ANALYSIS AND DESIGN OF SCREENING BUILDING

By

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Major Project

on

ANALYSIS AND DESIGN OF SCREENING BUILDING

Submitted in partial fulfillment of the requirements

For the degree of

Master of Technology in Civil Engineering
(Computer Aided Structural Analysis & Design)

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CERTIFICATE

This is to certify that the Major Project entitled "Analysis and design of Screening Building" submitted by Mr. Shah Chirag P. (06MCL017), towards the partial fulfillment of the requirements for the degree of Master of Technology in Civil Engineering (Computer Aided Structural Analysis and Design) of Nirma University of Science and Technology, Ahmedabad is the record of work carried out by him under my supervision and guidance. In my opinion, the submitted work has reached a level required for being accepted for examination. The results embodied in this major project, to the best of my knowledge, haven't been submitted to any other university or institution for award of any degree or diploma.

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ABSTRACT

A conveyor belt is a device that presents a continually moving surface that is designed to move objects from one location to another. The conveyor belt is a long loop of rubber or plastic (usually combined with steel for strength, just like tire treads), that is wrapped around a set of motorized rollers that cause the surface of the belt to move forward or backwards.

Screening building is a part of the conveyor belt systems which generally used in mining or cement industry. The main purpose of unit is to carried out material in desired size. It also has conveyor systems over it to carry out material on further unit over conveyor system.

A screening building is analyzed for various loads like transverse load due to stingers, longitudinal load due to moving of belt, Wind load, Earthquake load, dead load and live load. Its designed is carried out by using Staad-Pro and checked manually. The analysis and design of Raft Foundation is also carried out. Moreover this thesis also gives brief calculation and introduction about the connections. Further a comparative study is carried out by using different bracing pattern for the screening building.

The software used for modeling, analyzing and design is Staad-Pro 2007. This thesis also shows the brief introduction about the use of the Staad-Pro.

CONTENTS

Certificate		i
Acknowledgement		ii
Abstract		iii
Contents		iv
List of Figures		vii
List of Tables		viii
Abbreviation Notation and Nomenclature		ix
Chapter 1	**Introduction**	
1.1	General	1
1.2	Conveyor Systems	1
1.2.1	Components of Conveyor System	3
1.3	Feeding Devices	9
1.4	Crushers	10
1.4.1	Gyratory Crusher	11
1.4.2	Impact Crusher	12
1.4.3	Roller Crusher	12
1.4.4	Jaw Crusher	12
1.5	Screens	13
1.5.1	Vibrating Screen	14
1.5.2	Rotary Screen	14
1.5.3	Physical Principal Governs vibrating Screen	16
1.6	Objective of Study	16
1.7	Scope of Work	16
1.8	Organization of Major Project	17
Chapter 2	**Literature Review**	**18**
2.1	General	18
2.2	Equipments	18

2.2.1 Gyratory Equipments 18
2.2.2 Vibrating Screen 19
2.3 Literature Review 20

Chapter 3 Analysis of Screening Building 22
3.1 General 22
3.2 Static Analysis 22
3.2.1 Analysis of Head End 22
3.2.2 Analysis of Conveyor System 24
3.2.3 Analysis of Screening Building 27
3.2.4 Modeling Using Staad-Pro. 33
3.3 Dynamic Analysis 35
3.3.1 Free Vibration Analysis 35
3.3.2 Force Vibration Analysis 35
3.3.3 Permissible Deflection 37
3.3.4 Modeling Using Staad- Pro. 37
3.4 Design of Members 39

Chapter 4 Effect of Bracings 41
4.1 General 41
4.2 Analysis 41
4.3 Comparison of Results 42
4.3.1 Static Analysis 42
4.3.2 Dynamic Analysis 43

Chapter 5 Design of Connections 44
5.1 General 44
5.2 Design Principal 45
5.3 Rivet Connections 45
5.3.1 Types of Joints 45
5.3.2 Failures in Riveted joints 46

5.4 Connections 47
5.4.1 Simple Connections 47
5.4.2 Moment Connections 50
5.5 Column Bases 53

Chapter 6 Design of Raft Foundation 59
6.1 General 59
6.2 Types of Raft 60
6.3 Analysis of Raft foundation 61
6.3.1 Pressure Distribution under Raft 63
6.4 Modeling of Raft foundation using SAFE 66

Chapter 7 Summary and Conclusion 68

7.1 Summary 68
7.2 Conclusion 70
7.3 Future line of Action 70

References
Appendix – A Drawings
Appendix - B Design of Raft Foundation

List of Figures

Figure No.	Caption of Figure	Page No.
1.1	Conveyor Systems	2
1.2	Components of Belt Conveyor System	3
1.3	Carrying Idler	5
1.4	Drive pulley And Tail Pulley	6
1.5	Belt Cleaners	7
1.6	Conveyor Frame	8
1.7	Magnetic Pulley Separators	8
1.8	Material Feed Systems	9
1.9	Gyratory Crusher	11
1.1	Jaw Crusher	13
1.11	Vibrating Screen	14
1.12	Rotary Screen	15
2.1	Reciprocating Machine	18
3.1	Head End	23
3.2	Belt Tension on Head End	23
3.3	Conveyour Belt System	26
3.4	Modeling in Staad	33
3.5	Assigning Earthquake Definitions	34
3.6	Lump Mass in Staad Pro.	34
3.7	Assigning of Time history in Staad	37
3.8	Natural Frequency of Structure	38
3.9	Displacement of Dynamic Analysis	38
3.10	Design Window	39
3.11	Parameter Selection Window	39
3.12	Result for particular Beam	40
4.1	Frame With K Bracing in z direction	41
4.2	Frame with K Bracing in x direction	42
4.3	Deflection due to Earthquake Force	42

5.1	Types of Connections	44
5.2	Simple Frame Connection	47
5.3	Beam Column Connection- shear	50
5.4	Beam column moment connection	52
5.5	Type of Connection	53
5.6	Pressure Distribution under Base Plate	54
5.7	Base Plate	55
5.8	Detail of Base Plate	58
6.1	Types of Raft	61
6.2	Bending Moment in Y Direction	66
6.3	Bending Moment in X direction	67
7.1	Weight Comparison	68
7.2	Deflection Due to Earthquake Force	69

List of Tables

Table No.	Title Of Table	Page No.
3.1	Reaction of Head End	24
3.2	Reaction of Conveyor System	26
3.3	Self Weight calculation	28
3.4	Weight of Chequred Plate	29
3.5	Live Load On Walkway	29
3.6	Total Weight of each level	29
3.7	Earthquake force on different level	30
3.8	Forces due to crushers	36
4.1	Frequency Criteria	43
7.1	Weight Comparison	69

ABBREVIATION NOTATION AND NOMENCLATURE

d	Diameter of the wire
D	Diameter of Spring
F	Design wind load
G	Shear Modulus
h	compressed height of spring (under static load)
k1	The probability factor
k2	The terrain, height and structure size factor
k3	The topography factor
L	Length of the connecting rod;
L	Span of Truss
m_{rec}	Mass of the reciprocating parts
m_{rot}	Mass of the rotating parts
n	Number of coils
Ø	Solidity Ratio
p_z	Design wind pressure
r	Radius of the crank shaft
R	Radius of the spring (to the centroid of the wire)
Vb	Basic wind speed
Vz	Design wind speed
ɑ	Coefficient
η	Shielding factor
ω	Rotational speed (in radians per second)

1. INTRODUCTION

1.1 GENERAL

Human civilization grows rapidly after the industrial revolution because of easy availability of material which results in to the technological and economical progress with development of steam-powered ships, railways and latter into nineteenth century with the internal combustion engine and electrical power generation. The main reason of development of this era is better techniques of the process on the natural materials in the mining industry. Generally the handling of materials and the process of the natural materials are carried out by conveyor system and this system consist of various processing unit over it i.e. crushing, chemical processing unit etc. Crushing is important in case of Mining industry, Cement Industry etc.

1.2 CONVEYOR SYSTEMS

Conveyor systems are mechanical handling equipment that moves materials from one location to another. Conveyors are especially useful in applications involving the transportation of heavy or bulky materials. Conveyor systems allow quick and efficient transportation for a wide variety of materials, which make them very popular in the material handling and packaging industries. Many kinds of conveying systems are available, and are used according to the various needs of different industries.

Conveyor systems are used widespread across a range of industries due to the numerous benefits they provide.

- Conveyors are able to safely transport materials from one level to another, which when done by human labor would be strenuous and expensive.

- They can be installed almost anywhere, and are much safer than using a forklift or other machine to move materials.

- They can move loads of all shapes, sizes and weights. Also, many have advanced safety features that help prevent accidents.

- There are a variety of options available for running conveying systems, including the hydraulic, mechanical and fully automated systems, which are equipped to fit individual needs.

Conveyor systems are commonly used in many industries, including the automotive, agricultural, computer, electronic, food processing, aerospace, pharmaceutical, chemical, bottling and canning, print finishing and packaging. Although a wide variety of materials can be conveyed, some of the most common include food items such as beans and nuts, bottles and cans, automotive components, scrap metal, pills and powders, wood and furniture and grain and animal feed. Many factors are important in the accurate selection of a conveyor system. It is important to know how the conveyor system will be used beforehand.

Types of Conveyor systems are as follows.

- Belt Conveyor
- Roller Conveyor
- Screw Conveyor
- Apron Conveyor
- Bucket Conveyor (Fig. 1.1)
- Pneumatic Conveyor

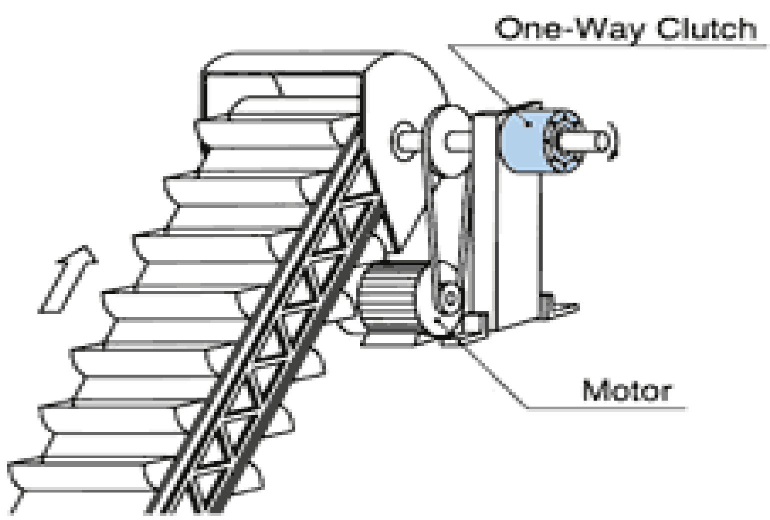


Fig.1.1 Conveyour Systems

1.2.1 COMPONENTS OF CONVEYOR SYSTEMS

In the conveyor system various types of mechanical components are used. Usually the belt conveyor is used for transporting coal as material in the system. It consists of a belt made up of layers of rubberized fabric, and is manufactured in widths capable of carrying a certain tonnage at certain speeds. The belt ends are spliced together, creating an endless loop which travels continuously between a head and tail pulley. The belt is supported on the top or carrying side by troughing rollers and on the bottom by straight or return idlers. It is normally driven by a motor connected to the head pulley shaft through a speed reducer. Proper load carrying tension is maintained by adjusting screw take-ups, or by gravity take-up counterweights. The basic components of the belt conveyor systems are shown in Fig. 1.2.

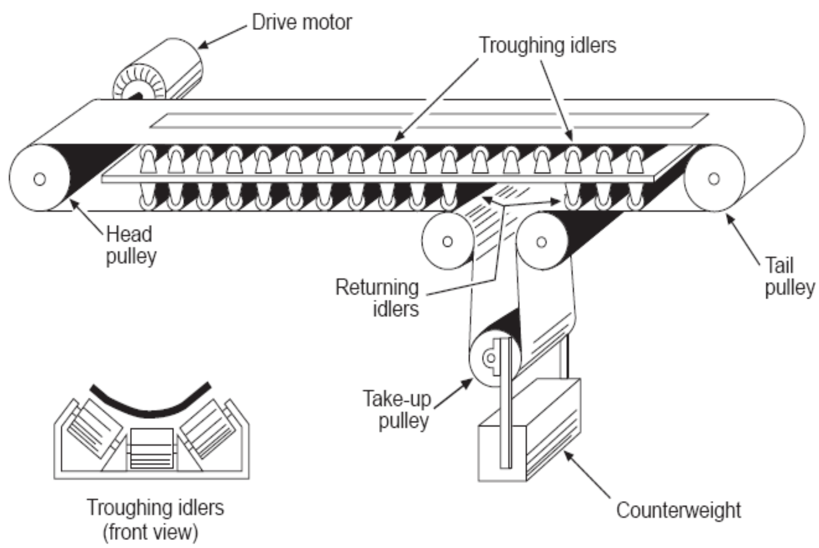


Fig. 1.2 Components of belt conveyor system

The detailed descriptions of various components of the Transfer tower conveyor systems are given below.

- The Belts
- The idlers - Carrying idlers and Return idlers
- Shuttle conveyor
- The pulleys
- Take up

- Belt cleaners
- Conveyor frame
- Magnetic pulley separator

I. The Belts

In the belt conveyor system the belt is used as the continuous moving load carrying and tractive element. The following types of textile belts are employed in belt conveyors: camel hair, cotton, duck cotton and also rubberized textile belts of various types. Conveyer belt should meet the following requirements: low hygroscoposity, high strength, low own weight, small specific elongation, high flexibility, high resistivity to ply separation, long service life. Rubberized belt meet these requirements better than other types therefore generally preferred. The belt of a conveyor should have a high strength, low mass and low relative elongation, high elasticity (flexibility) longitudinally, and should resist properly alternate stresses appearing on multiple bendings in the belt on pulleys and rollers supports. It should also have a high wear resistance to abrasion by the conveyed material and conveyor elements and an ample resistance to the physico-chemical action of the load surroundings. The width of the belt is governed by lump size of material conveyed and the capacity requirement. The manufactured standard widths of belt are 300, 400, 500, 650, 800, 1000, 1200, 1400, 1600, 2000, 2500, and 3000 mm.

II. The Idlers

The Idlers are used mainly conveyors handling bulk loads, less frequently unit loads, According to their location on the conveyor. The idlers are classified as,

1. Carrying (upper) idlers.
2. Return (lower) idlers.

a). The Carrying Idlers

The carrying idlers have generally three types of configurations,

- Five/three roll troughing idlers for troughed belts
- Two roll troughing idlers for troughed belts

- Horizontal carrying idler for supporting flat loaded belts

The Fig. 1.3 shows the three types of configurations in carrying idlers. The spacing of the idlers, diameter, and the design of the antifriction bearings are important factors in the design of a belt conveyor. If the spacing is excessive, the sag from idler to idler causes shock to the belt as it meets the rolls, shortening the life of the belt. Large diameter rolls reduce the abruptness of the bend as the belt rides the idler. The dust proof bearings are packed with lubricant by the manufacturer therefore no attention is required for long time.

b). The Return Idlers

The Return idlers which never contain more than single idlers is shown in Fig. 1.3 (III). Return idlers are subjected to the same severity as the carrying idlers, since they carry the empty belt, their spacing is doubled. There bearings and seals should be interchangeable with those of the carrying idlers, and the rolls should be so mounted in the hangers that they can be removed without disturbing the bearing adjustment.

(I) (II) (III)

Fig. 1.3 Carrying and Return Idlers

III. Shuttle Conveyor

Shuttle conveyor is the short length belt conveyor system which is used to feed from one belt to another which may be set at any point suited to desire point to discharge. Sometimes the reversing motor is used to provide adjustable stops which fix the limits of travel in either direction.

IV. The Pulleys

The Pulleys are the main component of the conveyor belt system. The Fig. 1.4 shows that the driving pulley and tail pulley. The diameter of the pulley is selected based on the percentage of tensile force (ratio between the working tensile force and maximum allowable tensile force of the selected belt). The Pulleys may be straight faced or have a crown on the pulley face. The driving pulleys are cast iron or welded of sheet steel. The crown serves to keep the belt centered. In the lighter tension range the power may be transmitted to the belt through a flat face cast iron or steel pulley. A pulley with crown face should not be used as it would cause uneven stress across the belt. For greater tensions, the pulley is legged with rubber securely bolted or riveted to the rim, and a snub pulley is provided to increase the arc of contact with the belt.

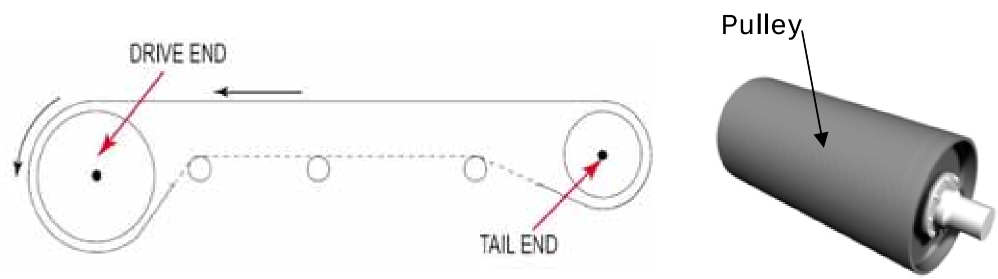


Fig. 1.4 Drive Pulley and Tail Pulley

V. Take Up

Take up are the main unit of the conveyor system for carrying the load initially on track. The choice of take up and their location has to be decided depending on the configuration and length of the conveyor and available space. But acceleration and braking of conveyors have certain effects on the take up.

The main functions of the take up are;

- Ensuring adequate tension of the belt leaving the drive pulley so as to avoid any slipping of the belt,
- Permanently ensuring adequate belt tension at the loading point and at any other point of the conveyor to keep the troughed belt in shape and limit belt sag between carrying idlers,

Generally two types of take ups are used in the conveyor system;

a) Fixed take up devices that are adjusted periodically and

b) Automatic Take up device (constant load type)

VI. Belt Cleaners

It is necessary to clean the belt when drive pulleys make contact with dirty side of the belt on the return run. This is especially the case when handling materials which are likely to pack on the belt, such as sticky and wet materials. The actual cleaning in scraper devices is performed by a strip of technical rubber facing a hinged bar or in the case of brushes, by rigid bristles or 1.0 to 1.2 mm Capron fiber facing the generating line of cylindrical brush face. The belt cleaners (Fig. 1.5) are mounted near the discharge pulley and scatter falls into the discharge spout.

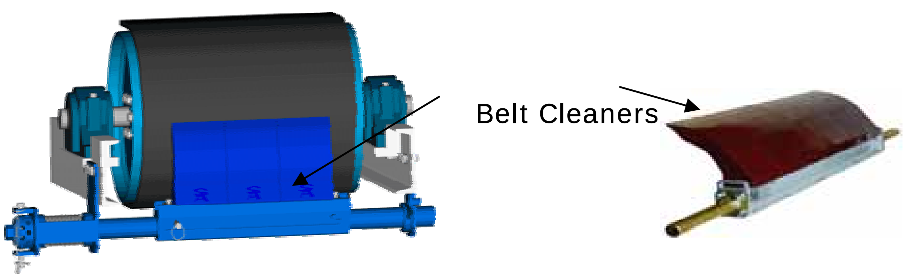


Fig. 1.5 Belt Cleaners

VII. Conveyor Frame

In the belt conveyor system the belt is supported by the conveyor frame. The arrangement of the supporting belt on the conveyor frame is shown in Fig. 1.6. The total arrangement of the belt supporting system is also known as the conveyor galley.

