Johor (SAKJ) Fasa 5 Di Dalam Negeri Johor Darul Ta'zim	Unit Perancang Ekonomi Negeri Johor	1. Habrisalam Architect 2. MRH Architect	177,500,000.00	15-APR-17	14-DEC-19

Source:Kumpulan Prasarana Rakyat Johor, Johor Darul Takzim

CHAPTER 3.0

CASE STUDY

3.1 Introduction to Case Study

The project that I have been signed up to during my practical training was Cadangan Pembinaan Sebuah Stadium Beserta Kemudahan Berkaitan Di Atas Lot PTD 181003 (Tanah Kerajaan), Mukim Tebrau, Daerah Johor Bahru, Johor Darul Ta'zim. The project covers the development of the Athlete Stadium, Astaka and Rugby and Shooting Range. These building was funded by the Johor state government and federation and will be used for competition at SUKMA JOHOR 2020 that will take place in this country on July 2020. The total cost for this project is One hundred and thirty-one million, three hundred and nine thousand, four hundred and fifty-four Ringgit and twenty-four cents (RM 131,309,454.24). The duration of this construction contract is for 675 days starting from 5th July 2017 and estimated to finish on 30th August 2019 with extension of time for 4 months after completion. The construction method for this project are by conventional with additional precast concrete method. There are several contractors involved in this project. Since it is a state-government linked, the client who monitor the whole project is Bahagian Perancangan Ekonomi Negeri Johor (BPENJ) and KPRJ BUILDERS Sdn. Bhd. as the main contractor that in charge fully on this project.

Figure 3.1 The Project Signboard

Figure 3.2 Location plan of site (Source: Farik Ghaffar Architect)

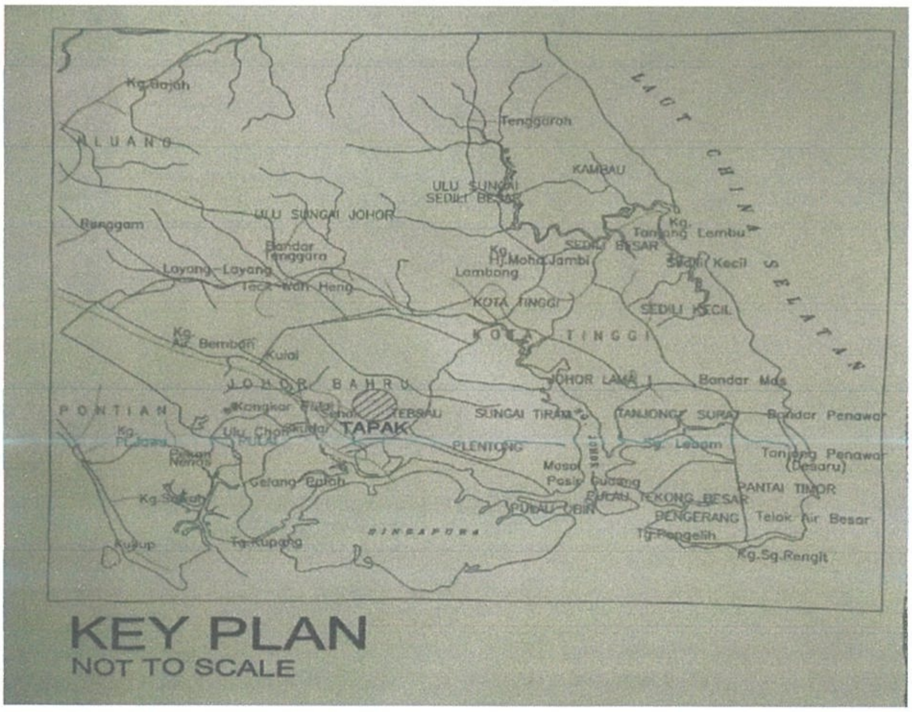


Figure 3.3 Key plan of siFigure 20. Scaffold to support formwork

Figure 3.4 View of site from above

Through the practical training that I been appointed to, I have been assigned to monitor and supervise the work in progress on these three projects. However, for this case study, I focused on the project on Astaka and Rugby.

This stadium is a concrete framed structure with an approximate floor area of 2.934 sf and a seating capacity of 560 spectators (all seated) and 40 for VVIP seating area. The facility includes a VVIP room along with pantry and toilet at the second level, utility room, multipurpose room, MDF room, management office, medical room, doping room, irrigation pump room, irrigation R.C water tank, male toilet, female toilet, two athletes' toilet, and two changing room. All of these room were separated with a non-load bearing wall. The new facility also offers greater seating accessibility, especially for less mobile guests. There is a wheelchair access ramp, as well as wheelchair seating (Figure 3.5).