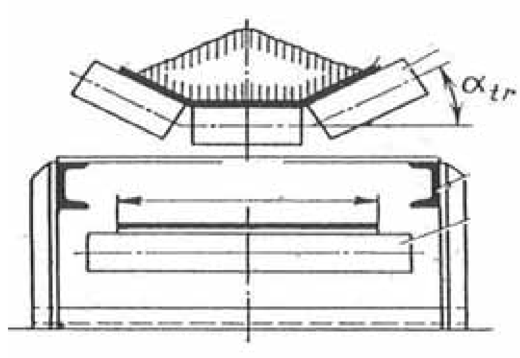


Fig. 1.6 Conveyor Frame

The supporting structure of the conveyor frame intermediate section is usually electric welded of profiled rolled stock, angle iron or channel bar, and consists of longitudinal beams, uprights and cross-pieces. The height of the frame is usually 400 to 500 mm; the spacing between the uprights is 2 to 3.5 m.

VIII. Magnetic Pulley Separator

Magnetic pulley is one of the main components of the coal transfer belt conveyor system. The Fig. 1.7 shows the arrangement of the Magnetic pulley separators in the drive units.

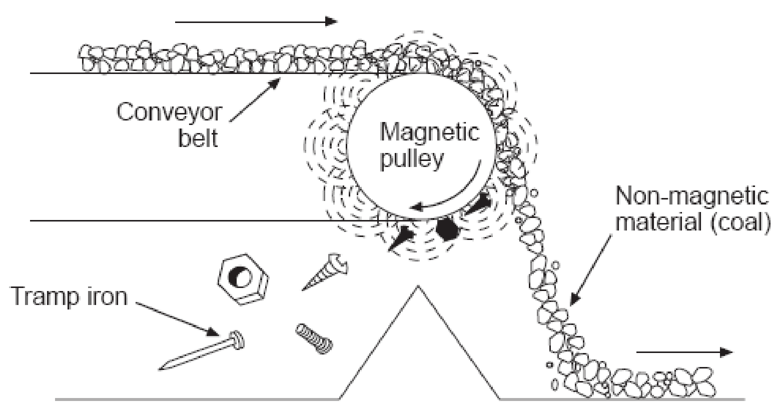


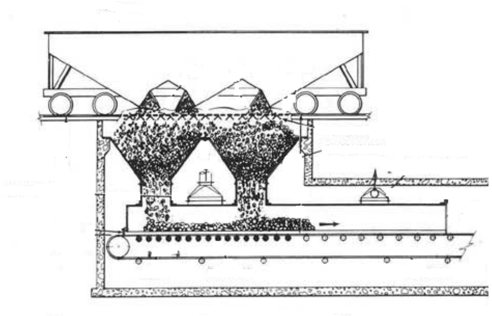
Fig. 1.7 Magnetic Pulley Separators

Either before or after the coal goes through the breaker, it passes over a magnetic pulley or separator which removes the tramp iron, dropping it into a tramp iron collector. After the coal passes through the breaker, it is delivered to the bunkers, to storage, or to the hammer mill crushers.

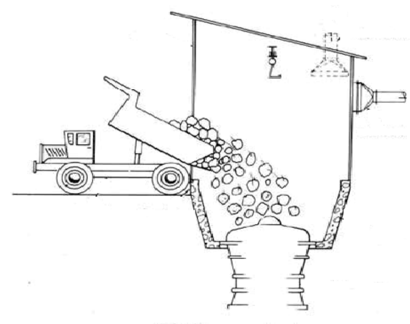
1.3 FEEDING DEVICES

Levels of primary crusher building will depend on method adopted for feeding the hopper. The feeding method may be of following

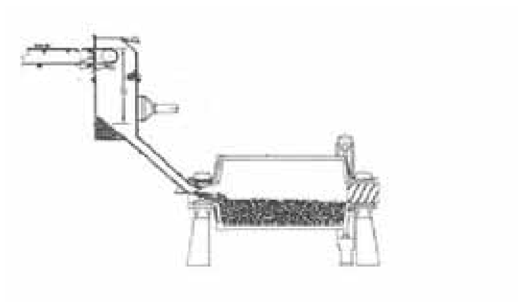
- Conveyor Belt System
- Truck loader System
- Train Wagon System



(a)Feed threw Railway Wagon



(b)Truck Loader System



(c)Conveyor Belt Systems

Fig. 1.8 Material Feed Systems

If railway siding is available, hopper top will be at ground level and materials will be fed through a wagon tippler as shown in Fig. 1.8 (a). In such case, the building may be as deep as 9 m below ground level to accommodate jaw crusher at a level lower provided with hopper at elevated level. Conveyor Belt System as a feeding device is used for the crushing of the ore mineral or clinker etc. and process The material to more then one plant. This type of system been used while the crusher unit are above the ground level. While in Truck loader system material is been directly crushed threw truck or loader.

Heavy material conveyors often cause excessive vibrations in structures. However, the nature and severity of these vibrations once again differ from one installation to the next, and specific values will have to be obtaining from the suppliers. The frequency of these vibrations depends on the speed of operation, the spacing of rollers and supports, and the nature of the material and the accuracy to which the equipment had been manufactured.

1.4 CRUSHERS

Crushers are important in case of handling the material into the particular size. The crusher unit consists of the mechanical crusher and the vibrating screen. Crushers generally cause excessive vibrations, and could lead to serious distress in buildings. The forces differ from one type of crusher to the next and actual measurements on similar installations may have to be performed.

Depending on quality of stone, single stage or two stage (primary and secondary) crushers are provided. In the primary stage, stone is crushed to 150mm size before feeding to roller press/ raw mills. As a buffer to quarry operation, primary crusher hopper capacity is generally provided as 25% of one day's requirement of stone.

For primary crushing, material from hopper is conveyed to jaw crusher. There is different arrangement of jaw crusher mechanism; the common feature is that like reciprocating machines, they create unbalanced inertia forces that depend on time period. These inertia forces form exciting loads, which induce forced vibrations of foundation. For detailed design, I.S. 2974–part 3: 1992 Code may be referred. The crushers and screens is to be rest on the frame type system and the final load is to be transferred to soil threw base plate system.

From an extractive metallurgical standpoint, there is a significant difference between crushing and grinding. In essence, crushing is a preliminary step to ensure that ore does not exceed certain dimensions which a grinder is capable of handling well.

Crushers are commonly classified by the degree to which they fragment the starting material, depending on its fragmenting capacity

- Coarse Crushers
- Intermediate Crushers
- Fine Crushers

Coarse Crusher churns the material in the coarse fragment while the fine crusher crushes the material in very fine part

Various types of crushers are available in the market but from them jaw crusher and gyratory crushers are used extensively. Various type of crushers available in the market are listed below.

1.4.1. Gyratory crusher (cone crusher)

A gyratory crusher (or cone crusher) is similar in basic concept to a jaw crusher, consisting of inner and outer vertical crushing cones; the outer cone is oriented with its wide end upward, and the inner cone is inverted relative to the outer with its apex upward. The inner cone has a slight circular movement, but does not rotate; the movement is generated by a cam or eccentric arrangement. While in the jaw crusher, material travels downward between two cones. And progressively crushed until it is small enough to fall through the gap between two cones at the bottom as shown in Fig. 1.9.

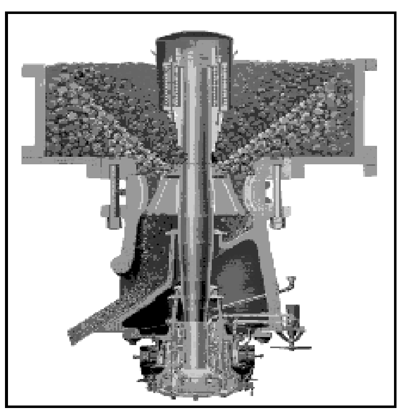


Fig. 1.9 Gyratory Crusher

1.4.2. Impact crushers

Impact crushers involve the use of impact rather than pressure to crush material. The material is contained within a cage, with openings on the bottom, end, or side of the desired size to allow pulverized material to escape. This type of crusher is usually used with soft material such as coal, seeds, or soft metallic ores.

- Hammer mills utilize heavy metal bars attached to the edges of horizontal rotating disks by hinges, which repeatedly strike the material to be crushed.

- Ball mills use metal balls in rotating cylinders.

1.4.3. Roller crushers

This type of intermediate crusher consists of a pair of horizontal cylindrical rollers through which material is passed. The two rollers rotate in opposite directions, which cause crushing of materials between them. A similar type of intermediate crusher is the edge runner, which consists of a circular pan with two or more heavy wheels known as millers rotating within it; material to be crushed is shoved underneath the wheels using attached plow blade recycling applications due to their ease of installation on building sites.

1.4.4 Jaw crusher

A jaw or toggle crusher consists of a set of vertical jaws, one jaw being fixed and the other being moved back and forth relative to it by a cam or pitman mechanism. The jaws are farther apart at the top than at the bottom, forming a tapered chute so that the material is crushed progressively smaller and smaller as it travels downward until it is small enough to escape from the bottom opening. The movement of the jaw can be quite small, since complete crushing is not performed in one stroke.

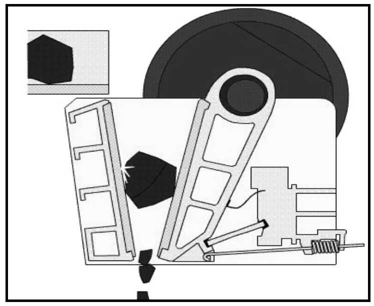


Fig. 1.10 Jaw Crusher

1.5 SCREENS

Screening is the practice of taking granulated or material and separating it multiple grades by particle size. This practice occurs in a variety of industries such as mining and mineral processing, agriculture, pharmaceutical, food, plastics, and recycling. Screening falls under two general categories:

- Dry screening
- Wet screening

From these categories, screening separates a flow of material into grades, these grades are then either further processed to a secondary product or a finished product. The mining and mineral processing industry uses screening for a variety of processing applications. For example, after mining the minerals, the material is transported to a primary crusher. Further down stream after crushing the material can pass through screens with openings or slots that continue to become smaller. Finally, screening is used to make a final separation to produce salable product based on a grade or a size range. A screening machine consists of a drive that induces vibration, a screen cloth that causes particle separation and a deck, which holds the screen cloth and the drive and is the mode of transport for the vibration. There are physical factors that enables screening practical. For example, vibration, gravitational force, bed density, and material shape all facilitate the rate or cut. Electrostatic forces can also hinder screening efficiency in way of water attraction causing sticking or plugging, or very dry material generate a charge that causes it to attract to the screen itself. As with any industrial process there is a group of terms that identify and define what screening is. Terms like blinding, contamination, frequency, amplitude, and others describe the basic characteristics of screening, and those characteristics in turn shape the overall method of dry or wet screening.

Screens can be classified according to its characteristics and shapes.

1.5.1. Vibrating Screens

Vibrating Screens have various means of securing the required movement of the screening surface, and they may be single or multiple deck. The unbalanced pulley type shown in Fig. 1.11. It is actuated by a weighted pulley on a shaft mounted on the frame, which causes the frame and the screen to follow the orbit of the center of gravity of the pulley when the pulley is revolved at high speed. Thus the material fed to the inclined screen surface passes through, or over. The frame frequently is carried on curved leaf-springs to reduce transmission of the vibration to the supporting structure. The positive drive type is quite similar except that the vibrations are produced by an eccentric-machined, fixed-throw, rotary shaft with counter balance, and are more pronounced.

Fig.1.11 Vibrating Screen

1.5.2. Rotary Screen

The rotary screen is a slowly rotating, slightly inclined, perforated cylindering which the material tumbles over itself, the undersize passing cause of the tumbling action the rotary screen is well adapted to washing operations as with gravel plants. It has disadvantages with fragile material because tumbling causes degradation. Often the cylinder is divided into longitudinal screening sections, or there may be two or more concentric sections, so that several sizes may be produced. Fig 1.12 indicates the rotary Screen.

The screen cylinder may be carried on spiders or spokes mounted on the shaft or carried on rollers. Since the axis of the cylinder is inclined, thrust rollers are needed to hold it in position for the driving gears to remain in mesh; in fact , it is not unusual for the cylinder to drift uphill as the result of slight variation in alignment of the rollers, and so thrust rollers at both ends may be advisable.

Each practical, when it reaches a perforation of sufficient size, will pass out; however, it does not always do so. The particles in the mass slip over the holes with more or less speed; they are crowded together by other particles. There fore the particles passing over any given size of opening are smaller then they should be, even though the screen is of considerable length. The operating performance thus varies somewhat from the result with test screens.

Fig 1.12 Rotary Screen

1.5.3 Properties governing mechanical Screening

Following are some principals which governs the response of screens.

➢ *Vibration*-Vibration of screen can be either sinusoidal vibration or gyratory vibration.

➢ Sinusoidal Vibration - Sinusoidal Vibration occurs at an angled plane relative to the horizontal. The vibration is in a wave pattern determined by frequency and amplitude.

➢ Gyratory Vibration - Gyratory Vibration occurs at near level plane at low angles in a reciprocating side to side motion.

➢ *Gravity*- This physical interaction is after material is thrown from the screen causing it to fall to a lower level. Gravity also pulls the particles through the screen cloth.

➢ *Density*- The density of the material relates to material stratification.

➢ *Electrostatic Force*- This force applies to screening when particles are extremely dry or is wet.

1.6 Objective of Study

The main objective of the study of the topic is as follows

➢ Analysis of screening building frame using staad software.

➢ Design of Members of screening building.

➢ Design of Foundations of screening building.

➢ Find out effective bracing pattern in the frame

➢ Cost comparison of vibrating structure.

1.7 SCOPE OF WORK

Looking above objective the scope of work is decide as,

➢ Collect the data of crusher unit and specification of its mechanical components.

➢ Analysis of frame using various alternatives in bracing pattern.

➢ Design of Members and connections.

➢ Design of Raft Foundation.

1.8 ORGANIZATION OF MAJOR PROJECT

The Major project is organized in following chapters.

Chapter 1 presents the introduction and background of the material handling structures and conveying systems. Chapter 2 presents brief literature review pertaining to structure and conveyor systems. In Chapter 3 analysis of conveyor component like Tail End and Conveyor system is given. Load evaluation of Screening building and Modeling of Screening Building is also given in Chapter 3. In Chapter 4 different kind of Bracing pattern is used in Screening Building. Chapter 5 presents the introductory part of the different types of connections and sample calculations. The Design and Detailing of the moment resisting connection is also given in this chapter. Chapter 6 presents the classification Raft foundation, bearing capacity of soil and the analysis and Design of the Pile foundation is given. Chapter 7 presents the comparative study of the different structures.

2.1 GENERAL

Review from various literatures such as research papers and different books has been carried out to support the present work. Literature survey has been carried out for lumping of vibrating equipment and analysis of the vibrating structure by approximate and exact methods.

2. 2 Equipments

The forces of different type of equipments can be found out by following equations.

2.2.1 Gyratory equipment- This type of equipment differs from the above two such that the machine gyrates in a circular motion at a near level plane at low angles. The drive is an eccentric gearbox or eccentric weights.

The total inertia forces in longitudinal (P_z) and transverse (P_y) directions are given by:

$$Pz = (m_{rec} + m_{rot})rw^2 \cos wt + m_{rec} r^2 w^2 \cos wt$$

$$Py = m_{rot} rw^2 \sin wt$$

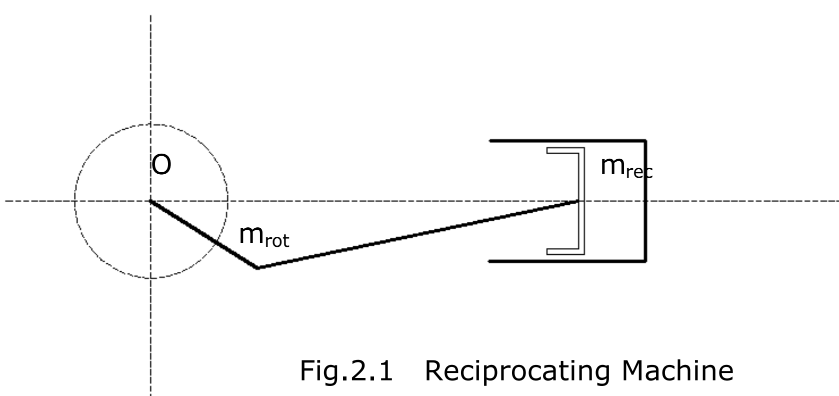


Fig.2.1 Reciprocating Machine

m_{rec} is the mass of the reciprocating parts;

m_{rot} is the mass of the rotating parts;

ω is the rotational speed (in radians per second);

L is the length of the connecting rod;

r radius of the crank shaft

2.2.2 Vibrating Screen

Vibrating Screens are commonly used in the mining industry for screening purposes. A screen typically consists of a rigid frame with a number of spring supports. The screen is usually vibrated by an eccentrically mounted rotating mass, which introduces the dynamic forces on the screen.

In practically all cases the stiffness of the supporting springs of these screens are not the same in the horizontal and vertical directions. In the case of rubber supports pads, the horizontal stiffness may be as much as 3 times less then the vertical stiffness, while for steel coil springs the stiffness in the two directions are given by the following two expressions.

The vertical spring constant of a steel spring is given by the following formula:

$$Kv = Gd^4 / 64R^3 n \quad N/m$$

$$K_h = K_v / (0.385\alpha(1 + 0.77\,(\mathrm{h/D})^2) \quad N/m$$

Where

G = Shear Modulus (80E9 to 83E9 N /m^2)

d = Diameter of the wire

R = Radius of the spring (to the centroid of the wire)

n = number of coils

h = compressed height of spring (under static load)

α = coefficient

D = Diameter of Spring

From the behaviour of a mass on springs, it will be clear that the maximum force exerted on the supporting structure is a function of the natural frequency of the system. Since the stiffness of the springs may not be the same in the two directions, the natural frequency, and therefore also the reaction forces, will also differ. For that reason it is clear that in the majority of cases the reaction forces will not act at 45′ to the horizontal, but rather at some other angle.

2.3 LITERATURE REVIEW

Various literatures have been studied for analysis of vibrating structure and brief review is as below.

G Krige and **D Wium**,[15], have carried out study on the vibrating structure and have indicated the various methods in the analysis of vibrating steel frame by manual method, the overview of dynamic loads and method of idealization of structure. They also shown the forces considered for different type of equipments as above.

2.3.1 Standard and Codes

IS 2974- 1982,[14], is an Indian code of practice by BIS, is for design and analysis machine foundation. Code specifies the types of load which has to be applied on the crusher frame.

2.3.2 Books

Don Danemanis. [2], The book describes the principal types of continuous conveying machines; conveyors, elevators, pneumatic and various auxiliary devices of conveying systems which in combination represent quite completely the modern means of complex mechanization in transporting materials-handling and storing operations. All types of conveying machines are described by a general scheme including their design, and operating principle.

J. D. Buch,[12], the book is based on the design of cement plant building. Which also describe the method of analysis of crusher frame on RCC frame.

J. W. Tedesco and C. Allenross,[2], The book is based on the structural dynamics and it gives the fundamentals of dynamics which found very useful while the dynamic analysis of frame.

Dr.B.C.Punmia, and A.K.Jain. [4], The book gives the basic knowledge for the analysis and design of steel structures based on the Indian standards. Its reference is made for the analysis and design of truss structures.

V. Afanasyev [1], gives description based on the various national code such as Indian (I.S:11592-2000), British standards, Russians standards and American standards. The book gives idea about conveying machines and some of the conveyors which are used in the industries. It gives description about the mechanical parts of the conveyer and show the different parts of the conveyer system.

Wilbur G. Hudson [3], is based on different national codes such as Indian, British, Russian, American, and German. The book describes different conveyors with their schematic diagram and gives important tables for the design of conveyor components. It also gives description and design for the elevators and crushers units.

Joseph E. Bowels [9], gives the analysis of the different foundation. The different techniques for soil exploration are suggested by him. The different tests on soil are also shown.

3. ANALYSIS OF SCREENING BUILDING

3.1 GENERAL:

Load evaluation is the most important part of design of crusher frame. An error in load assessment will make the design erroneous.

Structures shall be designed such that they are economical, safe and meet the functional & service requirements of the technological process for which they are designed.

Load evaluation in case of crusher unit is been carried out with the help of IS2974 (part4):1992. The analysis is divided in two parts

- Static Analysis
- Dynamic Analysis

3.2 STATIC ANALYSIS :

Details of plan and sections of crusher building are shown in drawings.

Whole structure is been divided in three components for the analysis of the screening building. (Refer Drawing 1 and 2).

1. Analysis of Tail End of Conveyor 043-CONV-003 / 004 / 005 and 006. Analysis of each tail end will be identical because all the loads for the conveyor systems are same.
2. Analysis of 043-CONV-013 as shown in drawing 2 at 982.990 TOS level in drawing 1 and 2.
3. Analysis of Screening Building. The reactions of tail end and conveyor systems is been transferred at particular point on the screening building.

3.2.1 Analysis of Head End

Head end is the end of conveyor system which rotates the belt in 360^{o} direction which transfers the belt tension to the supporting system as shown in fig. 3.1.

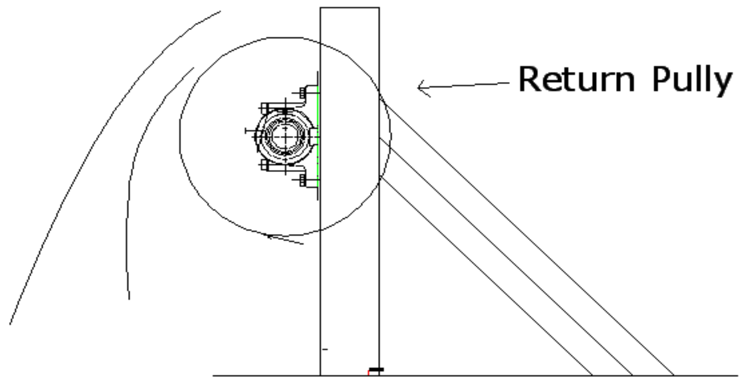


Fig. 3.1 Head End

Load Evaluation on Head End:

A) Dead Load

Reaction of Head end stringer = 2.3 kN (At each support)

Self Weight factor =1.1 (which includes connections)

B) Operating Load

Belt Tension = 158 kN

On each node = 158 /2 = 79 kN

Direction of belt tension is as shown in Fig. 3.2

Load due to pulley = 2.33 (At each support)

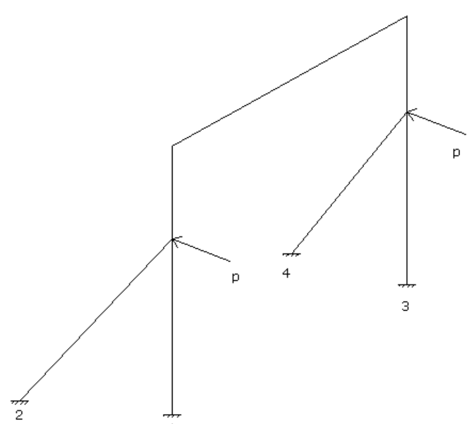


Fig 3.2 Belt Tension on Head end

The Reaction which are obtain from analysis of tail end has been listed in Table 3.1. This reaction is been applied to Screening Building.

Table 3.1 Reaction of Head End

Node	Load Combination	Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
1	DEAD LOAD	0	1.487	0	0	0	0
	LIVE LOAD	0	0	0	0	0	0
	OPERATING LOAD	0	-82.383	0	0	0	0
2	DEAD LOAD	0	0.955	0	0	0	0
	LIVE LOAD	0	0	0	0	0	0
	OPERATING LOAD	-79.25	87.213	0	0	0	0
3	DEAD LOAD	0	1.487	0	0	0	0
	LIVE LOAD	0	0	0	0	0	0
	OPERATING LOAD	0	-82.383	0	0	0	0
4	DEAD LOAD	0	0.955	0	0	0	0
	LIVE LOAD	0	0	0	0	0	0
	OPERATING LOAD	-79.25	87.213	0	0	0	0

3.2.2 Analysis of Conveyor System

Conveyor System 043-CONV-013 is been analyzed as bellow

1. Dead Load:

Dead load on the structures shall include self weight of the gallery (including connections), floorings and all other likely dead loads to be experienced by the structures during its lifetime.

The following are the values of the dead load:-

Weight of the belt = 0.46 kN/m

Rotating Mass of Carrying Idler = 0.62 kN/m

Rotating Mass of Return Idler = 0.155 kN/m

Weight of the technological structures

(Stringer supports and idler connections) = 0.80 kN/m

2. Operating Load:

The Operating Load on the structures shall include load of the material conveyed, weight of the conveyor components such as idlers, stringers supports, idlers connections, and weight of the belt

The following are the values of the operating load:-

Operating Load on Conveyor belt =1.4 times the design weight of material
Carried over the belt.

Weight of material (Nickel) carried over the belt = 4.68 kN/m
= 4.7 kN

3.2.2.1 Load Evaluation

- **Load of Conveyor**

Belt Width = 1400 mm

Weight of Belt = 40 kg / m

Weight of Carrying Idler = 62 kg / m

Weight of Return Idler = 15.5 kg /m

Impact Factor = 1.4

Weight of Stringer and Stand = 80kg / m

Bulk Density of Material carried over Belt (Ore Nickel) = 1850 kg /m^3

Maximum section of the handled Material = 0.324 m^2 (IS 11592- Table7)

Weight of Material Carried over the Belt = 1850 x 0.324
= 599.4 kg / m

Total DL = Weight of Belt + Weight of Carrying Idler + Weight of Return Idlers + Weight of Technological Structure
= 40 + 62 + 15.5 + 80
= 198 kg / m = 1.98 kN/m

Total DL on each stringer = 1.98 x 2 = 2.475 kN

Total Operating Load = Impact Factor x The design weight of material Carried over the Belt
= 959.04 kg / m
~ 9.6 kN /m

Load from each stringer = 12 kN / m

Total Load = DL+ OL
= 1158kg /m

Taking Total Load as 1200 kg /m = 12 kN / m

Spacing of Carrying idlers= 2.5 m c/c

Total Load from each stringer = 1500 kg = 15 kN

These loads are transferred to the conveyor system and frame is analyzed

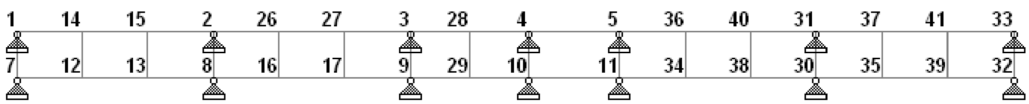


Fig 3.3 Nodes on Conveyor Belt System

The reaction of conveyor systems are as shown in Table 3.2 and node indicated as in Fig.3.3.

Table 3.2 Reaction of Conveyor System

Node	L/C	Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
1	1 D.L	0	4.226	0	0	0	0
	2 OL	-3.403	20.491	1.699	0	0	0
2	1 D.L	0	8.476	0	0	0	0
	2 OL	-5.087	41.098	1.711	0	0	0
3	1 D.L	0	6.549	0	0	0	0
	2 OL	-4.301	31.753	1.626	0	0	0
4	1 D.L	0	2.321	0	0	0	0
	2 OL	-2.394	11.252	2.225	0	0	0
5	1 D.L	0	5.218	0	0	0	0
	2 OL	-4.293	25.301	-0.267	0	0	0
7	1 D.L	0	4.226	0	0	0	0
	2 OL	-3.397	20.491	-1.701	0	0	0
8	1 D.L	0	8.476	0	0	0	0
	2 OL	-5.113	41.098	-1.694	0	0	0
9	1 D.L	0	6.549	0	0	0	0
	2 OL	-4.199	31.753	-1.781	0	0	0
10	1 D.L	0	2.321	0	0	0	0
	2 OL	-2.706	11.252	-1.179	0	0	0
11	1 D.L	0	5.218	0	0	0	0
	2 OL	-2.507	25.301	-3.666	0	0	0

30	1 D.L	0	8.604	0	0	0	0
	2 OL	-4.876	41.718	-5.581	0	0	0
31	1 D.L	0	8.604	0	0	0	0
	2 OL	-5.324	41.718	-5.581	0	0	0
32	1 D.L	0	4.205	0	0	0	0
	2 OL	-4.984	20.388	-3.106	0	0	0
33	1 D.L	0	4.205	0	0	0	0
	2 OL	-1.816	20.388	-3.106	0	0	0

3.2.3 ANALYSIS OF SCREENING BUILDING

Screening Building is the Building on conveyor system used for the screening of the material. It contents screens which are supported on building frame. Due to motor of screen during screening forces vibrations are transferred from the supporting system to the rest part of the building.

3.2.3.1 Load Evaluation of Screening Building

In the analysis of screening building following cases is been used.

- Dead Load (DL)

  It includes the reactions from Head Frame, Self weight of the screening unit and hopper weight and reaction of belt conveyor system

- Live Load (LL)

  Live load over walkway is taken as 5 kN / m^2

- Operating Load (OL)

  Operating load includes reactions from head Frame, hopper full condition weight and material weight over conveyor system.

- Seismic Force (SF)

  Seismic loads shall be calculated as Zone III as per IS: 1893-2002(Part I) on the basis. Factors and coefficients will be considered accordingly.

  Self weight of structure is been assumed by suitable section. As shown in Table 3.3

Table 3.3 Self Weight Calculations

Level	Description	Length m	Weight kg / m	Total Weight kN	Total Weight kN
996.23 TOS LVL					
	Beams				
	ISMC200D	76.00	27.80	2112.80	
	ISMC150	28.00	9.90	277.20	
	Columns				
	ISMB450	31.50	103.70	3266.55	5656.55
991.72 TOS LVL					
	Beams				
	ISMC300D	104.00	71.60	7446.40	
	ISMC350D	68.00	84.20	5725.60	
	ISMC300D	68.40	71.60	4897.44	
	Columns				
	ISMB550	56.70	103.70	5879.79	
	ISMB450	25.20	72.40	1824.48	25773.71
989.32 TOS LVL					
	Beams				
	ISMC175D	56.00	38.20	2139.20	
	ISMC250D	76.00	60.80	4620.80	
	ISMC175	38.00	19.10	725.80	
	ISMC175D	60.00	38.20	2292.00	
	Columns				
	ISMB550	70.00	103.70	7259.00	
	ISMB450	44.80	72.40	3243.52	20280.32
986.12 TOS LVL					
	Beams				
	ISMC225D	169.10	51.80	8759.38	
	ISMC125D	122.40	25.40	3108.96	
	ISMC100D	76.00	18.40	1398.40	
	Columns				
	ISMB550	89.60	103.70	9291.52	
	ISMB450	44.80	72.40	3243.52	25801.78
982.92 TOS LVL					
	Beams				
	ISMC300D	169.10	84.20	14238.22	
	ISMC175D	76.00	38.20	2903.20	
	ISMC100	60.00	9.20	552.00	

	ISMC75X50X6	62.80	14.32	899.30	
	Columns				
	ISMB550	110.32	103.70	11440.18	
	ISMB450	110.32	72.40	7987.17	38020.07

The chequred plate at the base of walk way is kept as 6mm thickness and its unit weight is determined by specification available on the internet. The area of walkway is determined from the drawing 2 in Annex A which is been multiplied by the unit weight of chequred as shown in Table 3.4. Live load on chequired plate for EQ is considered as 50 percentage of actual load is shown in Table 3.5.

Table 3.4 Weight of Chequred Plate

Description	Area m^2	UNIT WEIGHT kN /m	Weight kN
991.720 TOS LVL	131.4	0.596	78.34
989.320 TOS LVL	189.004	0.596	112.64
986.12 TOS LVL	189.48	0.596	112.93
982.920 TOS LVL	87.012	0.596	51.85

Table 3.5 Live Load on Walk way

Level	Area	kN / m^2	Reduction	
991.720 TOS LVL	131.4	5	0.5	328.5
989.320 TOS LVL	189.004	5	0.5	472.51
986.12 TOS LVL	189.48	5	0.5	473.7
982.920 TOS LVL	87.012	5	0.5	217.53

The total weight at each level is given in table 3.6

Table 3.6 Total Weight of Each level

	Self Weight	Chequred Plate	Operating Load	Live Load	Total kN	kg
996.23 TOS LVL	5656.55				5656.55	565655
991.720 TOS LVL	25773.71	78.31	1356.76	328.5	27537.28	2753728
989.320 TOS LVL	20280.32	112.93	1313.12	472.51	22178.88	2217888
986.12 TOS LVL	25801.78	112.65	1313.12	473.7	27701.25	2770125
982.920 TOS LVL	38020.068	51.86	1313.12	217.53	39602.58	3960258
Total W =						12267654

Time period for Steel Frame = $0.085 \times h^{0.75}$ (IS 1893:2002)

= $0.085 \times 15.64^{0.75}$

= 0.0668 sec

Sa / g = 2.5 (For Medium Soil)

Importance Factor = 1

Zone Factor = 0.16

$$A_h = \frac{ZIS_a}{2Rg}$$

A_h = 0.039

Base Shear $V_b = A_h \times W$

= 0.039 x 12267654

= 478438.50 kg

Table 3.7 Earthquake Force on different level

Storey Leval	W_i	h_i	h_i^2	$W_i h_i^2$	Q_i kg
991.720 TOS LVL	565655	15.64	244.6096	138364643	87520.64
991.720 TOS LVL	2721640.6	11.14	124.0996	337754505	213641.9
9893.320 TOS LVL	2171736	8.74	76.3876	165893700	104933.8
986.12 TOS LVL	2723850.9	5.54	30.6916	83599341	52879.61
982.920 TOS LVL	3939009.4	2.34	5.4756	21568440	13642.82
Total				747180629	472618.8

- **Wind Force (WF)**

The design wind load shall be calculated as per provisions of IS: 875 (Part-III).

Basic wind speed (V_b): 44 m/sec

Design wind speed (V_z): The basic wind speed shall be modified to include the following effects to get design wind velocity at any height.

$V_z = V_b k_1 k_2 k_3$ = 47.08 m/s

Where,

k_1 = 1.07 (probability factor)

k_2 = 2 (terrain, height and structure size factor)

k_3 = 1 (topography factor)

Class of building structures = class C

Design wind pressure (P_z): The design wind pressure at any height above mean ground level shall be obtained by the following relationship between wind pressure and wind velocity.

$$P_z = 0.6\ V_z^2 = 1.329\ N/m2$$

Design wind load (F):

The wind load F, acting in a direction normal to individual structural element or cladding unit is,

$$F = A \times C_f \times p_d \quad = 594.32 \times 1.3 \times 1329\ N$$

$$=1026806\ N$$

Where,

C_f = pressure coefficient,
A = surface area of structural element or cladding unit,
p_d = design wind pressure.

The structure having two or more parallel frames where the windward frames may have a shielding effect upon the frames to leeward side. The windward frame and any unshielded parts of other frames shall be calculated in accordance with Cl.6.3.3.3 of IS: 875-1987(part3), but the wind load on the parts of the frames that are sheltered should be multiplied by solidity ratio of the windward frame, the types of the members comprising the frame and the spacing ration of the frames.

The obtained values of the parallel frame are:

The **Solidity Ratio** for the frame **(Ø)** = (projected area of all individual elements of frame to the area enclosed by boundary of the frame)

Total Area = 38 x 15.64 = 594.32 m^2

Projected Area =

Beams	0.2	190	38
Columns	0.19	109.48	20.8012
Machine Width			92.44
			151.2412

Solidity Ratio = 0.254

Frame Spacing Ratio = (c/c distance of frame to the least Overall dimension)

Shielding factor **(η)** = 0.75

Design wind load **(F)** = 770104.5 N

Hear earthquake load is more then wind load hence earthquake load is used for further design.

Location of Load is given as sheet in Appendix A sheet 3.

3.2.3.2 Load Combinations

Following load combinations are used in analysis of the screening frame.

- DL + LL
- DL + LL + OL
- DL + LL $\pm$ EQ in x and z direction
- DL + LL +OL $\pm$ EQ in x and z direction

3.2.4 Modeling using STAAD Pro.

STAAD PRO is widely used software for analysis of the structure. From model generation, analysis and design to visualization and result verification, STAAD PRO is the professional's choice for steel, concrete, timber, aluminum and cold-formed steel design of low and high-rise buildings, culverts, petrochemical plants, tunnels, bridges, piles and much more.

The model of crusher frame is prepared using Staad-Pro-2007 software. The model is prepared from the available G.A drawing of Screening Frame.

The model made in staad pro by following procedure:

At first space option is selection and a file name is given. More over the specific units and code are also selected.

First the model is been prepared as shown in Fig. 3.4

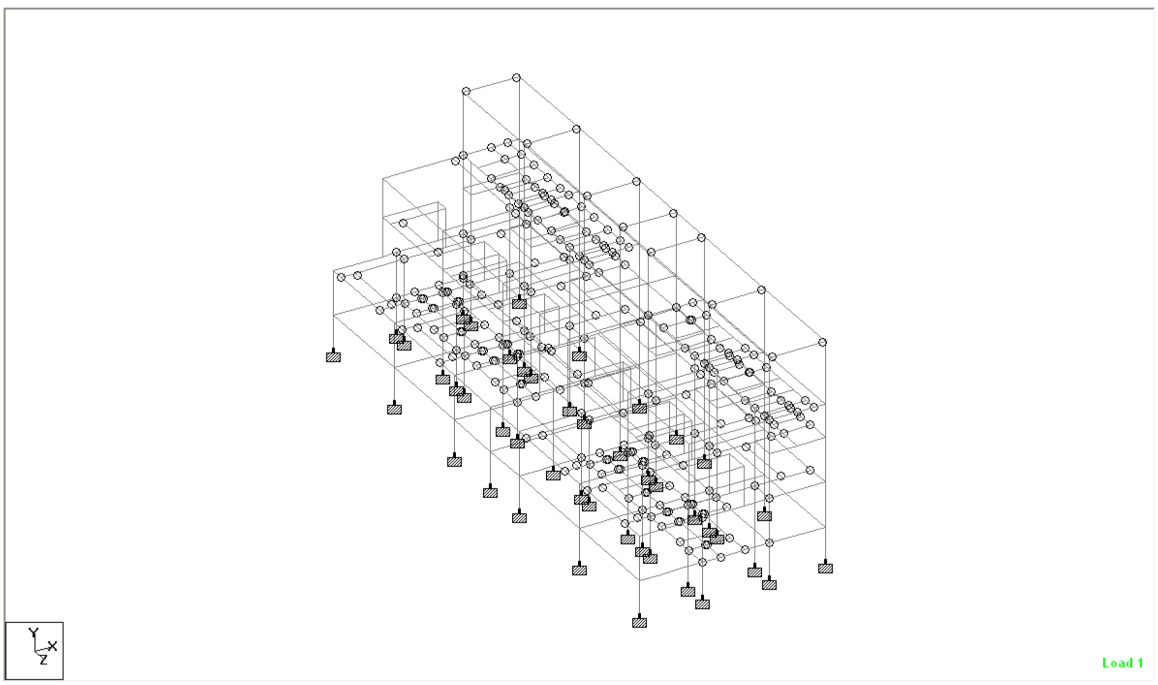


Fig. 3.4 Modeling in Staad

The earthquake force is assign as follows. First the earthquake code is been specified in load as shown in Fig. 3.5.