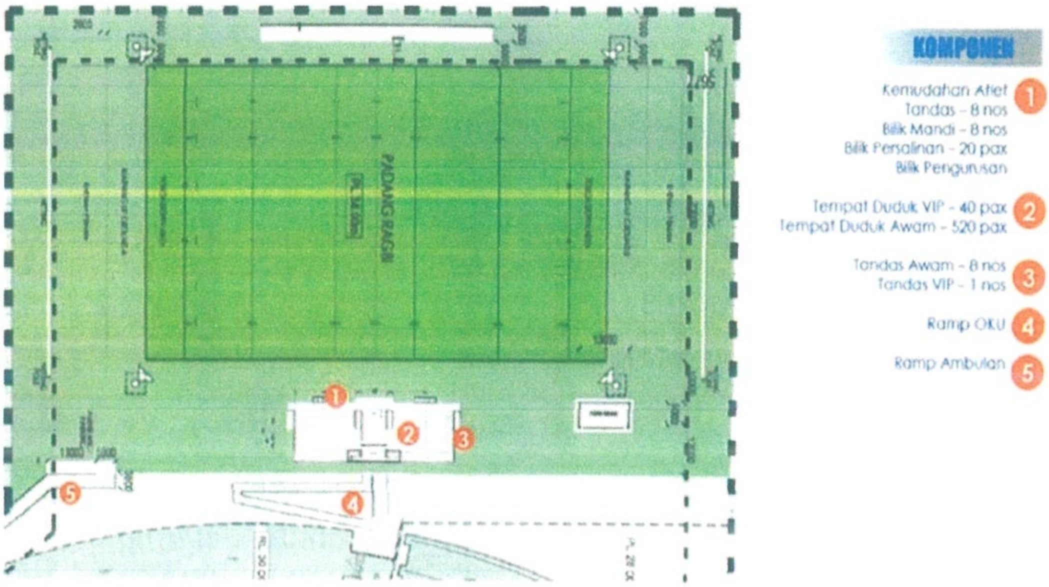


Figure 3.5 The component of the stadium. (Source: Farik Ghaffar Architect)

There are key-persons in-charge for all activities occurred at site to ensure all works run smoothly, which are the Senior Project Manager, En. Zakaria Bin Mohd Zin, En. Ungku Ahmad Bin Ungku Ibrahim as the Site Agent, En. Zamzurin Bin Abdullah as Safety and Health Officer with his assistant supervisor, En. Mohd Fadhil Bin Samingam, En. Badrol Hisham Bin Nazarudin as the Site Engineer, En. Muhamad Nur Hafiz Bin Md Ayob as Site Supervisors.

For this case study, the focus will only be on the superstructure work of Astaka according to the KPRJ BUILDERS Sdn. Bhd. specification.

KPRJ BUILDERS SDN BHD

ORGANIZATION CHART

CADANGAN PEMBINAAN SEBUAH STADIUM BERSERTA KEMUDAHAN-KEMUDAHAN BERKAITAN DI ATAS SEBAHAGIAN LOT 160866 (PTD 181003) (TANAH KERAJAAN), MUKIM TEBRAU, DAERAH JOHOR BAHRU, JOHOR DARUL TA'ZIM.