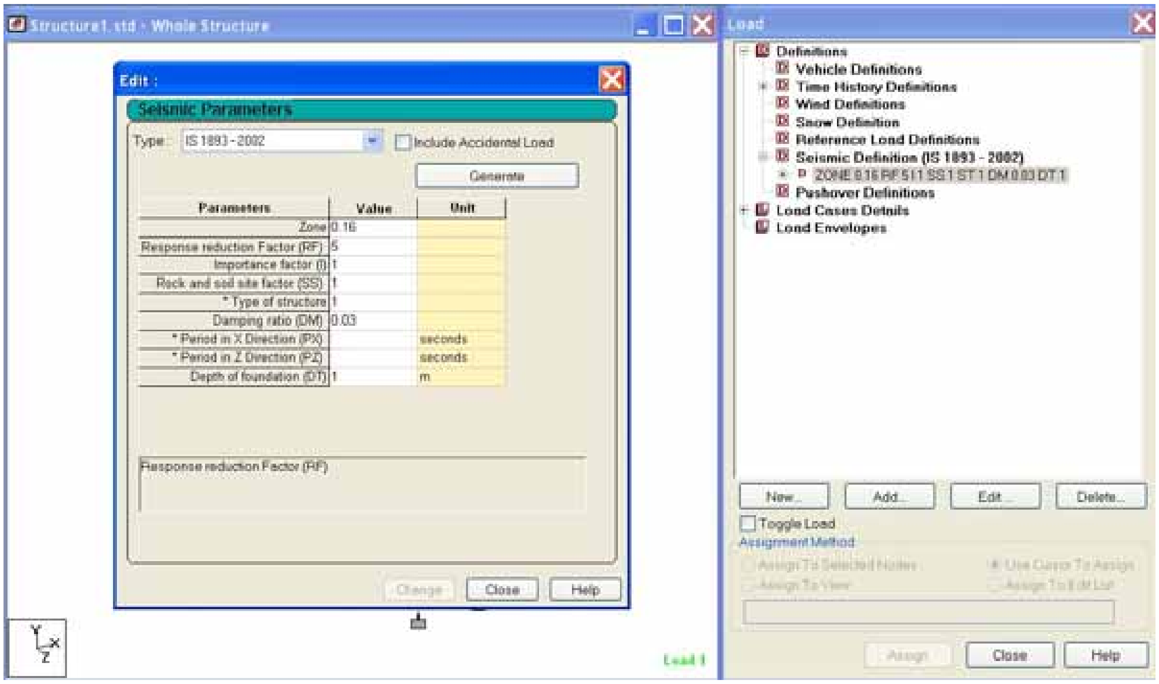


Fig 3.5 Assigning Earthquake Definitions

Lump mass for the earthquake load is been assign as the following given in Fig. 3.6.

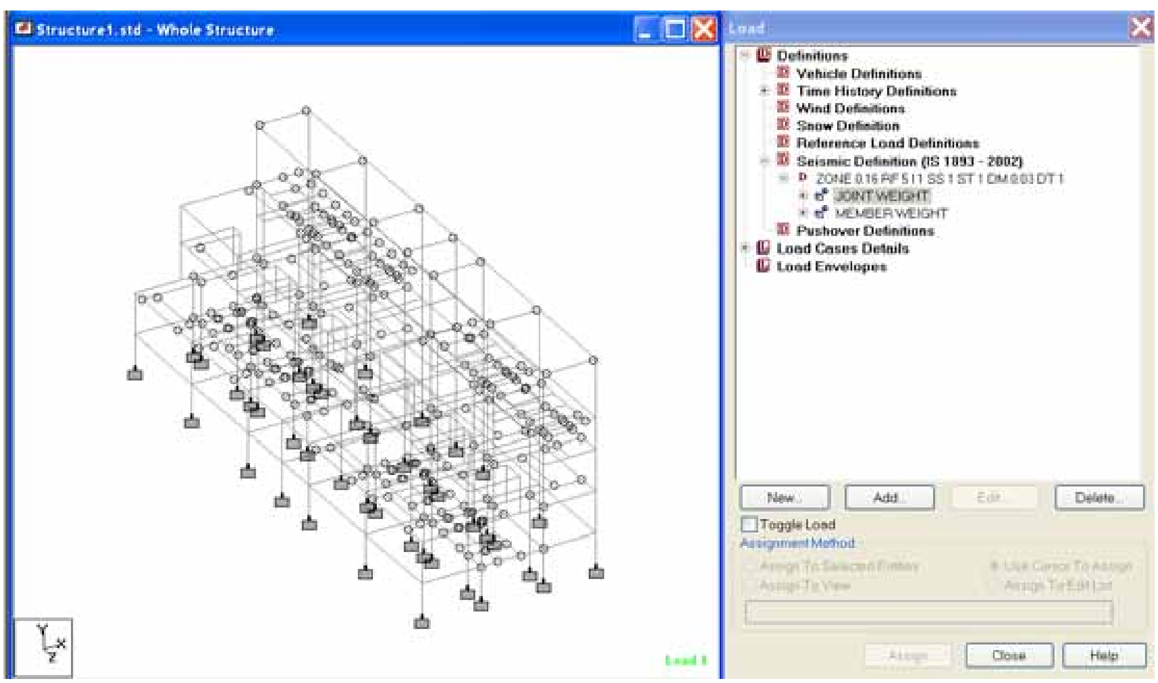


Fig. 3.6 Lump Mass in Staad Pro

3.3 DYNAMIC ANALYSIS

Dynamic Analysis of the crusher frame has been carried out for the free vibration analysis and forced vibration analysis as per IS 2974 (part 4):1992.

3.3.1 Free Vibration Analysis

Free Vibration analysis is been carried out to determine the natural frequencies and mode shapes of the foundation. As per IS 2974(Part 4):1992 the damping can be neglected for the purpose of free vibration analysis.

The frequency criteria should be checked in case of free vibration Analysis in which the fundamental natural frequency shall be at least 20 percentages away from the machine operating speed to avoid the resonance in the structure.

That is

fn < 0.8 fm

or

fn > 1.2 fm

where

fn = fundamental natural frequency of the frame.

fm = operating speed of the machine.

3.3.2 Forced Vibration Analysis

Forced Vibration analysis shall be performed at the operating speed. And the force generated by unbalanced mass forces can be calculated with the help of IS2974 (Part 4):1979.

The unbalanced mass force for the Gyratory crusher can be calculated by the following equations

1) Gyratory crusher with steep cone-

The value of the generating force due to unbalanced mass forces may be determined by the following formula.

$$R = (m_1 r_1 - m_2 r_2) w^2$$

$$P_x = R \sin wt$$

$$P_y = R \cos wt$$

Where

R = Unbalanced generating force (Tones)

m_1 = Total Mass of Main shaft and crushing cone attached to it Tonn sec^2/m

m_2 = mass of rotor tonn sec^2/m

r_1 = distance between crusher axis and centre of gravity of eccentric shaft

r_2 = Distance between other axis of the crusher and centre of gravity of eccentric shaft

2) Gyratory Crusher with flat cone and a crusher

$P = P_0 \sin wt$

Where

P = Unbalanced generating Force.

Where P_0 is been found by table given in the IS2974 (Part 4) -1979

Table 3.8 Forces due to crushers

Types Of Crusher	Size of Crusher mm	N Rev / min	P_0 tonnes
Gyratory With Flat Cone	Ø1200	270	-
	Ø1650	240	1.5
	Ø2100	220	8.2
Jaw Crusher	1200 X 900	170	6.00
	1500 X 1200	135	9.00
	2100 X 1500	100	12.00

For Crushers with dimension are given in table but having different speed N_1

The force (P_0') be calculated by the following equation

$$P_0' = P_0 \times \frac{N_1^2}{N}$$

If the crushers of different dimension then given in table P_0 is to be assumed threw interpolation.

3.3.3 Permissible Amplitudes

As per IS2974 (Part 1):1982 following limitations should be considered in to account while dynamic analysis of the structure.

- To avoid Damage of Machinery.
- To avoid the neighboring building due to Resonance.
- To avoid Discomfort of Persons.
- To avoid Settlement of structure.

Permissible Displacements are limited to 30 mm in horizontal direction and L /325 in gravity direction.

3.3.4 Dynamic Analysis Using Staad Pro.

The harmonic force of the screen is been modeled in dynamic analysis of the building. And the frequency criteria and displacement criteria is been checked for the safety of the structure.

The harmonic Force is been assigned in Staad Pro as Fig 3.7.

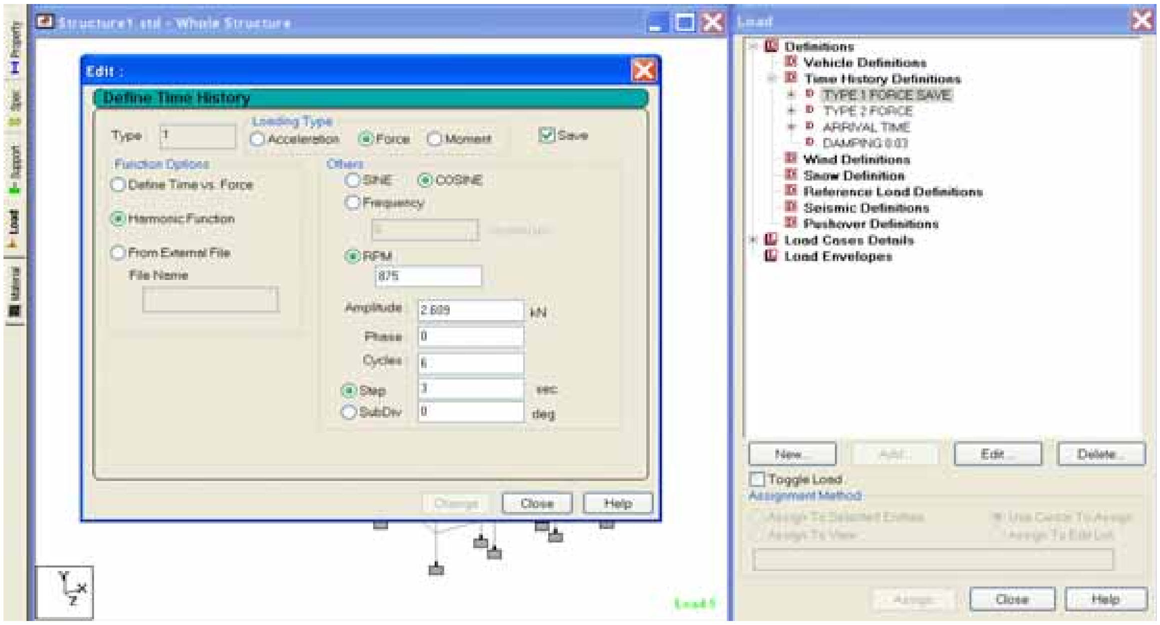


Fig 3.7 Assignment of Time History in Staad

After assigning the time history function the Time history is been assign at particular nodes on structure. And Dead load and Operating load should be assigning at the same load case for the analysis of the structure. Results of Dynamic Analysis is been carried out as Fig. 3.8 and Fig. 3.9.

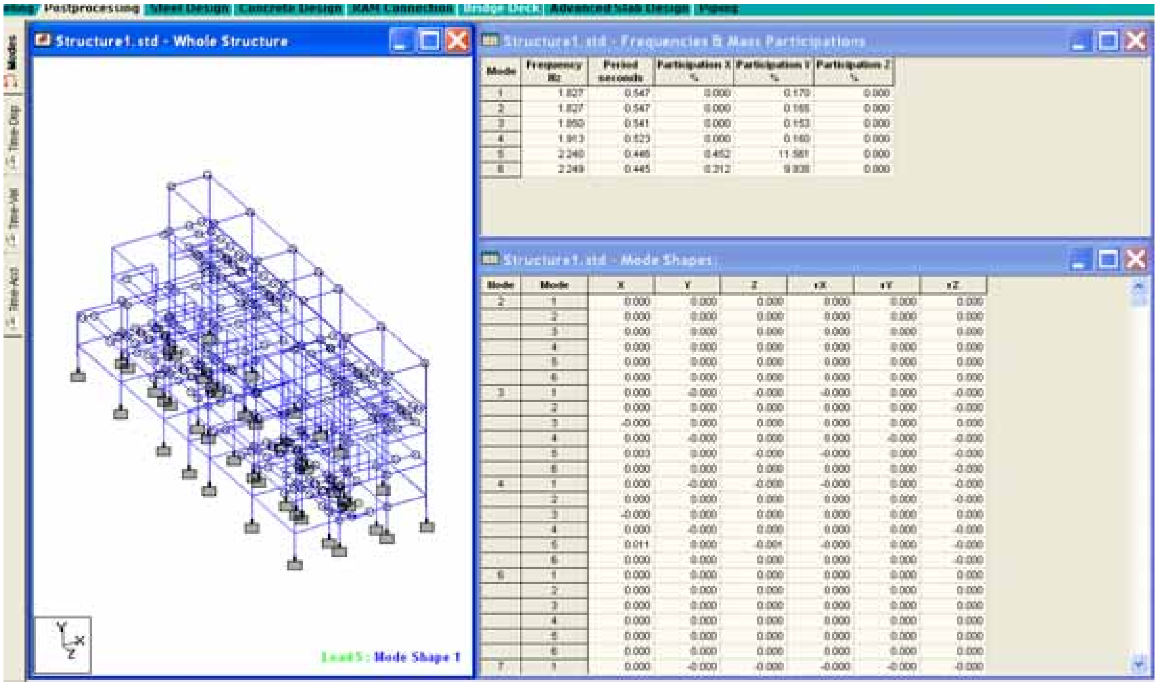


Fig 3.8 Natural Frequency of Structure

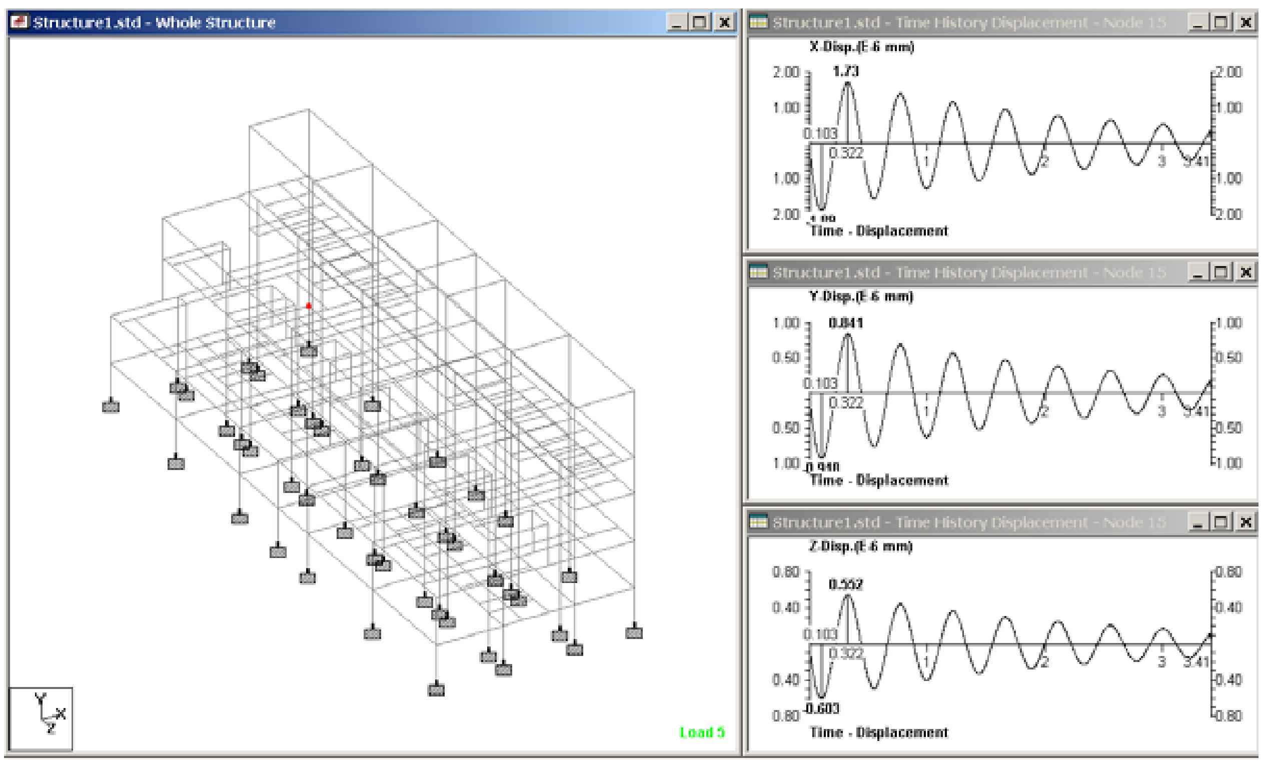


Fig 3.9 Displacement of Dynamic Analysis

3.4 DESIGN

After the analysis is carried out from the assumed sectional properties, the members are checked as safe or not. The Fig. 3.10 shows the procedure in Staad-Pro.

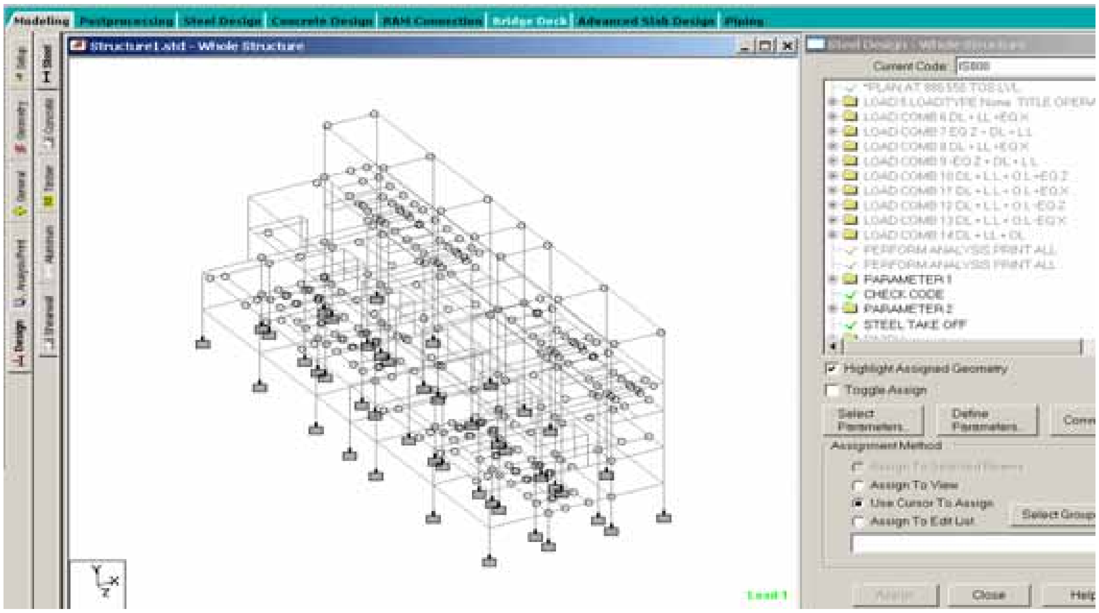


Fig. 3.10 Design Window

The Code is selected from the codal options and then the select parameter is pressed for selecting parameter as shown in Fig. 3.11 and 3.12.

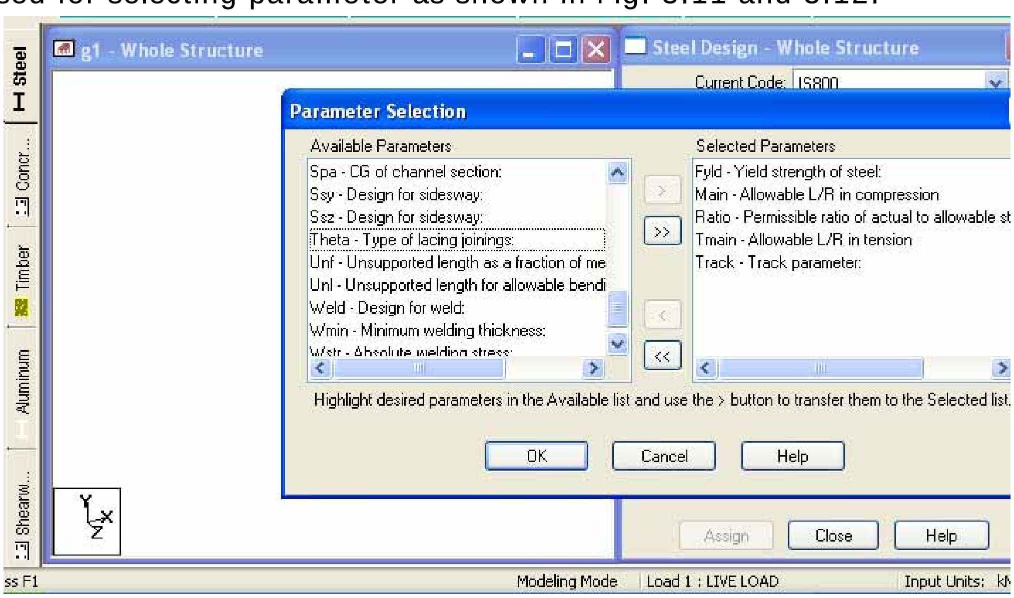


Fig. 3.11 Parameter Selection Window

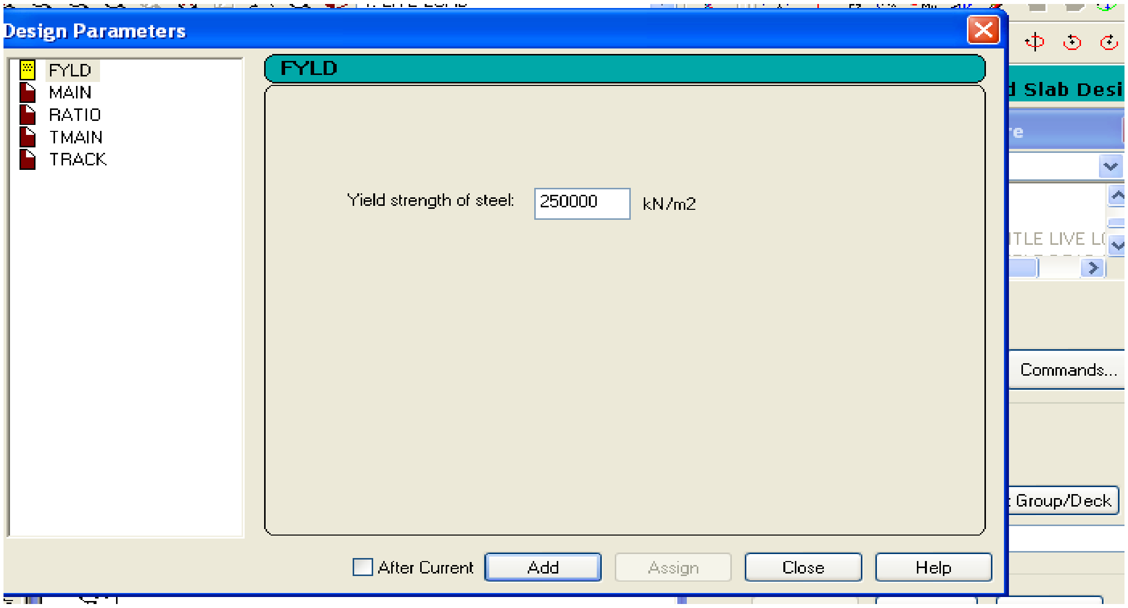


Fig. 3.12 Define Parameter window

After the parameter is selected the parameter is defined as shown in Fig. 3.12. By double clicking on the member the window shows the result for the steel design as shown in Fig. 3.13.

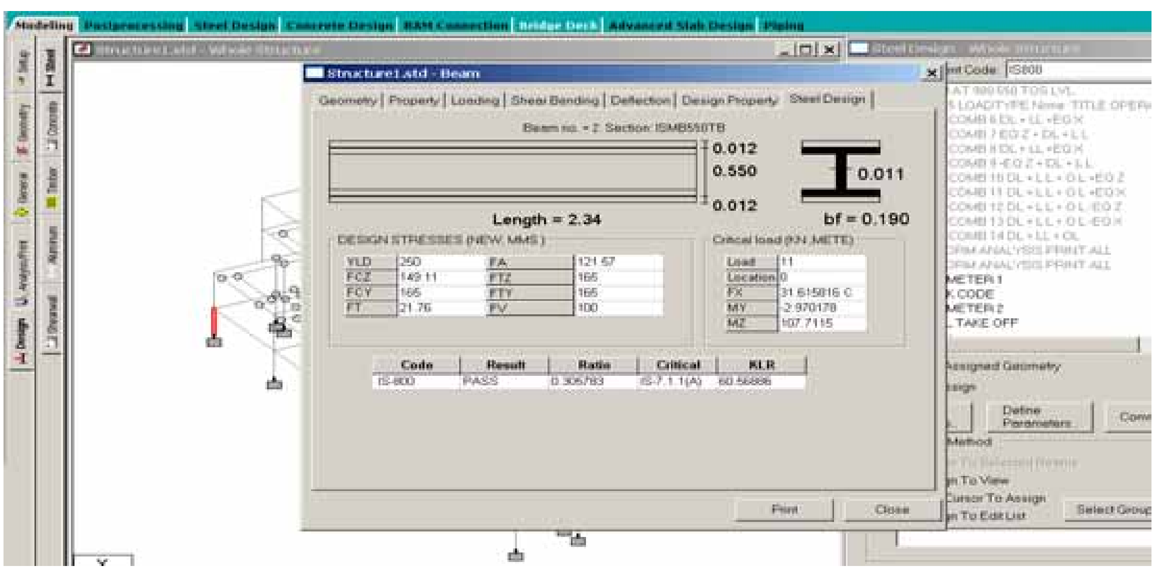


Fig. 3.13 Result shown for particular beam

The above steps show the design in Staad-pro. The design is checked manually.

4. EFFECTS OF BRACINGS

4.1 GENERAL

Traditional building structural systems utilize columns mainly to support typical vertical dead and live load and horizontal wind and seismic loads. The bracing system is designed to resolve the sudden excess horizontal impact problem to a structural system. This is applicable to new-construction or retrofit of existing building. The bracing system could be provided at every level of the building floors or just at levels as required. In these chapter comparisons of different bracing system is given in same dynamic and static condition.

4.2 ANALYSIS

The structure is been analyzed as shown in Previous chapter. Type of Bracing system which is used for the analyses of structures areas follows

1. Structure with X bracings
2. Structure with K bracings
3. Structure without Bracings system

The frame consisting of conveyor system and mechanical components as shown in Drawing 1 and 2 in Annex A. Hence the location of bracing is provided as shown in Fig 4.1 and Fig 4.2. Which is section at Grid 1 of Drawing 1 in Annex A. While Fig 4.2 is section at Grid A,D ,G etc. at Drawing 1 in Annex A.

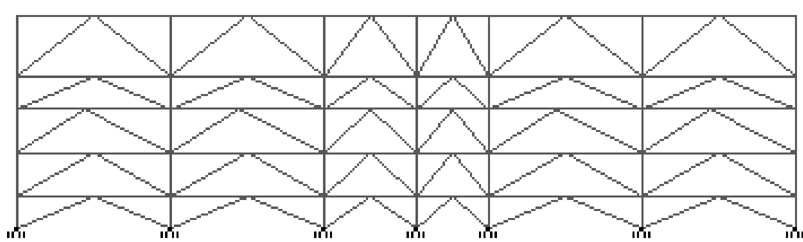


Fig. 4.1 Frame with k Bracing in z direction

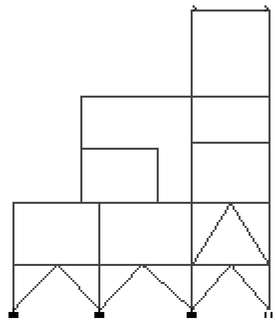


Fig 4.2 Frame with k Bracing in x direction

Similar Location is been used for the X Bracings.

4.3 COMPARISION OF RESULTS

4.3.1 Static Analysis

The Results of static analysis are the member design of the frame which is given in Drawing 3, 4 and 5 for various alternatives.

Maximum Deflection due to earthquake forces are as shown in Fig 4.3.

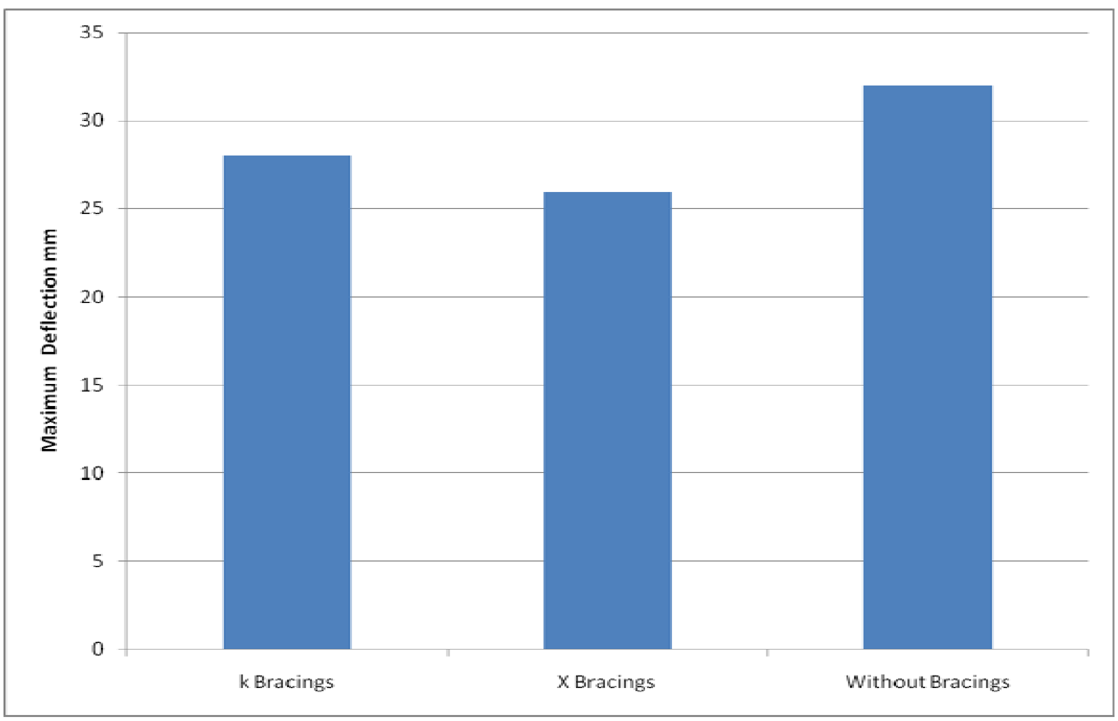


Fig 4.3.: Deflection Due to EQ Force

4.3.2 Dynamic Analysis

- Frequency Criteria

  Forcing Frequency f_m = 750 RPM

  = 750 / 60 =12.5 Hz / sec

Table 4.1 Frequency Criteria

	Natural Frequency f_n			Frequency Ratio f_n / f_m		
Modes	K Bracings	X bracings	Without Bracings	K Bracings	X bracings	Without Bracings
1	1.827	2.715	1.827	0.128	0.217	0.146
2	1.827	2.718	1.827	0.146	0.217	0.146
3	1.828	2.761	1.85	0.146	0.220	0.148
4	1.959	2.761	1.913	0.156	0.220	0.153
5	2.094	6.622	2.24	0.167	0.529	0.179
6	2.095	6.652	2.249	0.167	0.532	0.179

In all cases the Frequency Ratio is less then 0.8 hence structure is safe against resonance.

5. CONNECTIONS

5.1 GENERAL

Structures consist of simple members, beams, ties and columns, suitably connected at their ends as shown in Fig 5.1. For true overall strength the connections of a structure should be at least as strong as the members themselves. The problem of design of joints is therefore equally important. But unfortunately, the distribution of stresses in joint details is not known to the same accuracy as that in the main members.

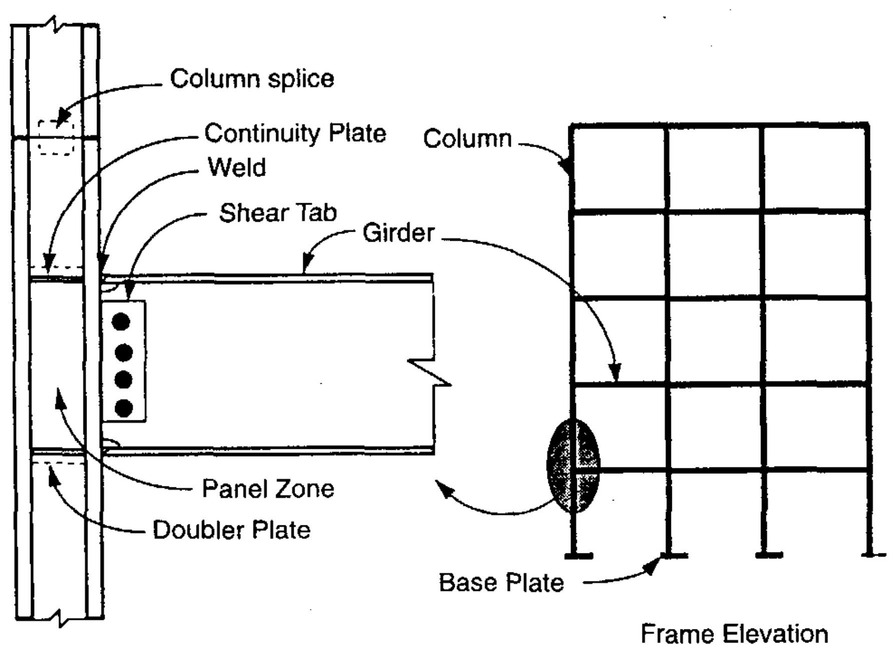


Fig. 5.1 Types of Connections

The problem, therefore, is more complicated and warrants conservativeness in proportioning joint details. Greater attention than for the members is called for in detailing the connections so that the transmission of stresses through the joint should be gradual and that no part of the members or the joint should be over stressed. At the same time the greatest economy in material and labors should be achieved. The necessary requirements of a good joint are that it should be free from permanent distortion, should be elastic and not subjected to wear. The latter can be achieved by not allowing a relative motion to occur between the members connected. The aim in the design of joints should be that at ultimate the failure should take place in the members and not in the joints so that the full strength of the members is actually developed.

5.2 DESIGN PRINCIPALS

There is a need for the design of connections to be consistent with the engineer's assumptions regarding the structural behavior of the steel frame. Therefore, when choosing and proportioning connections the engineer should always bear in mind the basic requirements such as the stiffness or flexibility of the connection, strength and the required rotational capacity.

Care should also be taken to ensure that the assumptions made for the design of the various elements of the connection are compatible.

The engineer should also consider economy, which is at least as important as the structural considerations. Connections should be simple and good access should be provided for any welding operations and/or the placing and tightening of bolts.

5.3 RIVVETED CONNECTION

Rivets are made with one head only. This is done by heating the rivet rod and upsetting one end of the rod by running it into the rivet machine. Sometimes it becomes necessary to flatten the rivet heads so as to provide sufficient clearance. A rivet head which has the form of a truncated cone is called countersunk rivet. When a smooth flat surface is required it is necessary to have countersunk and chipped.

The diameter of a rivet hole shall be taken as the nominal diameter of the rivet plus 1.5 mm larger than the size of rivets up to 25 mm, and 20 mm for the rivets of nominal diameter exceeding 25 mm.

5.3.1 Types of Joints:

1. Lap Joints
2. Butt Joints

5.3.2 Failure of a Riveted Joint:

1. **Tearing of the plate between rivet holes:** Such a failure is due to insufficient margin. If d is diameter of the rivet, then the effective margin should be at least 1.5 d in order a failure may not occur.

2. **Shearing of rivet:** When the load per pitch length is large it is possible that the rivet may shear off.

   If f_s = safe shearing stress for the rivet and d = diameter of rivet then safe load per pitch length to prevent failure =

   $$P_s = (n) f_s \frac{\pi d^2}{4}$$

   Where,

   n = 1 for single riveted lap joint

   = 2 for double riveted lap joint

   = 3 for triple riveted lap joint

3. **Bearing of Plate or rivet:** If the top plate be pulled a bearing stress is induced between the plate and rivet. If the stresses are high it is quite possible that the plate or rivet may be crushed.

   If f_b = allowable bearing stress, d = diameter of rivet and t = thickness of plate then,

   $$P_b = f_b d t$$

4. **Edge cracking:** The plate will crack at the back of a rivet if it is placed very near to the edge of the plate. This failure is prevented if the minimum edge distance as per codal provision is provided.

5.4 Connections:

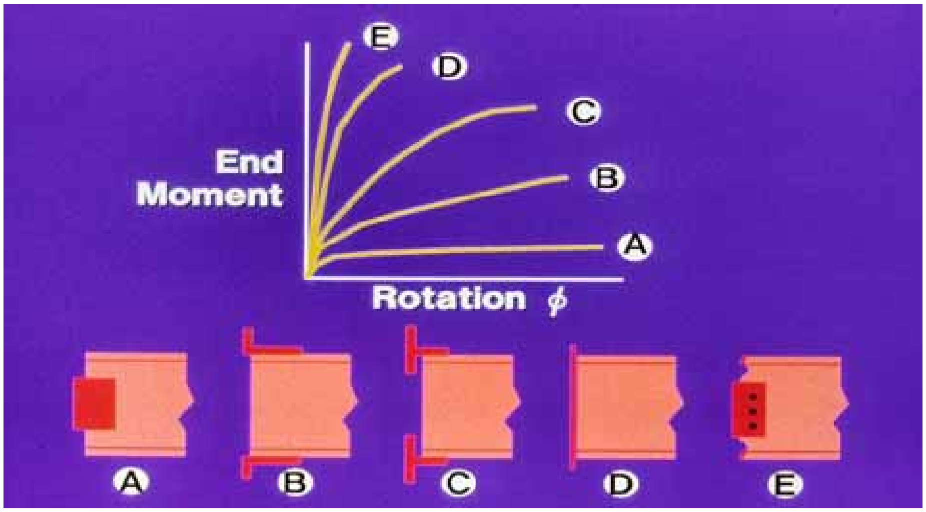


Figure 5.2: Simple Frame connection

- All Connections have a certain amount of rigidity
- Simple connections (A above) have some rigidity, but are assumed to be free to rotate
- Semi-Rigid moment connections (B and C above) are designed to be semi-rigid
- Rigid moment connections (D and E above) are designed to be fully rigid

The different steel frame connections are

1. Simple connection
2. Moment Resisting connection

5.4.1 Simple Connections:

Steel beams are supported at their ends either by masonry walls and piers or by steel columns or by other heavier beams and girders. In the case of steel supports, the beam reaction is borne by end connection of the beam with the supporting member. There are two basic types of end connections in use.

1. Single Plate connection
2. Double Angle connection

3. Shear end plate connection
4. Single Angle connection
5. Seated connection
6. Tee connection

The simple connection should be-

- Designed as flexible connections.
- Connections are assumed to be free to rotate.
- Vertical shear forces are the primary forces transferred by the connection.
- Require a separate bracing system for lateral stability.