PACKAGE 2 – PILING WORKS, BUILDING WORKS, INFRASTRUCTURE WORKS & ALL ASSOCIATED WORKS

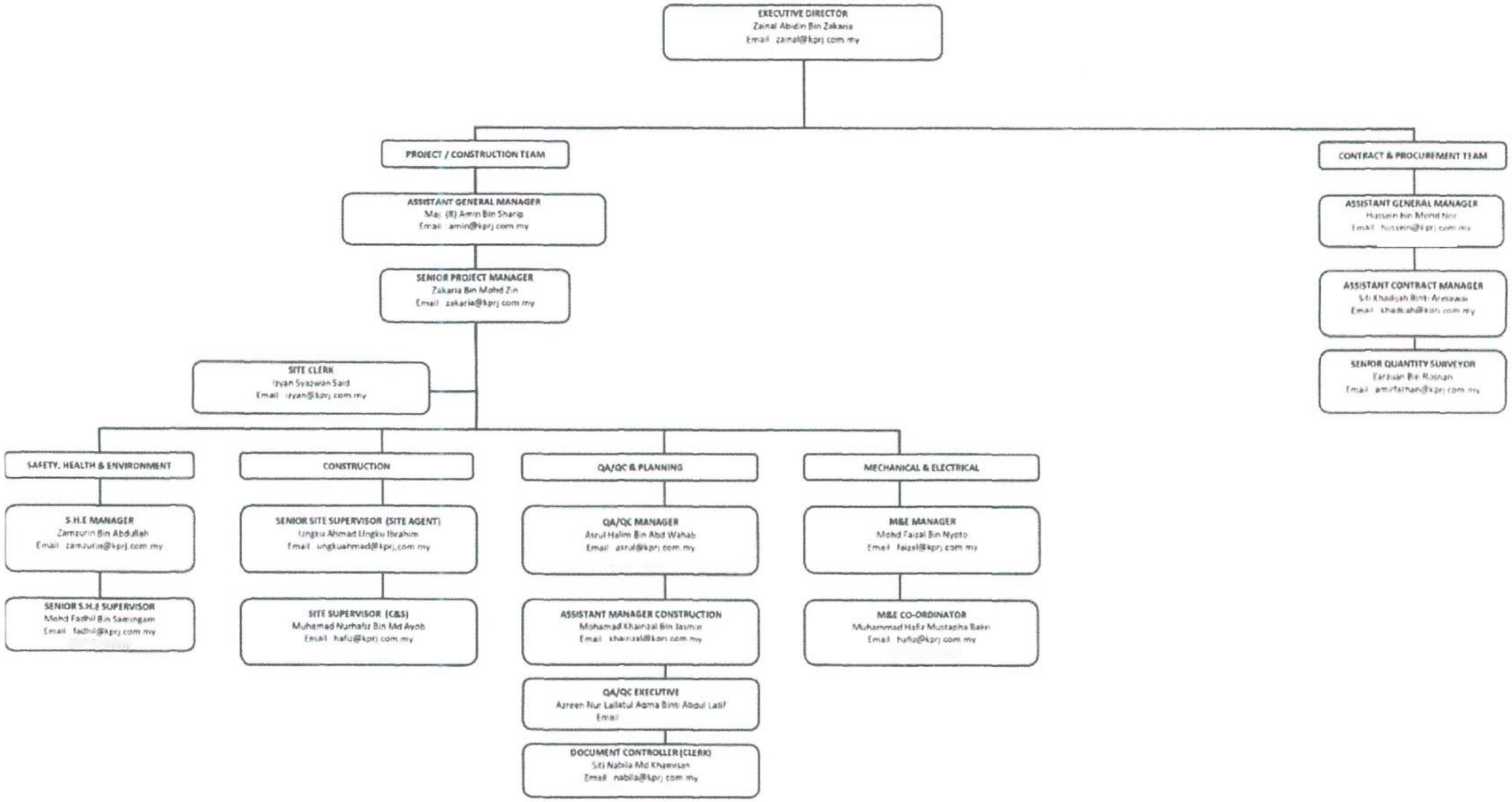


Figure 3.6 Site organization chart (Source: KPRJ Builders Sdn. Bhd.

3.2 Method for concreting superstructure

3.2.1 Design of formwork

Figure 3.7 Design of formwork

a. The design of formwork and its construction shall be the sole responsibility of the Contractor. It shall include all moulds for forming the concrete and all temporary construction for the proper execution of the work. The design shall be submitted to the Engineer for approval before construction work commences.
b. When selecting formwork, the type of concrete and temperature of the pour are important considerations as they both effect the pressure exerted. The formwork sides must be capable of resisting the hydrostatic pressure of the wet concrete which will diminish to zero within several hours depending on the rate of setting and curing. The formwork base or soffit must be capable of resisting the initial dead load of the wet concrete and the dead load of the dry set concrete. It shall be securely braced, supported and wedged so as to retain its position without displacement or deflection during the placing and compaction of concrete.
c. Care should be taken, when re-using formwork, that its surface shall be smooth and clean and that it shall be free from warping twisting or other deformation Any formwork, which has in the opinion of the Engineer deteriorated sufficiently to render it unsuitable for the work shall be rejected and must be removed from the site within 48 hours or must be broken up a once, and new formwork to be provided at the Contractor's expense.

Figure 3.8 Scaffold to support formwork

3.2.2 Cutting and bending of reinforcement

a. Bending of reinforcement steel bars requires adequate supervision, skilled workmanship and efficient equipment (IS: 2502). Personnel duly qualified shall be employed for cutting and bending operations.

b. The dimension of bends shall be so given that a minimum amount of calculation is necessary for marking of bars. The dimensioning procedure shall be used as per drawings and in absence of dimension on drawings, IS: 2502 shall be referred for bending. Dimensions shown in the bar bending schedule shall be checked before cutting the bars.

c. Rebar cages are either pre-fabricated or constructed on site using hydraulic benders and shears. Site labourers known as steel fixers place the rebar and ensure adequate concrete cover and embedment. Rebar cages are connected either by spot welding, tying steel wire or with mechanical connections. Mechanical connections, also known as 'couplers' or 'splices', are an effective means of reducing rebar congestion in highly-reinforced areas for cast-in-place concrete construction.

d. Bars shall be cut and bent cold by the application of slow, steady pressure or in an approved bar-bending machine. Bending at temperatures in excess of 100°C may only be carried out with the Superintending Officer's approval and under his supervision.

e. Cold worked and hot rolled bars shall not be straightened or bent again once having been bent. Where it is necessary to bend the free end of mild steel reinforcement already cast in the concrete, the internal radius of the bend shall not be less than twice the diameter of the bar.

f. Special care shall be taken that the overall length of bars with multiple bends is accurate and that after bending and fixing in position the bars remain in place without wrap or twist.

3.2.3 Fixing of reinforcement

a. The number, size, length, shape, type and position of all reinforcing bars, links, spacer bars and other parts of steel reinforcement, shall be in accordance with the Drawings.

b. The reinforcement shall be fixed accurately and securely in position so that the reinforcement is in the correct position in relation to the formwork to give the specified concrete cover and will not be displaced due to trafficking around site or during the placing

Figure 3.9. Fixing the BRC

and compaction of the concrete or any related operations.

c. The correct cover shall be maintained by the use of plastic spacers or other approved means. Concrete spacing blocks is approved for use. Concrete spacers should be comparable with strength, durability and form to the surrounding concrete. Spacers fixed are to parallel the reinforcement bars that cannot be located in a line across a section Timber, stone or metal spacers are not permitted.

Figure 3.10 Types of Spacing

d. Starter bars to columns and walls must be securely fixed to the reinforcement in the parent concrete and accurately located to maintain the specified cover. Reinforcement embedded in hardened concrete shall not be bent.

3.2.4 Installation of electrical conduit pipe

Figure 3.11 Installation of electrical conduit pipe

a. Piping shall be installed so that it follows the lines of the building structure and horizontal piping shall be graded wherever necessary to allow for venting and draining of the pipework.
b. During the course of the installation of the conduit system, procedures for working and dressing the installation as recommended shall be employed.

c. All bends and sets shall be in accordance with IEE regulation 522-08 formed with the aid of a helical spring fitted internally, with if necessary, the conduit warmed sufficiently for it to move without avoidable wall thinning of the outside of the bend.

d. The minimum and maximum sizes of conduit to be employed shall be 20mm and 32mm diameter respectively, unless otherwise stated in subsequent sections of the specification.