The different simple connections are as follows:-

Sample calculation of Beam to Column Shear Connection

DATA :	**DESIGN FRAMED CONNECTION AT THE END OF BEAM AND COLUMN**		
	END REACTION =	120	kN
	COLUMN SECTION		
	ISMB550 @		
	D =	200	mm
	Tf =	9	mm
	BEAM SECTION		
	ISLB 350		
	D =	350	mm
	Tw =	7.4	mm
	RIVET SELECTED		
	Power – Driven Rivets		
	Permissible Axial Tension =	100	MPa
	Permissible Shear Stress =	100	MPa
	Permissible Bearing Stress =	300	MPa
	Diameter of Rivet =	16	mm

<u>SOLUTION :</u>

STEP - 1

Strength Of 16mm Dia. Rivet
Gross Diameter Of Rivet = 17.5mm

In Single Shear = 24052.82N
In Double Shear= 48105.64N
In Bearing
On 7.4 mm thk. Web Of Beam = 38850N
On 9.0 mm thk. Flange Of Column = 47250N

STEP - 2

Rivets Which Connect Web Of Beam With Angle are in double shear and in bearing With the beam web

Rivet Value= 38850N
No. Of Rivets = 3.089 ~ 4

STEP - 3

Rivets Which connect Flange Of Column with angle are in Single Shear and in Bearing With the column Flange

Rivet Value = 24052.82N
No. Of Rivets = 4.99 ~ 6

STEP - 4

Select An Angle For Connection		90X90X8
Length Of Angle =	221	mm
Shorter Side =	90	mm
Longer Side =	90	mm
t=	8	mm

The Maximum Applied = 50.90Mpa O.K
Shear Stress

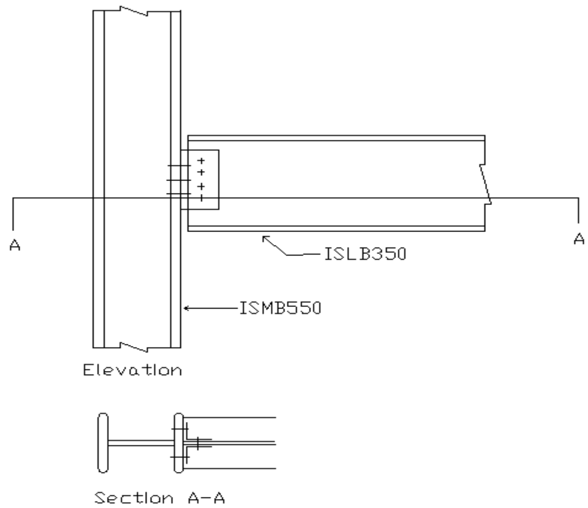


Fig.5.3: Beam Column Connection

5.4.2 Moment Resisting Connection

Many times, instead of flexible connection joints are used to transmit large moments in addition to shears. This is the case in continuous construction like the portal and gable frames and multistory building frames.

There are two kinds of construction in use:

1. Rigid construction
2. Semi-rigid construction

Sample Calculation for Moment Connection.

DATA : DESIGN OF MOMENT RESISTING CONNECTION AT THE END OF BEAM AND COLUMN JUNCTION

END REACTION =	166.667	kN
END MOMENT =	37.73	kN-m
COLUMN SECTION		
ISMB550 @ 86.9 KG/M		
D =	550	mm
Tf =	19.3	mm
BEAM SECTION		
ISMC300		
D =	300	mm

Tw =	7.6	mm
RIVET SELECTED		
Power – Driven Rivets		
Permissible Axial Tension =	100	MPa
Permissible Shear Stress =	100	MPa
Permissible Bearing Stress =	300	MPa
Diameter of Rivet =	18	mm

SOLUTION :

STEP - 1

Strength Of 16MM Dia. Rivet

Gross Diameter Of Rivet = 19.5 mm

In Single Shear = 29864.77 N

In Double Shear= 59729.53 N

In Bearing

On 7.5 MM Thk. Web Of Beam = 44460 N

In Tension = 29864.77 N

STEP - 2

DESIGN OF RIVETS IN TENSION

Tension Carrying Capacity Of Rivet= 29864.77 N

No Of Rivets Use At Top and Bottom Each= 4

Lever Arm Between = 315.84 MM
Top and Bottom Rivet

Rivet Value = 44460 N

No. Of Rivets = 3.75

4 SAY

STEP - 3

DESIGN OF RIVETS IN SHEAR

Total Shearing Force in = 125766.67 N
Rivets On Flange Of Beam

No. Of Rivets In Single Shear = 4.21

5.00 SAY

STEP - 4

Select an Angle for connection		150X150X10
Length of Angle =	400	mm
Shorter Side =	150	mm
Longer Side =	150	mm
Thickness of Angle	12	mm

Actual Lever Arm Provided =		470	mm
Force Acting on the rivet R =		80276.596	N
M = 0.6XRXa	a=	73	mm
M = 3516115	Nmm		
As Per Formula, f =(M/Z) =	187.5	MPa	

$L*t^2/6 = M/f$ **Z=I/Y**

t^2 = 281.29

t = 16.77 mm

Angle is not available of this section hence Use ISMB550 To prepare Section

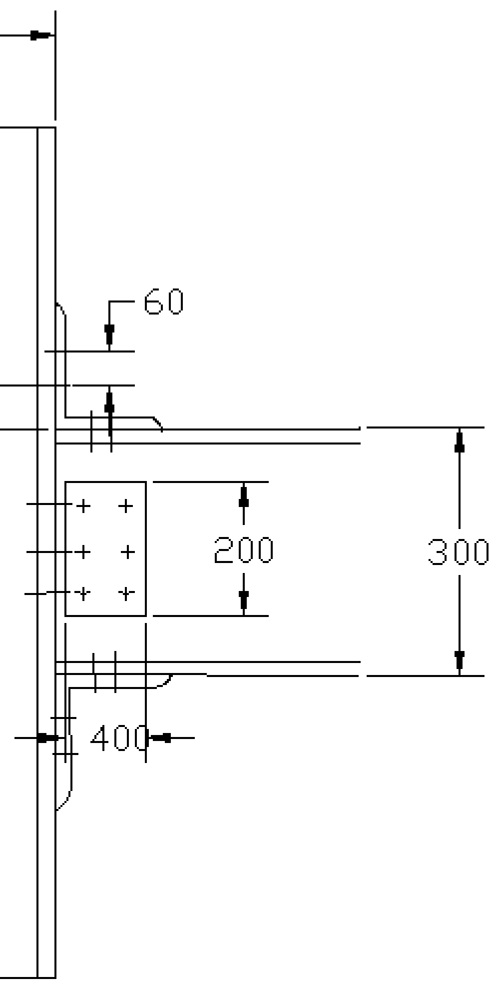


Fig. 5.4 Beam- Column Moment Connection

Location of Shear and Moment Connection are as shown in Fig. 5.5.

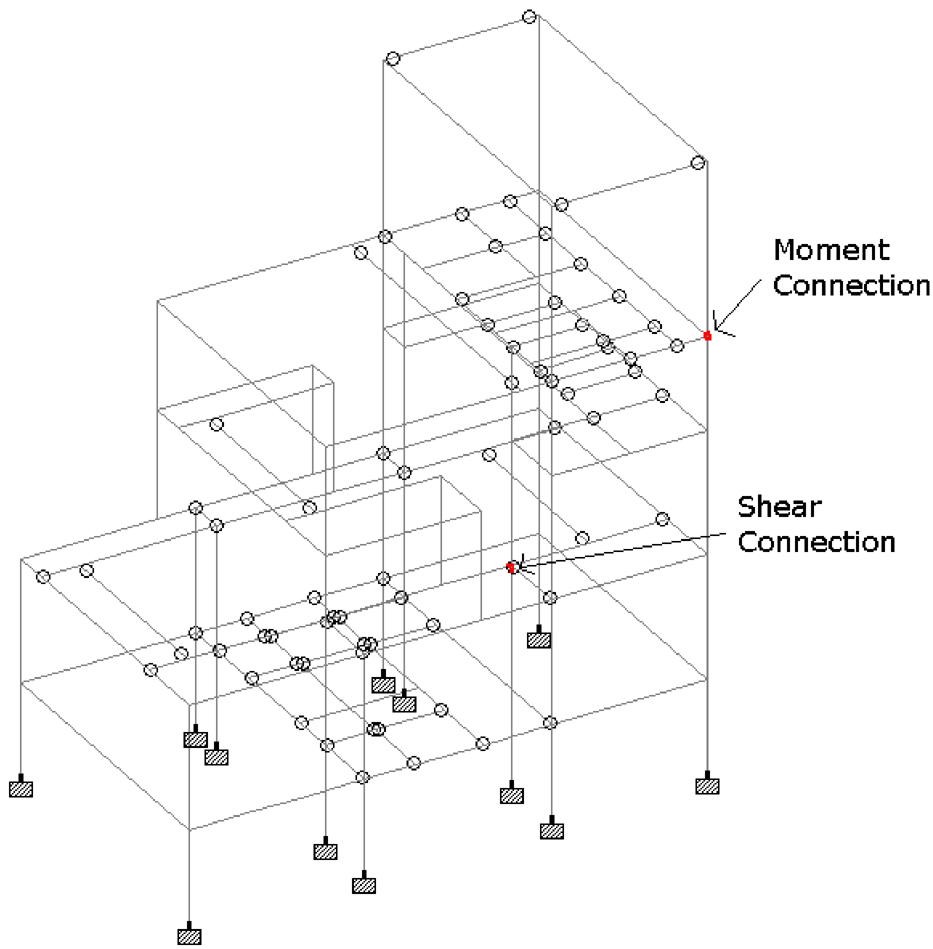


Fig. 5.5 Location of Connection

5.5 COLUMN BASE

The purpose of a column base is to distribute the load of a column on a greater area so that the bearing pressure on concrete or masonry, on which the steel column stands, is not exceeded. For an axially loaded column, supported on a symmetrical base plate as shown in Fig. 5.4. the intensity of pressure between the base plate and the concrete or masonry pedestal will be assumed to be uniform. The actual pressure distribution will probably be non-uniform as shown in Fig. 5.6. a small upward deflection of the outer edges of the plate will relive the pressure near the centre. Yielding of pedestal at the points, where the pressure is higher will tend to make the pressure uniform. The exact pressure distribution will depend upon the deformation of the supporting pedestal and the base plat. For design purposes, the pressure is assumed to be uniform and the permissible bearing pressure on masonry is kept slightly low to compensate for the non-uniformity of pressure distribution. The assumption of uniform pressure distribution, however, results in a safer design of base plate.

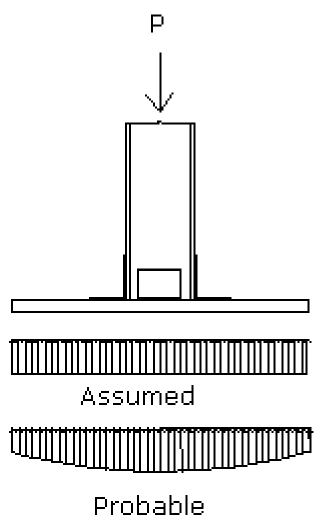


Fig. 5.6 Pressure distribution under base plate

Mainly three types of column bases are used for the axially loaded columns:

1. Slab Base
2. Gusseted Base
3. Grillage Foundation

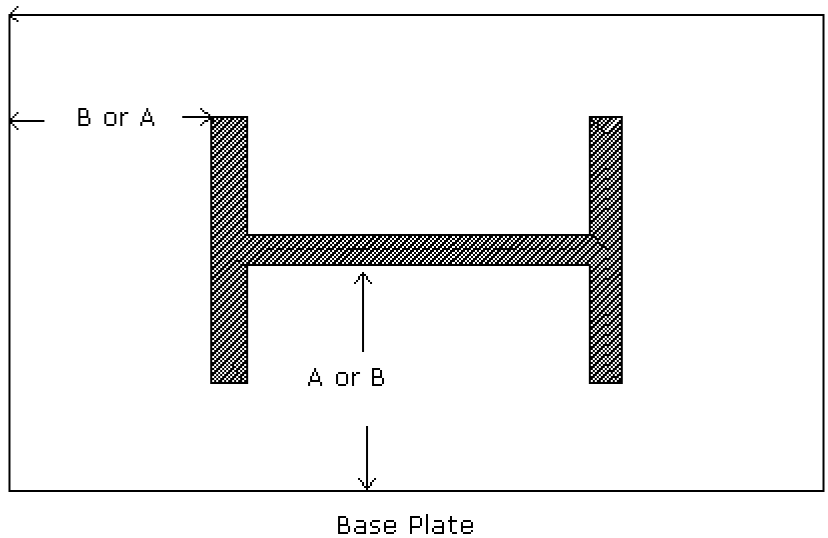


Fig. 5.7 Base Plate

1. Slab Base

These are very convenient to use because the fabrication required is minimum. The column end is machined to transfer the load to slab base by direct bearing. No gussets are required, but fastenings are provided sufficient to retain the parts securely in place and to resist all moments and forces other than direct compression, including forces arising due to transit, unloading and erection.

The thickness of the slab base can be computed by the following formula given in IS 800-1984.

$$t = \sqrt{\frac{3w}{F_b}\left(A^2 - \frac{B^2}{4}\right)}$$

Where t = the slab thickness

A = the greater projection of the plate beyond column (Fig 5.7)

B = lesser projection of plate beyond column (Fig 5.7)

W = the pressure or loading on the underside of the base,

F_b = permissible bending stress in the slab bases

The permissible bending stress for slab is 185 N/mm^2

When a solid round column is supported on a square slab base, the required thickness of the slab base can be found from the following expression:

$$t = \sqrt{\frac{9wD}{16F_b(D - d_0)}}$$

Where

t = the thickness of plate

W = Total axial load

D = Length of the side of base, to be kept not less than 1.5 (d_0+75) mm

d_0 = diameter of column

F_b = Permissible Bending stress, i.e. 185 N/mm^2

- Design of Base Plate

Design for Node 341 X Bracing

fck	20	N/mm^2
Axial load =	150.467	kN
Moment =	3.608	kNm
permissible bearing pressure on footing=	4	N/mm^2
Column section =	ISHB	350
Es =	415000	N/mm^2 (for bolts)
Ec =	22360.7	N/mm^2

e = M/P = 23.97868mm

Base plate size (assume) = 500mm x 350mm

Taking moment about the anchor bolts

M = 0.5*pN*h*b*(h-(N*h/3))

The above eq gives following quadratic eq:-

$42145833N^2$ -- 126437500N = 4.5E+07

N^2 -- 3 N = 1.0674

therefore N = 0.535
and Nh = 227.375mm

Equating the vertical forces to zero

T + P = 0.5*Nh*b*p
T = 8695.5N
= 8.6955kN

the stress in bolt is given by :-

Es/Ec = 18.559364
fs = 4x(1-N/N)xn
= 64.52414N/mm^2

Area of steel bolts on one side = 134.764mm^2
so for two side req area = 269.527mm^2

	nos.	dia	area prov. (mm^2)	
so provide	2	30	1413	O.K

The critical stress will act at = 83.75mm

pressure at this point = 2.526663N/mm2

Hogging moment at section = 76085.6Nmm

Sagging moment = 4307022.5Nmm

If permissible bending stress= 185N/mm2

thickness t = 19.97765mm

Use plate with	length(mm)	width(mm)	thk(mm)
	500	350	20

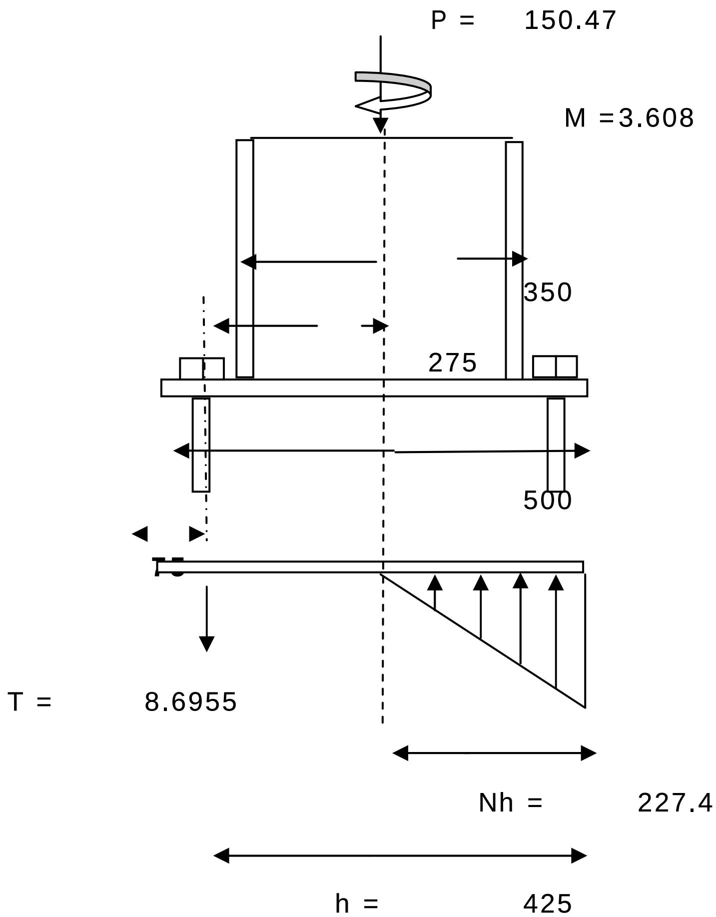


Fig.5.8 Detail of Base plate

6. DESIGN OF RAFT FOUNDATION

6.1 GENERAL:

Raft or Mat foundation is a combined footing that covers the entire area beneath a structure and supports all walls and columns. This raft or mat normally rests directly on soil or rock, but can also be supported on piles as well.

Raft is generally suggested in the following situations:

A. Whenever building loads are so heavy or the allowable pressure on soil so small those individual footings would cover more than floor area.

B. Whenever soil contains compressible lenses or the soil is sufficiently erratic and it is difficult to define and assess the extent of each of the weak pockets or cavities and, thus, estimate the overall and differential settlement.

C. When structures and equipment to be supported are very sensitive to differential settlement.

D. Where structures naturally lend themselves for the use of raft foundation such as silos, chimneys, water tower etc.

E. Floating foundation cases wherein soil is heaving very poor bearing capacity and the weight of the super-structure is proposed to be balanced by the weight of the soil removed.

F. Buildings where basements are to be provided or pits located below ground water table.

G. Buildings where individual foundation, if provided, will be subjected to large widely varying bending moments which may result in differential rotation and differential settlement of individual footing causing distress in the building.,

6.2 TYPES OF RAFT

Raft can be classified into various types on the basis of criteria used for classification.

Based on the method of their support, raft can be classified as follows

1. Raft supported on soil
2. Raft supported on piles
3. Buoyancy raft

On the basis of structural system adopted for structure of the raft

1. Plain Slab rafts

Raft of uniform depth is most popular due to its simplicity of design and construction. This type is most suitable where the column loads are moderate and the column spacing fairly small and uniform. Pedestals are utilized to distribute the load on a bigger area in case of heavy column loads.

2. Beams and slab raft

Beam and Slab raft is used as a foundation for heavy buildings where stiffness is the principal requirement to avoid excessive distortion of the super structure as a result of variation in the load distribution over the raft or the compressibility of the supporting soil.