3.2.5 Production of concrete

a. All concrete shall be subjected to production control under the responsibility of the contractor. Production control comprises all measures necessary to maintain the properties of concrete in conformity to specified requirements. It includes:

   i. selection of materials.

   ii. concrete design.

   iii. concrete production.

   iv. inspection and tests.

   v. the use of the results of test on constituent materials, fresh and hardened concrete and equipment.

   vi. For ready-mixed concrete, inspection of equipment used in transporting fresh concrete.

b. The production control system shall contain adequately documented procedures and instructions. These procedures and instructions shall, where relevant, be established in respect of the control requirement as given.(Refer Appendix A,B and C)

3.2.5.1 Ready mixed concrete

a. Ready mixed concrete are batched, either dry or wet, at a control plant and transported in purpose-made agitators operating continuously or truck mixers to the Site.

b. Ready mixed concrete shall comply with the requirements of designed concrete as in sub-section 3.2 and MS 523-1. All concrete materials, including water and admixtures shall be mixed in the plant and delivered to Site in purpose made truck mixers. No extra water or admixtures are allowed to be added after the concrete has left the plant.

c. Ready mixed concrete delivered to the Site shall be accompanied by delivery ticket and manufacturer's batching record stating the details of mix proportions by weight, the grade of concrete, type and size of aggregate, date and time of loading at plant, type and dosage of chemical admixtures and other relevant production details in suitable format, failing which the S.O, or his representative, shall immediately reject the total load of the concrete. The S.O, or his representative, and the contractor shall ensure the information provided in the delivery tickets and the manufacturer's batching record complies with the details of the approved 'designed concrete' and its corresponding consistence.

d. Rejected concrete shall be removed from the Site. The delivery ticket shall be marked 'REJECTED'.

3.2.5.2 Site mixed concrete

a. The quantities of cement, fine aggregate and various sizes of coarse aggregate shall be measured by weight unless otherwise approved by the S.O. A separate weighing machine shall be provided for weighing the cement. Alternatively, the cement may be measured by using a whole number of bags in each batch. The quantity of water shall be measured by volume or by weight. Any solid admixtures to be added shall be measured by weight; liquid or paste admixtures shall be measured by volume or weight.

b. The batch weight of aggregate shall be adjusted to allow for the moisture content of the aggregate being used. All measuring equipment shall be calibrated on site or their calibration status established by certificates from accredited laboratories.

c. The mixing time shall be not less than two minutes and not more than five minutes or any other time recommended by the mixer manufacturer after all the ingredients have been placed in the mixer.

d. Mixers that have been out of use for more than 30 minutes shall be thoroughly cleaned before any fresh concrete is mixed. Unless otherwise agreed by the S.O., the first batch of concrete through the mixer shall contain only two thirds of the normal quantity of coarse aggregate. The mixer shall be thoroughly cleaned before changing from one type of cement to another.

e. The water content of each batch of concrete may be adjusted so as to produce concrete of the workability required. However care shall be taken to ensure the free water: cement ratio is maintained. The total amount of water added to the mix shall be recorded.

3.2.6 Pouring concrete

a. Concrete shall be transported, placed and spread by approved means and in such a way as to prevent segregation. Concrete not placed within 90 minutes of adding water to the mix or before starting its initial set shall be rejected, unless an approved retarding admixture is used.

b. All formwork and reinforcement contained in it shall be clean and free from standing water immediately before the placing of concrete. Concreting shall be carried out continuously between and up to predetermined construction joints in one sequence of operation. It shall be thoroughly compacted by either hand tamping or mechanical vibration or both and shall be thoroughly worked into the corners. After tamping into place, the concrete shall not be subjected to disturbance other than such as incidental to compaction by vibration. In the event of unavoidable stoppage in positions not predetermined, the concreting shall be terminated on a horizontal plane and against vertical surfaces by the use of stop boards. The location for termination shall be subjected to the approval of the Superintending Officer.

c. Concrete must be carefully and thoroughly compacted during placing to ensure that it completely surrounds the reinforcement fills the formwork and excludes voids. While casting, all concrete should compact using the vibrators.

Figure 3.12. The concreter is pouring concrete

d. Except where otherwise approved by the S.O., concrete shall be deposited in horizontal layers to a compacted depth not exceeding 450 mm when internal vibrators are used or 300 mm in all other cases. The surface of the concrete shall be maintained reasonably level during placing.

e. Concrete shall not be dropped into place from a height exceeding 1.5 m. However, higher drops may be allowed provided the mix has been well designed and proportioned. When trunking or chutes are used, they shall be kept clean and used in such a manner as to avoid segregation.

3.2.7 Compaction of concrete

a. Concrete shall be thoroughly compacted by vibration and thoroughly worked around the reinforcement, tendons or duct formers, around embedded fixtures and into corners of the formwork to form a dense, homogenous mass, free from voids and which will have the required surface finish when the formwork is removed. Vibration shall be applied continuously during the placing of each batch of concrete until the expulsion of air has practically ceased and in a manner, which does not promote segregation of the ingredients.

b. Concrete shall not be subjected to any disturbance within 24 hours after compaction. No standing or flowing water shall be allowed to come into contact with exposed concrete surfaces during the first two (2) hours after placing and compaction of the concrete.

c. In the event where inadequate or improper compaction is suspected, the S.O. has the right to inspect and to carry out further tests. The tests may include non-destructive and destructive methods. All expenses incurred in carrying out such sampling, testing and remedial works shall be borne by the Contractor irrespective of whether the tests prove the structure to be sound or otherwise.