3. Cellular Raft or Framed Raft

Buoyancy raft are necessarily to be provided with a basement so that the weight of the soil removed balance to a large extent, the imposed load. Cellular raft consisting of foundation slabs, walls, columns and ground floor slab can be designed. But it creates considerable amount of uncertainties, difficulty of construction and quite often even in such cases, raft is designed as a slab of uniform thickness

Various types of Raft are shown as Fig.6.1

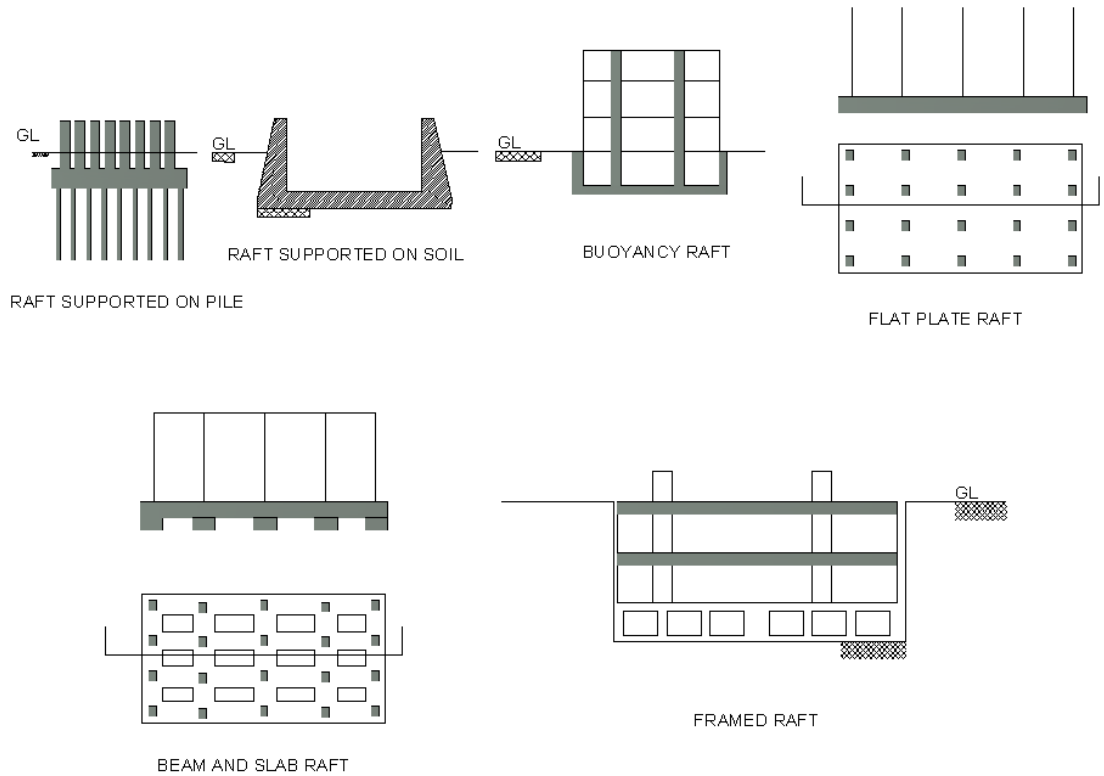


Fig.6.1 Types of Raft

6.3 ANALYSIS OF RAFT FOUNDATION

In design of raft foundation two design approach is been used for the analysis as stated below.

a) Rigid Approach

In rigid foundation approach, it is presumed that raft is rigid enough to bridge over non-uniformities of soil structure. Pressure distribution is considered to be either uniform or varying linearly. Design of rigid raft follows conventional methods where again following two approaches have been sugg4ested:

- Inverted Floor system
- Combined footing approach

In rigid rafts, differential settlements are comparatively low but bending moment and shear forces to which raft is subjected are considerably high.

b) Flexible Approach

In flexible foundation approach, raft is considered to distribute load in the area immediately surrounding the column depending upon the soil characteristics. In this approach differential settlements are comparatively larger but bending moments and shear forces to which the raft is subjected are comparatively low. Analysis is suggested basically on two theories

- Flexible plate supported on elastic foundation, i.e., Hetenyi's Theory
- Foundation supported on bed of uniformly distributed elastic springs with a spring constant determined using coefficient of sub-grade reaction. Each spring is presumed to behave independently, i.e. Winkler's foundation

Based on these two basic approaches, methods suggested include simplified methods subject to certain limitations which can be carried out by manual computation. Also now available are computer based methods like finite element and finite difference methods. Finite difference method is based on the second approach of uniformly distributed elastic springs and can consider one value of sub-grade modulus for the entire area. Finite element method transforms the problem of plates on elastic foundation into a computer oriented method of matrix structure analysis. In this method, plate is idolized as a mesh of finite elements inner-connected only at the nodes, and the soil may be modeled as a set of isolated springs or as elastic isotropic half space. The matrix structural analysis can be extended to include the influence of the super-structure as well. Thus, the interaction between the super-structure, the foundation and the soil can be accounted for. It is possible to consider different values of sub-grade modulus in different areas of the raft foundation.

In case of piled rafts against the usual assumption of entire load being carried by piles alone, emphasis is now being laid on sharing of load between raft supported on soil, i.e., raft soil system and raft pile system. Sufficiently accurate methods for practical distribution of these loads are not yet available.

As a simplification of treating the entire raft as a plate, concept of beam on elastic foundation is also being used. For this purpose raft is considered to consist of beams in both the directions. Each of these beams is treated as supported on springs having spring constant calculated using modulus of sub grade reaction and carrying column loads. The bam is then analyzed as a beam on elastic foundation.

6.3.1 Pressure Distribution under the Raft

A problem which has to be solved while designing a raft foundation is to evaluate the actual contact pressure of the soil against the raft. This problem has occupied many researchers theoretically and a lesser number experimentally with no exact values being known. Contact pressure, settlement of foundation, soil characteristics and its behavior are so much inter-related and their relationship so complex, that soil foundation structure interaction is not clear even now. Considering all these aspects it can be said that the contact pressure distribution under the raft depends upon:

- The nature of the soil below the raft, i.e., a single homogenous mass or a layered formation, thicknesses of various layers and their relative locations
- Properties of the soil
- The nature of the foundation, i.e., whether rigid, flexible or soft
- Rigidity of the super-structure.
- The quantum of loads and their relative magnitude.
- Presence of adjoining foundation.
- Size of raft.
- Time at which pressure measurements are taken.

The total settlement under the raft foundation can be considered to be made up of three components, i.e.,

$$S = S_d + S_c + S_s$$

Where

S_d = The immediate or distortion settlement,

S_c = the consolidation settlement

S_s = Secondary compression settlement

The immediate component is that portion of the settlement which occurs simultaneously with the load application, primarily as a result of distortion within the foundation soils. The settlement is generally not elastic although it is calculated using elastic theory. The remaining components results from the gradual expulsion of water from the void and corresponding compression of the soil skeleton. The distinction between the consolidation and secondary compression settlement is made on the basis of physical process which controls the time rate of settlement. Consolidation settlements are largely due to primary consolidation in which the time rate of settlement is controlled by the rate at which the time rate of settlement is controlled by the rate at which water can be expelled from the void spaces in the soil. The secondary compression settlement, the speed of settlement is controlled largely by the rate at which the soil skeleton itself yields and compresses. The time rate and the relative magnitude of the 3 components differ for different soil types. Water flows so readily through most clean granular soil that the expulsion of water from the pores for all practical purposes is instantaneous and thus foundation settles almost simultaneously with the application of load. Ion cohesive soil, it takes considerable time for water to escape and thus settlement in cohesive soils continues much longer. In fact, it has been reported that the pressure under a mat foundation on clay may vary from time to time.

Effect of groundwater table is appreciable on the load carrying capacity of the soil and consequently settlements. It is, therefore, necessary to consider the expected ground water table in life time of the structure including the temporary rises as during floods. Even in areas where sub-soil water table is not present, it is necessary to consider long term built up water for design of basement and raft foundation. If permeability coefficient of the soil is below 0.1mm per second, soil is cohesive and probability of surface water accumulated against basement walls exist. In such situations, it may be necessary to design raft foundation of basement for water uplift also.

The conventional analysis of footings, in general , uses the concept of a rigid footings and wit h rigid footing are associated the concept of uniform soil pressure, Actually to have a uniform soil pressure distribution, we require very flexible footing. If simultaneously we accept the concept of soil being elastic (modulus of elasticity or coefficient of sub-grade modulus), settlement of rigid footing will be uniform and that for a flexible footing the settlement would be non-uniform and but if this is the case then how can the contact pressure be uniform (under a rigid footing). In reality we have a soil structure interaction problem and there is a non-uniform soil pressure and differential settlements within the footings. It has been suggested that in case of square footing resting on clay on average contact pressure of 0.6 P/A along edges would be reasonable. Pressure distribution, For a rectangular footing of large length it is suggested that it would be reasonable to have an average pressure equal to 0.8P average +0.1 P/B for the edges. Here P is total load. A, area and B, length of the footing.

Foundation Analysis and Design by Joseph. E. Bowels

The mat may be designed as a rigid structure thereby soil pressure are computed as Q= V/ A in the case where the resultant of the forces coincide with the centre of the mat area. If resultant has eccentricity with respect to geometric centre, soil pressure is calculated by the relation

$$Q = \frac{V}{A} \pm \frac{M_Y X}{I_Y} \pm \frac{M_X Y}{I_Y}$$

If the eccentricity is very large, the resulting internal stresses may be seriously in error. Once the dimensions of the mat are established, soil pressure at various locations beneath the base may be computed. With the pressure distribution known, the mat is sub-divided into a series of beams; shear and moment diagram may be established using either combined footing/analysis or beam moment coefficient. The depth is selected to satisfy shear stresses and is usually constant but the steel reinforcement varies from strip to strip, the perpendicular direction is analyzed similarly.

The design of Raft foundation using manual method is given in Appendix B

6.4 Modeling Using SAFE

In sophisticated flexible analysis, utilizing computer, it is soil properties which matter to a large extent. In exact analysis all soil properties matter, but in commonly adopted analysis where soil-raft interaction is idealized as a spring of known rigidity most important soil property is modulus of sub-grade reaction.

The modulus of sub grade reaction of Soil is been assigned as 150 N /mm^2

Reaction of Load Combination Transferred to the Raft is DL + LL + OL.

Bending Moment is been obtained in Mxx and Myy direction are given in Fig. 6.2 and 6.3.

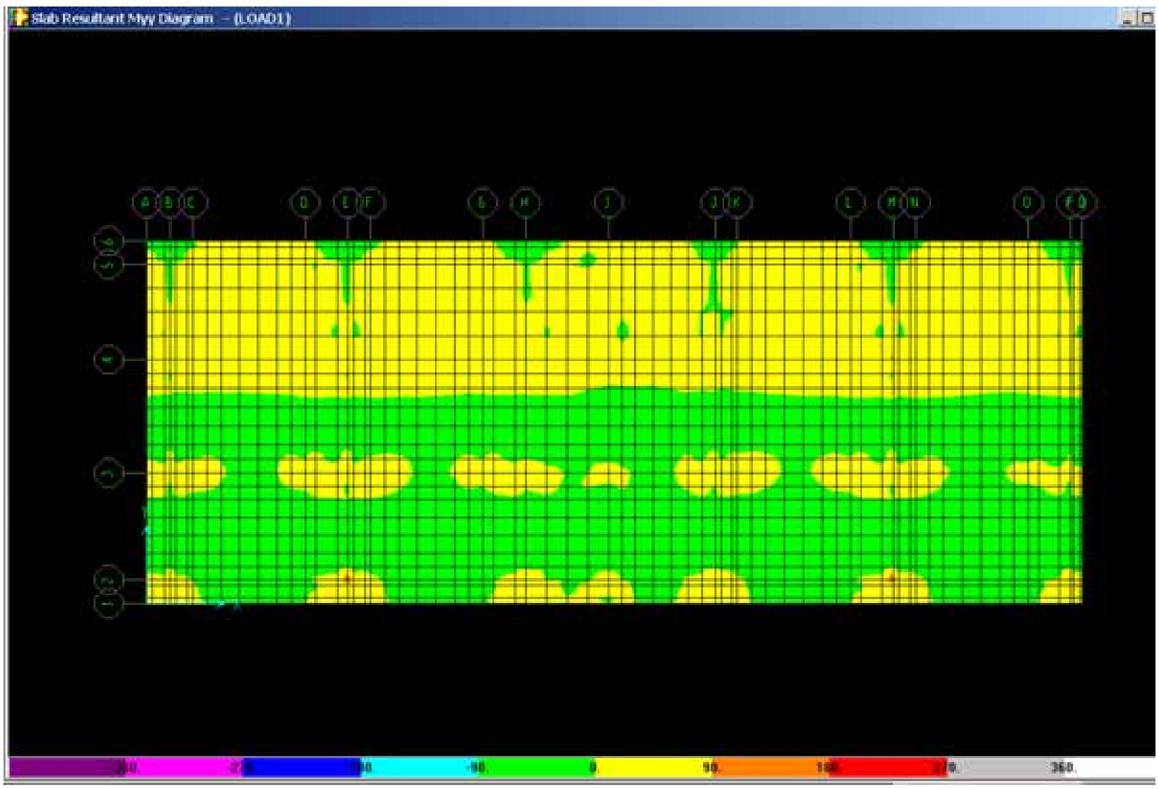


Fig 6.2.Bending Moment in Y Direction

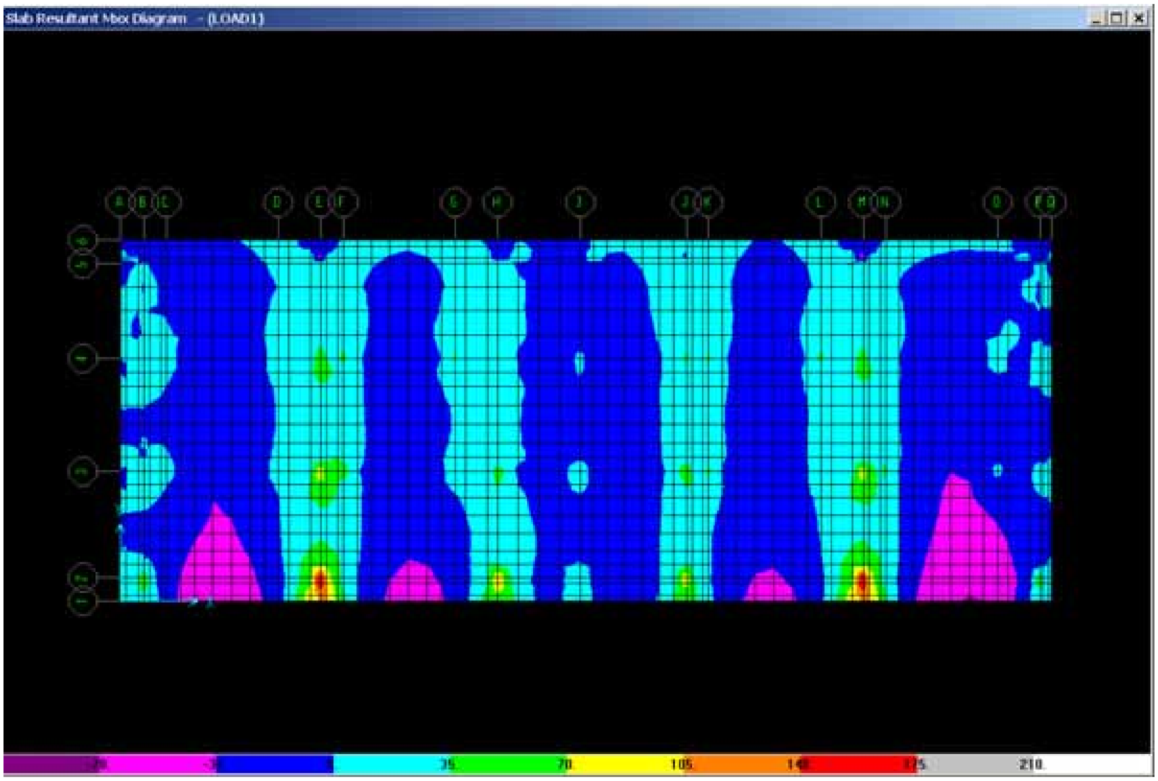


Fig 6.3 Bending Moment in X Direction

7. SUMMARY AND CONCLUSION

7.1 SUMMARY

Screening Building is acted upon by different loads like earthquake load, conveyor load, equipment load etc. The structure is analyzed for different types of loads. Moreover it is checked for the deflection to be within its permissible limit. It shall be designed for economy, safety and functional requirements of the process.

Screening building is been analyzed for the different bracing pattern and different load condition. And the weight comparison of different arrangement is given in Fig. 7.1 and Table 7.1.

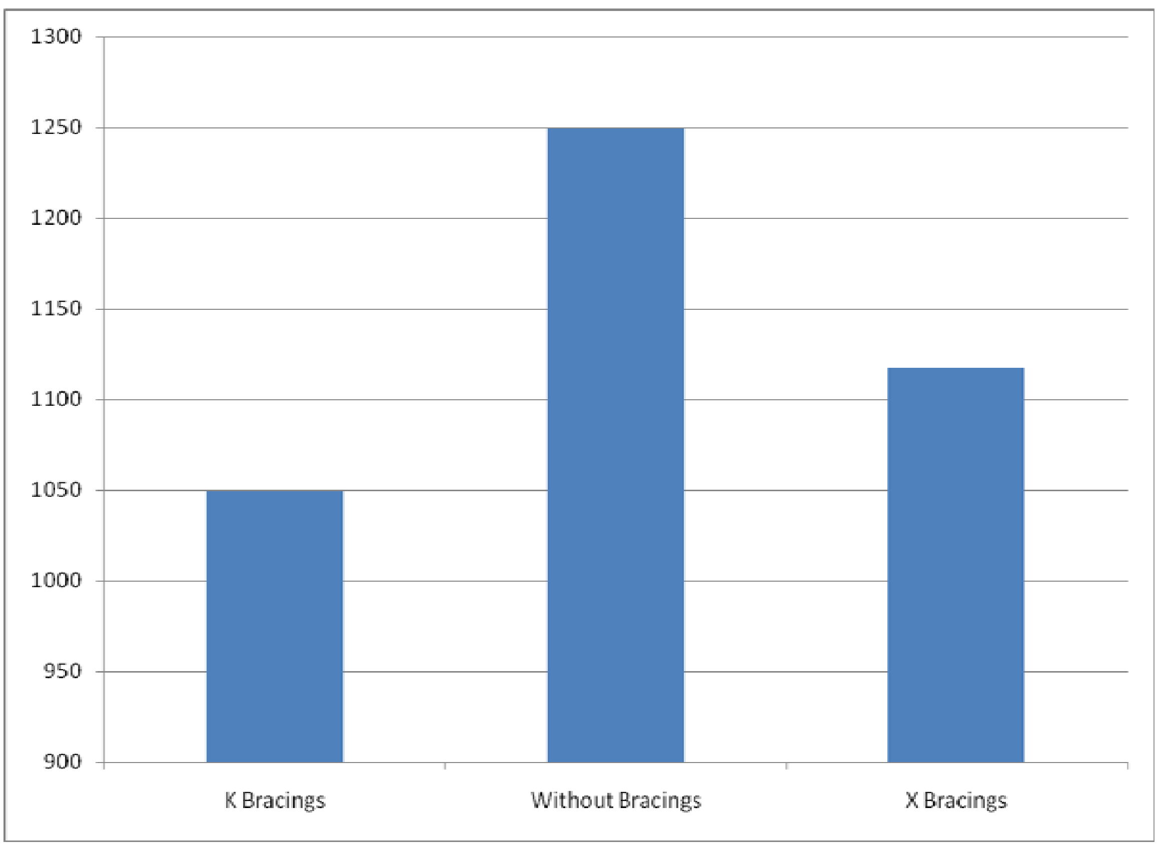


Fig 7.1 Weight Comparison

Table 7.1 Weight Comparison

	Weight kN
K Bracings	1049.43
Without Bracings	1249.076
X Bracings	1117.439

Deflection due to Earthquake force is been found out as Fig 7.2

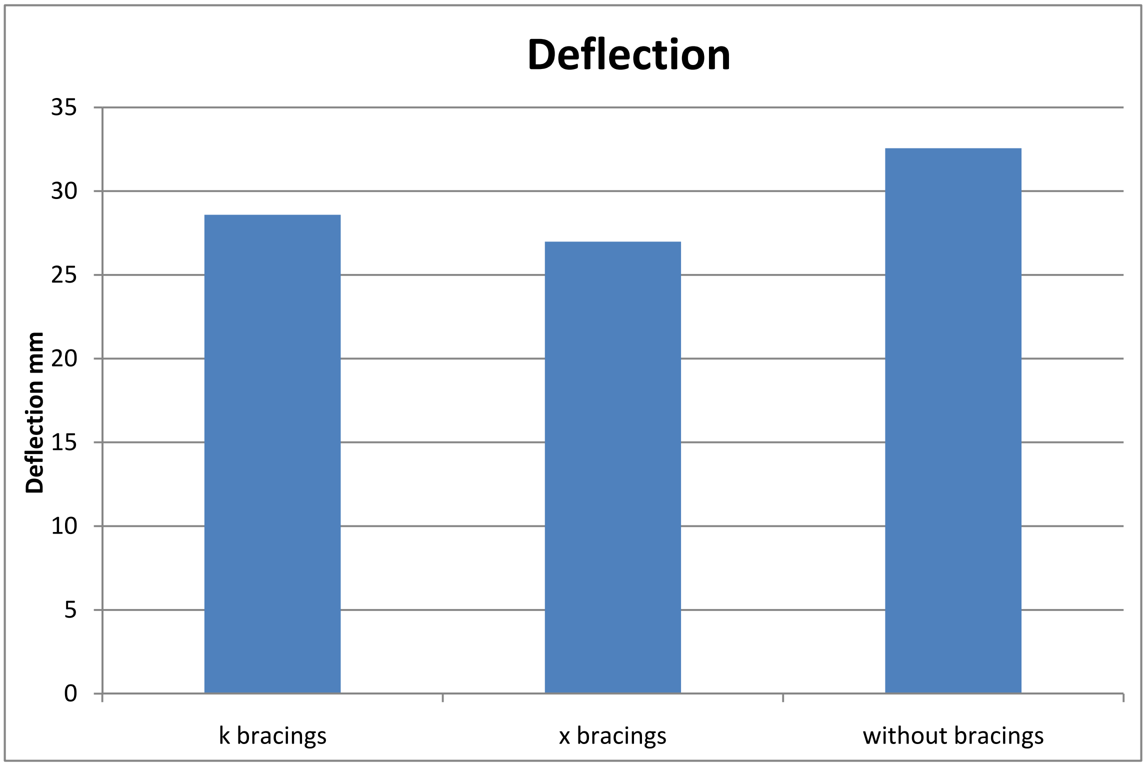


Fig 7.2.: Deflection Due to EQ Force

7.2 CONCLUSION

- By altering the bracing pattern the column sizes decreases. No changes on beam sizes appear.
- K Bracing System appears most suitable for the structure.
- Earthquake Force is the governing force in case of lateral Forces.
- The maximum displacement due to dynamic analysis is less then 2 mm.