Figure 3.13 The concreter is compacting the poured concrete

3.2.8 Curing and protection

a. Curing and protection shall start immediately after compaction of the concrete to protect it from:

   i. Impact damage such as shock, overloading or falling earth which may disrupt the concrete and interface with its bond to reinforcements.
   ii. Premature drying out from direct sunlight and wind.
   iii. Leaching out by rain and flowing water.
   iv. High internal thermal gradient.

b. Concrete, after it is placed and until the expiration of the curing duration, shall not be allowed to dry out. Provision shall be made for adequate protection against direct sunlight and wind to allow the process of curing to complete within the specified period.

c. Curing and protection shall be accomplished by covering the exposed concrete surface with an impermeable material such as polyethylene sheet, which should be well sealed and fastened and if required, this treatment can be continued efficiently throughout the whole period of curing.

d. When the concrete has attained its final set, one of the following curing methods shall be adopted:

   i. Water curing shall be accomplished by keeping the surface of the concrete continuously wet by Ponding with water.

ii. Curing may be accomplished by sealing in the water as specified above by covering with an approved waterproofed curing paper or plastic sheeting laid with airtight joints. It must be securely positioned to prevent displacement by wind and protected from tearing or other injury.

e. The use of other methods of curing may be deemed necessary when the concrete is subjected to high internal thermal gradient, or with large exposed surface area. The Contractor shall submit a method statement to the approval of the Superintending Officer.

f. In the event where the Contractor does not do proper curing, the S.O. has the right to inspect and to carry out further tests which may include destructive methods. All expenses incurred in carrying out such sampling, testing and remedial works shall be borne by the Contractor irrespective of whether the tests proved the structure to be sound or otherwise.

3.2.9 Dismantling of formwork

a. Formwork should not be removed until the concrete has developed sufficiently strength to support all loads placed upon it. The time required before formwork removal depends on the structural function of the member and the rate of strength gain of the concrete (Refer Appendix D). The grade of concrete, type of cement, water/cement ratio, temperature during curing etc. influence the rate of strength gain of concrete.

b. The formwork removal procedure should be supervised by the engineer to ensure that quality of hardened concrete in structural member, i.e. it should be free from or has minimum casting defects such as honeycombing, size and shape defects etc. These defects in concrete influence the strength and stability of structure. Thus, immediate repair works can be done or the members can be rejected.

c. The separation of forms should not be done by forcing crowbars against the concrete. It may damage the hardened concrete. This should be achieved by using wooden wedges.

3.2.10 Precast Concrete construction

a. After the method of manufacture has been approved, no changes shall be made without the approval of the Superintending Officer.

b. The Contractor shall inform the Superintending Officer in advance of the date of commencement of manufacture and casting of each type of precast concrete component.

c. When the Superintending Officer requires tests to be carried out, none of the precast concrete components to which the tests relate shall be dispatched to the site until the tests have been completed and the results approved by the Superintending Officer.

d. All precast concrete components shall be indelibly marked to show the identification marking as specified in the Drawings, the production batch on which they were manufactured and the date on which the concrete was cast. If the components are symmetrical, the face that will be uppermost when the member is in its correct position in the work shall be clearly identified.
e. When the precast concrete components are stored, they shall be firmly supported only at the points specified in the Drawings. No accumulation of trapped water and deleterious matter shall be allowed in the components. Care shall be taken to avoid rust staining and efflorescence.
f. The precast concrete components shall be lifted only at points specified in the Drawings or otherwise approved by the Superintending Officer and shall be handled and placed without impact. The method of lifting, the type of equipment and transport to be used, and the minimum age of the components to be handled shall be to the approval of the Superintending Officer.

3.3 Construction of column, beam and slab

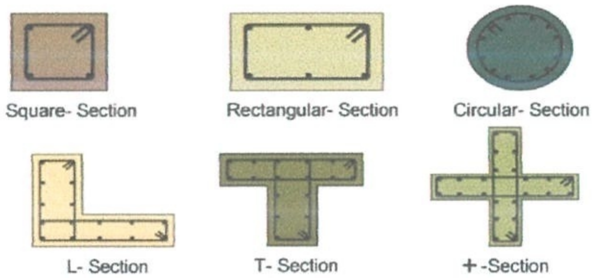
3.3.1 Construction of column

Figure 3.14 Checking the vertically of column

Columns are basically rigid vertical structural members designed primarily to support axial compressive loads coming from beams and slabs and then transfer it to ground through footing. In our human body bones give strength as well as transfer over body weight to bottom i.e. to over legs, in the same way the different loads that are generated in a structure are transferred by column to footings and footing to soil. So, column plays an important role in whole load transfer mechanism and without its structure doesn't exists.

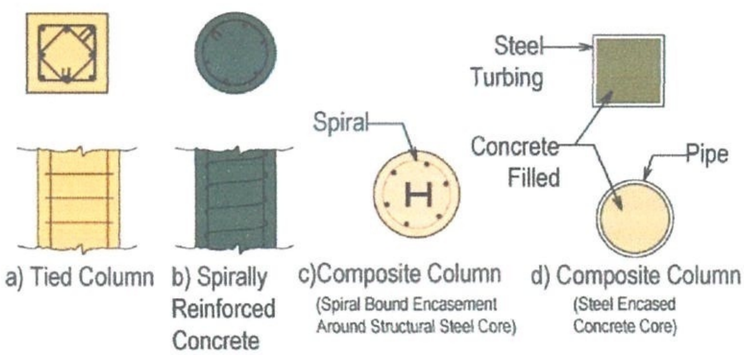
However, every vertical member cannot always be a column. A column is a member whose length is more than 3 times its least cross-sectional dimension. If this criterion is not followed then that vertical member is called as strut.

The strength of a column depends on largely strength of material used, geometry, shape and size of cross section, length and position of column with respect to support condition at both ends.



Columns can be classified based on different criteria as follows:

a. On basis of its cross section
b. On basis of its length and behavior
    i) Long column
    ii) Short column
c. On basis of its loading
    i) Axially Loaded Column
    ii) Axially Loaded and uni-axial bending
    iii)Axially Loaded and bi-axial bending
d. On basis of its longitudinal reinforcement



3.3.1.1 Things to be considered on construction column

Figure 3.15 Setting out line mark

1. Setting out line mark by Main Con 500mm from gridlines for both side of brick wall upon completion of floor slab.
2. Make sure the vertically of the column. To plumb corner column and pull string to all edges and party wall.
3. Make sure the size, quantity and arrangement of reinforcement and the link are following the engineer design.
4. Make sure concrete cover is according to Engineer requirement. Use concrete spacer.
5. Additional of floor height of 2 inch to allow for floor finishing work. (Ground floor/first floor power float finishes with flat sheet ceiling).
6. Additional of floor height of 5 inch to allow for plaster ceiling at last level with tiling works.
7. Ensure the starter bar for each column is sufficient. (46 x diameter).
8. The formwork for column should follow the design in drawing. Use screw and nut system to ensure formwork is well tied if the column is big (usually < 300).
9. Dowel bar for brick work should be install interval of 2ft.
10. Do not forget to allow pipe sleeve opening for plumbing and electrical work.
11. To put poker in the column.
12. Removal of column formwork = minimum 48 hours.
13. To mark CFL + 1. Om for all columns after concreting

3.3.2 Construction of beam

Figure 3.16 Formwork of beam

Beams are structural elements that transfer loads imposed along their length to their end points where the loads are transferred to walls, columns, foundations, and so on.

A beam is a structural member which spans horizontally between supports and carries loads which act at right angles to the length of the beam. The width and depth of a typical beam are "small" compared to their span. Generally, the width and depth of are less than 10 cm.

Usually, a beam is exposed to two sets of external forces and two types of internal forces. The external loads are the loads applied to the beam and reactions to the loads from the supports. The two types of internal force are bending moments and shear forces. The internal shear force and the internal bending moment can be represented as pairs of forces. The Figure below shows a Typical Beam with Internal and external forces acting on it.

3.3.2.1 Things to be considered on construction beam

<u>*Ground Beam*</u>

1. Determine the location of ground beam.
2. All formwork needs to apply with a layer of used oil plus diesel before using
3. Lean con is to be laid before installing reinforcement. Make sure column stump is free of lean con and dirt. Do sloping down where necessary.
4. Make sure the reinforcement and the link are as shown in C&S Engineering drawing.
5. The formwork should be strut properly and free

Figure 3.17 Installation of bar at ground beam

from gap to avoid concrete leakage during concreting work.

6. Ensure that the spacer block is apply before pouring the concrete.
7. Counter check the right angle for building. To provide drop area for car porch, toilet etc.
8. Do not forget to allow pipe sleeve opening for building and electrical work.
9. To install stiffener as per drawing.
10. For beam next to perimeter apron/car porch install starter bar to prevent cracks to apron.
11. Ground slab to sit on top of full ground beam size for suspended slab (depends on engineer's approval). Propose Y10 @ 300c/c.
12. Ground beam width tolerance allowance-5mm.

Roof Beam

1. Make sure the roof beam are levels.
2. To consider allowance for ceiling and tiling. Normal case is 125mm allowance for roof beam. For high rise construction normally do not practice allowance.
3. To install stiffener for roofing work and future brickwork purpose.
4. Never miss out all coping for architectural design.
5. Removed all formwork and strut at gutter area during concreting and proper patching to prevent leakage.
6. Make sure cleaning work is carried out at ground/first floor slab after concreting roof beam.

3.3.3 Construction of slab

Concrete slabs are form for roof and floors of reinforced concrete buildings. Usually, slabs will be designed to act as diaphragms to transfer horizontal loads to the structural frame. Slabs are often reinforced with welded wire fabric, but can also bond directly to a steel deck. The deck is supported by joists, which may be open web steel joists or concrete.

Figure 3.18 Compacting fresh concrete for slab

Slabs transfer loads in either one or two directions. A one-way slab is usually longer than its spanning width. The load will flow perpendicular to the long axis. Two-way slabs are roughly square in plan, and the load is dispersed along both axes.

Concrete slabs can be prefabricated off-site and lowered into place or may be poured in-situ using formwork. If reinforcement is required, slabs can be pre-stressed or the concrete can be poured over rebar positioned within the formwork.

There are several different types of slab, including:

i) Flat Slab
ii) Conventional Slab
iii) Hollow core ribbed slab
iv) Waffle Slab
v) Solid Slab Raft
vi) Composite Slab

Through the practical training I have been appointed, the VVIP Room at Astaka is using the Flat Slab. This is a typically a reinforced slab supported directly by columns or caps, without the use of beams. This type of slab is generally easy to construct and requires little formwork.

3.3.3.1 Things to be considered on construction slab

1. Make sure pre order materials such as BRC cut to size, scaffolding, U head, Jack base and formwork. Scaffolding, U head and Jack base must mark with blue paint to avoid theft.
2. Make sure the size, quantity and arrangement of B.R.C follow the engineer design. (Short span and long span are placed accordingly)
3. Ensure the slab are level. Additional of floor height of 2 inch to allow for floor finishing work.
4. Make sure all drop area are allowed. (Toilet drop should add 1 inch to allow tiles lay to fall).

Figure 3.19 Surface should be clean before concreting

5. Toilet and gutter area not allow using spaces block. Must use steel bar chair to prevent leakage.
6. The formwork for slab should be strong enough and can support the concrete load. Check all prop and scaffolding bracing properly install.
7. Never miss out all coping for architectural design to avoid to. Determine location of stiffeners (if additional is required).
8. Formwork for toilet and drops area, size must be slightly bigger from architectural dimension.

3.4 The problem and solution for superstructure

3.4.1 Honey-comb

Problem

Figure 3.20 Honeycomb defect

Honeycombs are hollow spaces and cavities left in concrete mass on the surface or inside the mass where concrete could not reach. These look like honey bees' nest. Improper vibration and workability of concrete are main causes of honeycombs in concrete.

Honeycombs which are on sides are visible to naked eyes and can be detected easily as soon shuttering is removed. Honeycombs which are inside mass of concrete can only be detected by advanced techniques like ultrasonic testing.

Honeycomb is due to non-reaching of concrete to all places due to which cavities and hollow pockets are created, main reasons are:

i) Improper vibration during concrete.
ii) Less cover to reinforcement bars
iii) Use of very stiff concrete (this can be avoided by controlling water as per slump test).
iv) Places like junction of beam to beam to column and to one or more beams are the typical spots where honeycombs are observed. This is due to jumbling of reinforcement of beams and column rods at one place; special attention is required at such place during concreting and vibrating.
v) Presence of more percentage of bigger size of aggregate in concrete also prevents concrete to fill narrow spaces between the reinforcement rods

Solution

Functional/aesthetic concrete only:

1. Chip by hand to remove any loose material
2. SSD (saturated, surface dry). This is the process of saturating the concrete substrate to receive a topping or patch with water to prevent the rapid absorption of the new materials moisture, which could cause shrinkage and loss of strength. Following saturation, the substrate is blown-off with clean air, or vacuumed so the surface is dry.

Figure 3.21 Recover the honeycomb defect

3. Scrub coat
4. Float-in a polymer modified, architectural finishing mortar.
5. Finish with a sponge float.
6. Cure and seal.

Structural concrete: *If the extent of the honeycombing reaches to the reinforcing steel or beyond, it must be treated as a structural repair.*

1. Saw-cut perimeter of patch to minimum ½" deep. This step serves several purposes, with respect to repair area durability. It contributes to proper patch geometry (a patch that is irregular in shape and depth will cure and shrink irregularly). A square shoulder also provides a straight line between new and existing materials that is easier to anchor, bond, and seal, as well as being more damage resistant.
2. Chip out the unsound material to a minimum depth of ½" beyond the rebar. This step is part of the diverse topic of surface preparation. Mechanically profiling the contact surfaces of a repair area to a fractured aggregate profile greatly increases the total bond surface area and provides mechanical interlock between the new and existing. This is especially important with coatings, toppings and overlays that are not anchored like a patch would be. For this reason the International Concrete Repair Institute (ICRI) established industry accepted standards for surface preparation, and product manufacturers will specify requirements based on those standards (below).
3. Prep rebar if corroded.
4. Saturate prepped surfaces with water (SSD)

5. Apply a bond-scrub-coat: scrubbing the repair material into the profiled surface of the substrate using a stiff brush or gloved hand. This forces the repair material into intimate contact with the substrate promoting 100% bond and mechanical interlock between the new and existing. Note: This process is sometimes referred to in error as a "bond-slurry-coat". This is misleading, and implies that the scrub material be of fluid consistency. This often results in far too much water being used in the scrub material, resulting in a weak mix, counter-productive to the intent. The scrub material should use the same amount of water or less than the patch material.
6. Patch with a polymer modified, fiber-reinforced structural mortar.
7. Cure and seal.

3.4.2 Spalling of Concrete

Problem

Figure 3.22 Spalling concrete

The word Spall in engineering, describes the chips or fragments of a material that is broken off a bigger object. The process of spalling also known as spallation is the surface failure that occurs when a material such as concrete, brick, or limestone is subjected to excess moisture, corrosion, weathering, and much more.

Left untreated and exposed to the elements will cause extensive structural damage and may cause it to break away from the façade, potentially injuring the public and damaging property.

Spalling, at a low level, is mainly a cosmetic problem but it can lead to structural damage if not dealt with immediately. If left untreated, damage can occur to the reinforcing bars within the concrete. Also, large enough fragments could fall off which could lead to serious consequences.

Concrete spalling is usually caused by corrosion of the steel reinforcement bars embedded in the concrete matrix, but can be caused by other ferrous elements either fully or partially embedded in the structure. Steel frame window systems, handrails, structural I-beams, metal pipes and conduits are among the most common of the damage causing building components.

Solution


Figure 3.23 Recover the spalling concrete

1. Remove the concrete at the spalled areas to expose the corroded steel bars.
2. Scrape and clean the exposed steel bars and use a wire brush to remove the rust.
3. Apply two coats of anti-rust paint to the steel bars.
4. Before patching the area, apply a bonding agent to the affected surface to ensure proper adhesion.
5. Patch up the hacked area using polymer modified cement mortar.

3.4.3 Unacceptable beam

Problem

Figure 3.24 Beam should be removed

Demolition of buildings and structures are required for various reasons. Design structure changes are also the cause of a structure such as beam, being demolished. This is also to ensure the building is construct according to the specifications.

Through the practical training I have been appointed, a slanting beam needs to be demolished as the architect changes a new design. According to the architects, the precast bench could not be installed because the slanting beam obstructed the precast bench position.

Solution

1. Before the slanting beam is remove, the Site Engineer and Safety Officer will need to confirm the method for demolishing the structure.
2. The slanting beam is then fastened with chains and ropes.

3. A labour will hack the beam and cut off the reinforcement bar between the slanting beam and the horizontal beam.
4. The unacceptable slanting beam will be lifted up by the crane and remove from the site.


Figure 3.25 Cutting the connection bar


Figure 3.26 Removing the unacceptable slanting beam

CHAPTER 4.0

CONCLUSION

Overall after involvement in building construction focusing on superstructure elements, construction of column, beam and slab is the main bone of the building structure as all loads are transmitted through it. Generally, superstructure is the above foundation / ground level part of the building. Therefore, it is important to understand the various components that make up the column, beam and slab in selecting the possible materials suitable for the superstructure. Other than that, the characteristic of the method choose are also necessary to make sure it is time and cost efficient for both parties. Concrete work also needs to be done by experienced workers throughout the process as it is dangerous and required skills, this can ensure the concrete work are done properly to provide a stable and strong superstructure for the building. In addition, based on KPRJ BUILDERS Sdn. Bhd. regulation of building lifespan, all the designs of superstructure are made to last more than 50 years, and this definitely require a high quality of concrete work.

Moreover, in ensure the reinforced concrete column, beam and slab are completely strong and safe for the superstructure, Quality Assurance and Quality Control inspection is a must to prevent any damage or defects. Some common defects caused by agents such as atmospheric pollution, poor workmanship or the use of inferior materials and climatic conditions are more frequent Defective building construction not only contributes to the final cost of the product but also to the cost of maintenance, which can be substantial. Defective construction includes activities such as compaction not done to specifications leading to fragile concrete strength and eventual early deterioration of structures. This may lead to the complete failure of a superstructure. Additionally, inherent failures may also happen in a building in which has to cope and carry any unsettled problem of the defects. Problems of the defects may lead to an unstable building structure, which is unsafe to users and occupants.

Building or housing is the most fundamental need for humankind. Therefore, stable and secure buildings are important for the long term. With a strong superstructure, the building can last a lifetime.

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APPENDIX A

MINIMUM RATE OF SAMPLING FOR ASSESSING CONFORMITY

Production	Minimum rate of sampling for assessing conformity		
	First $50m^3$ of production	Subsequent to first 50m of roduction[e]	
		Concrete with production control certification	Concrete without production control certification
Initial (until at least 35 test results are obtained	3 samples	$1/200m^3$ or 2/production week	$1/150m^3$ or l/production day
Continuous (when at least 35 test results are available		$11400m^3$ or l/production week	

a. Sampling shall be distributed throughout the production and should not be more than 1 sample within each 25 m^3

b. Where the standard deviation of the last 15 results exceeds 1,37σ, the sampling rate shall be increased to that required for initial production for the next 35 test results

APPENDIX B

CONFORMITY CRITERIA FOR COMPRESSIVE STRENGTH

Production	Number n of test results for compressive strength in the group	Criterion 1	Criterion 2
		Mean of n results (f cm) N/mm2	Any individual test result (f_{ci}) N/mm
Initial	3	$\geq f_{ck} + 4$	$\geq f_{ck} - 4$
Continuous	15	$\geq f_{ck} + 1{,}48\sigma$	$\geq f_{ck} - 4$

APPENDIX C

RECORDED DATA AND OTHER DOCUMENTS

Subject	Recorded data and other documents
Cements, aggregates, admixture, additions	Name of suppliers
Tests on mixing water (not required for otable water	Date and place of sampling. Test results
Test on constituent materials	Date and test results
Composition of concrete	Concrete description Record of masses of constituents in batch or load Water/cement ratio . Chloride content
Tests on fresh concrete	Date and place of sampling Location in structure Consistence (slump or other methods) Density Concrete temperature Air content Volume of concrete batch or load tested Number and codes of specimens to be tested Water/cement ratio
Tests on hardened concrete	Date of testing Code and ages of specimens Test results for density and strength Special remarks (e.g . unusual failure pattern of specimen
Evaluation of conformit	Conformity /non-conformity with specifications
Additionally for ready mixed concrete	Location of work Numbers and dates of delivery tickets related to tests Delivery tickets

APPENDIX D

MINIMUM PERIODS BETWEEN CONCRETING AND REMOVAL OF FORMS

Vertical faces of beams, wall, columns, piles, foundation plinths and precast components	3 days
Slabs (props left under)	4 days
Removal of props to slab	10 days
Beam soffits (props left under)	8 days
Removal of props to beams	21 days

Note: This table is applicable only for CEM1 cement. Where other types of cement, admixtures or additional material are to be used, the minimum periods between concreting and removal of forms shall be as approved by the Superintending Officer.