7.3 FUTURE SCOPE OF WORK

- The Screening Building can be analyzed by altering the sizes of screens.
- For avoiding Resonance the frame shall be checked with providing dampers.

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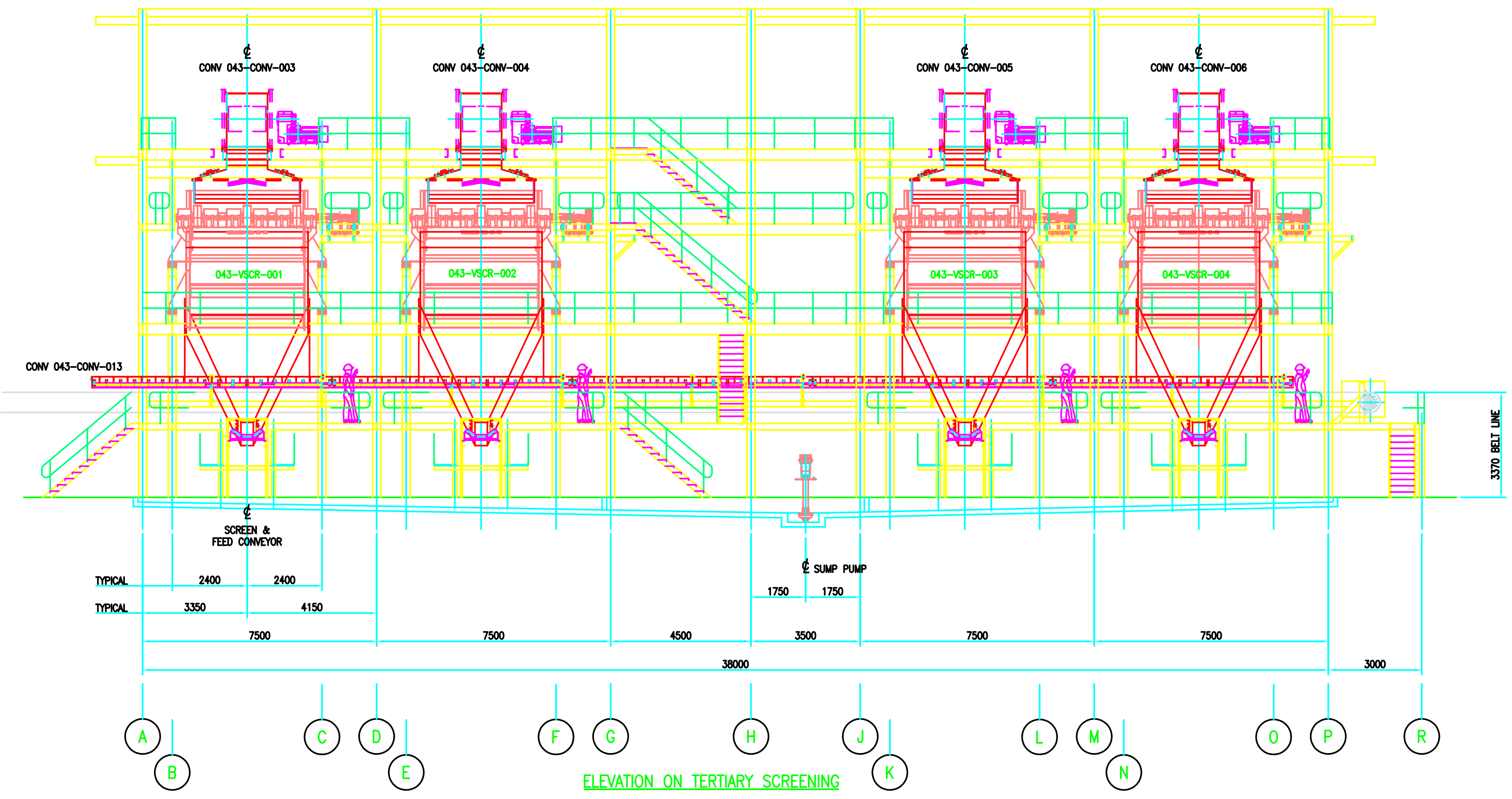
APPENDIX-A DRAWINGS

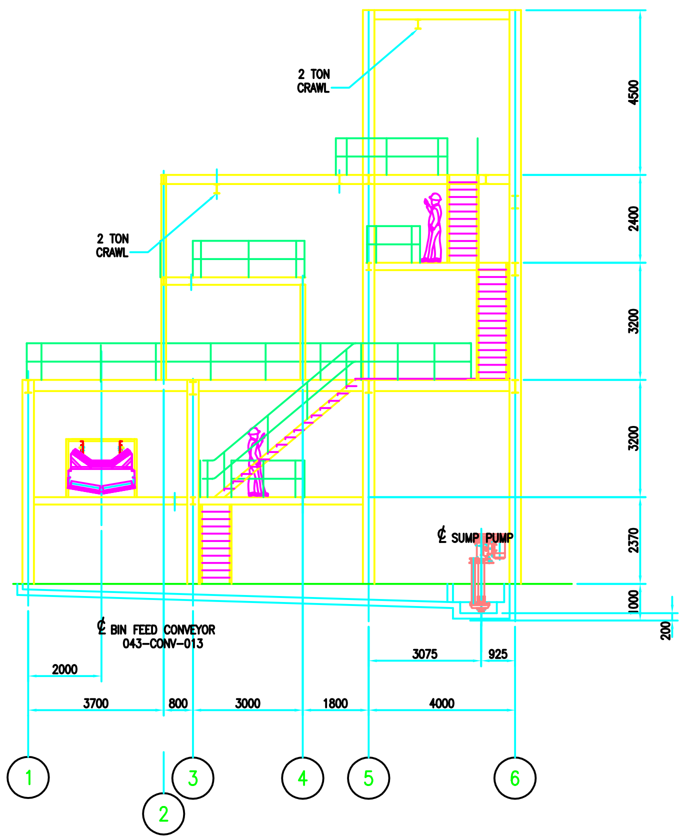
Appendix A Consists Drawings Which are listed Below.

Sheet 1	GA Drawing 1
Sheet 2	GA Drawing 2
Sheet 3	Machine Details
Sheet 4	Load Details
Sheet 5	Property Without Bracings
Sheet 6	Property With X Bracings
Sheet 7	Property With K Bracings

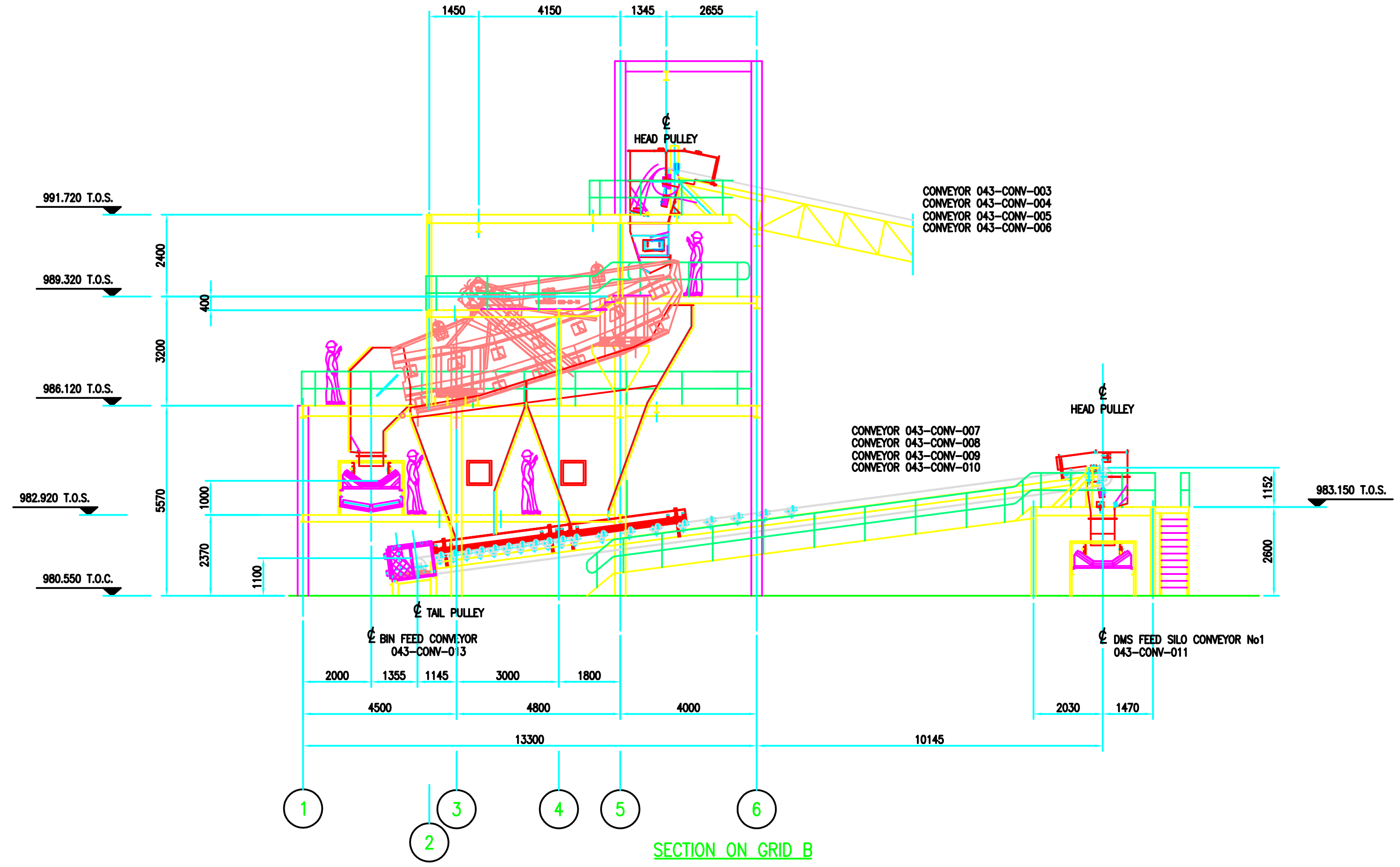
1 GA Drawing 1



ELEVATION ON TERTIARY SCREENING



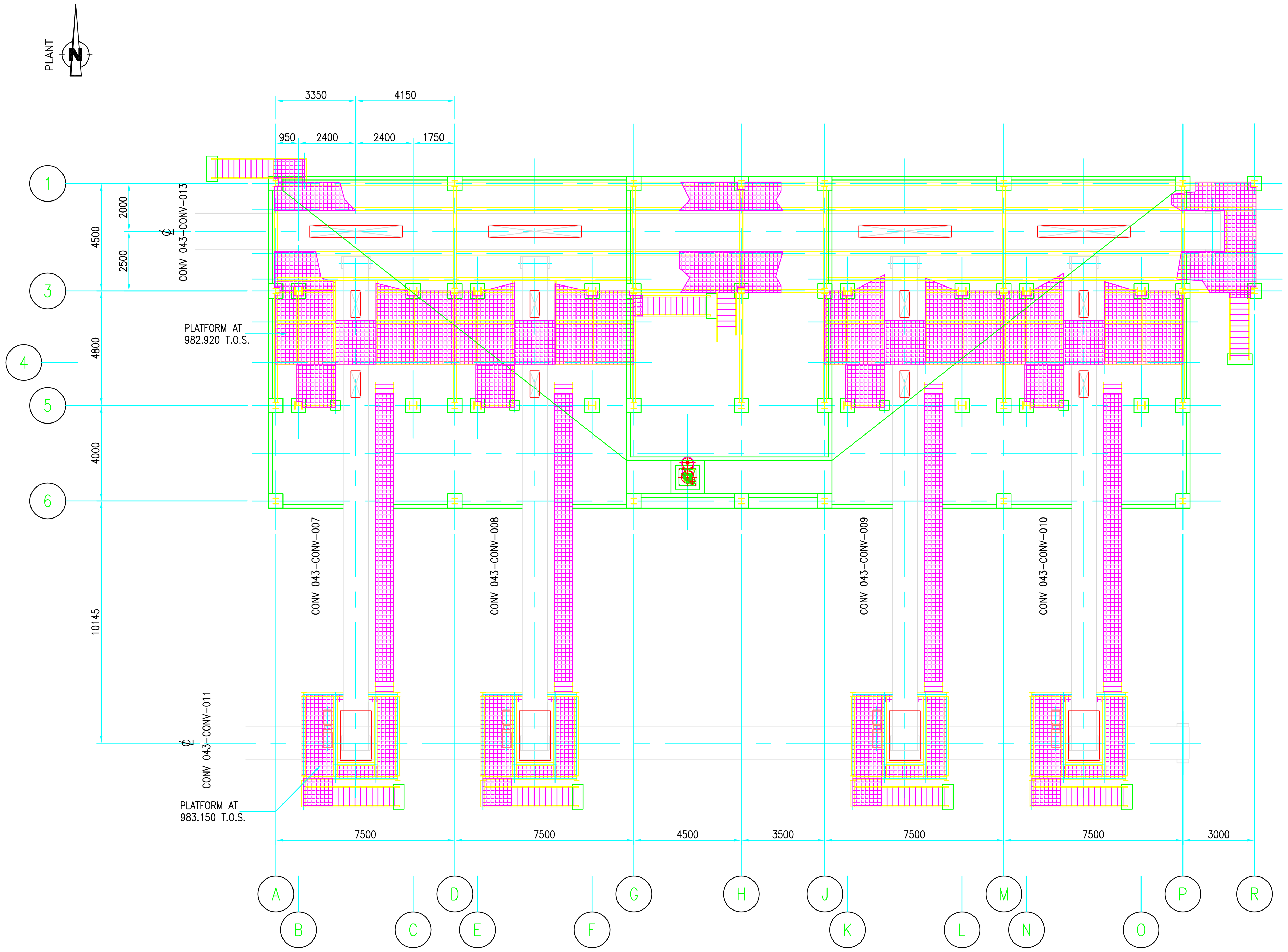
SECTION ON GRID G



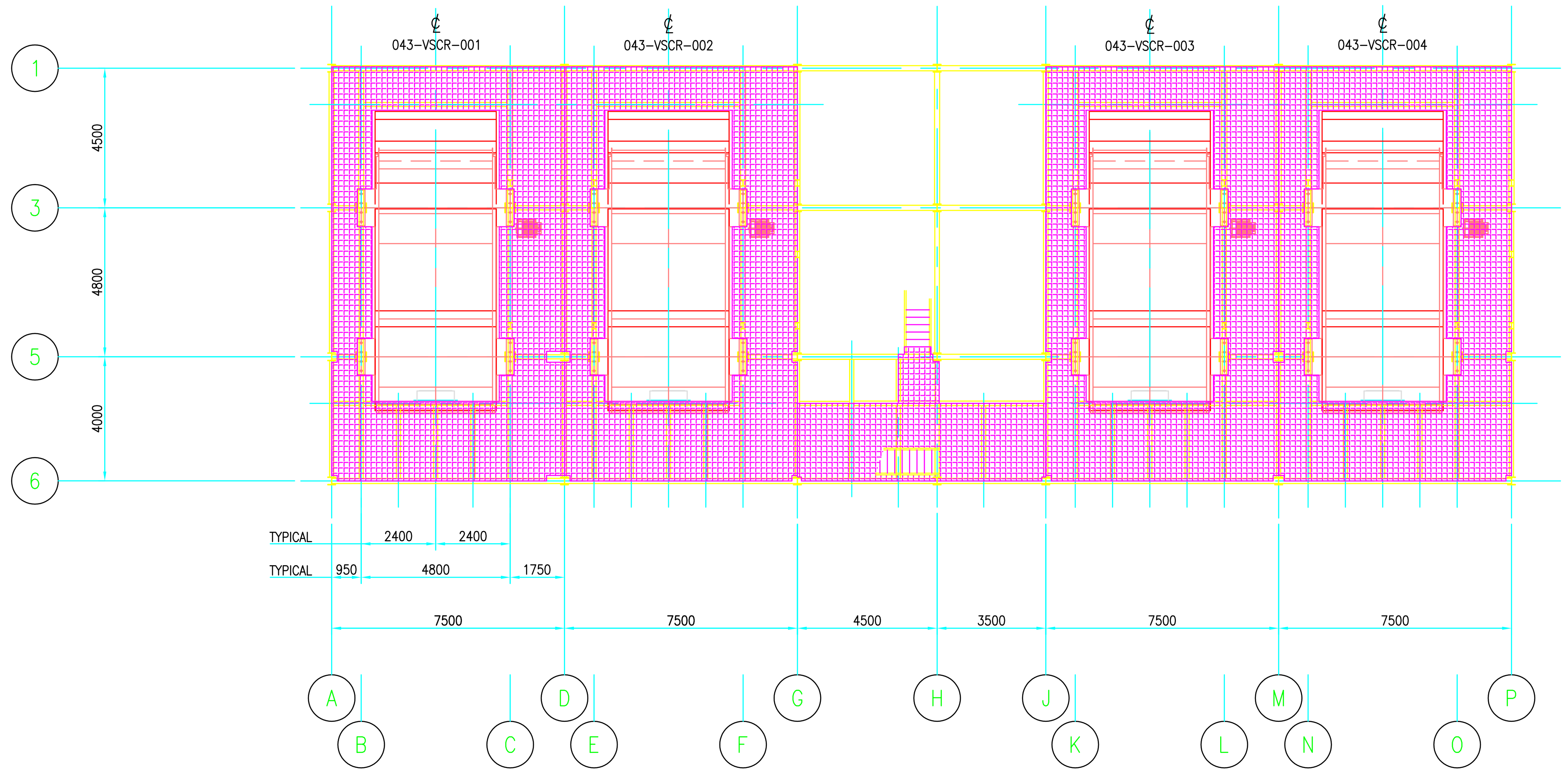
SECTION ON GRID B

ALL DIMENSIONS ARE IN MM

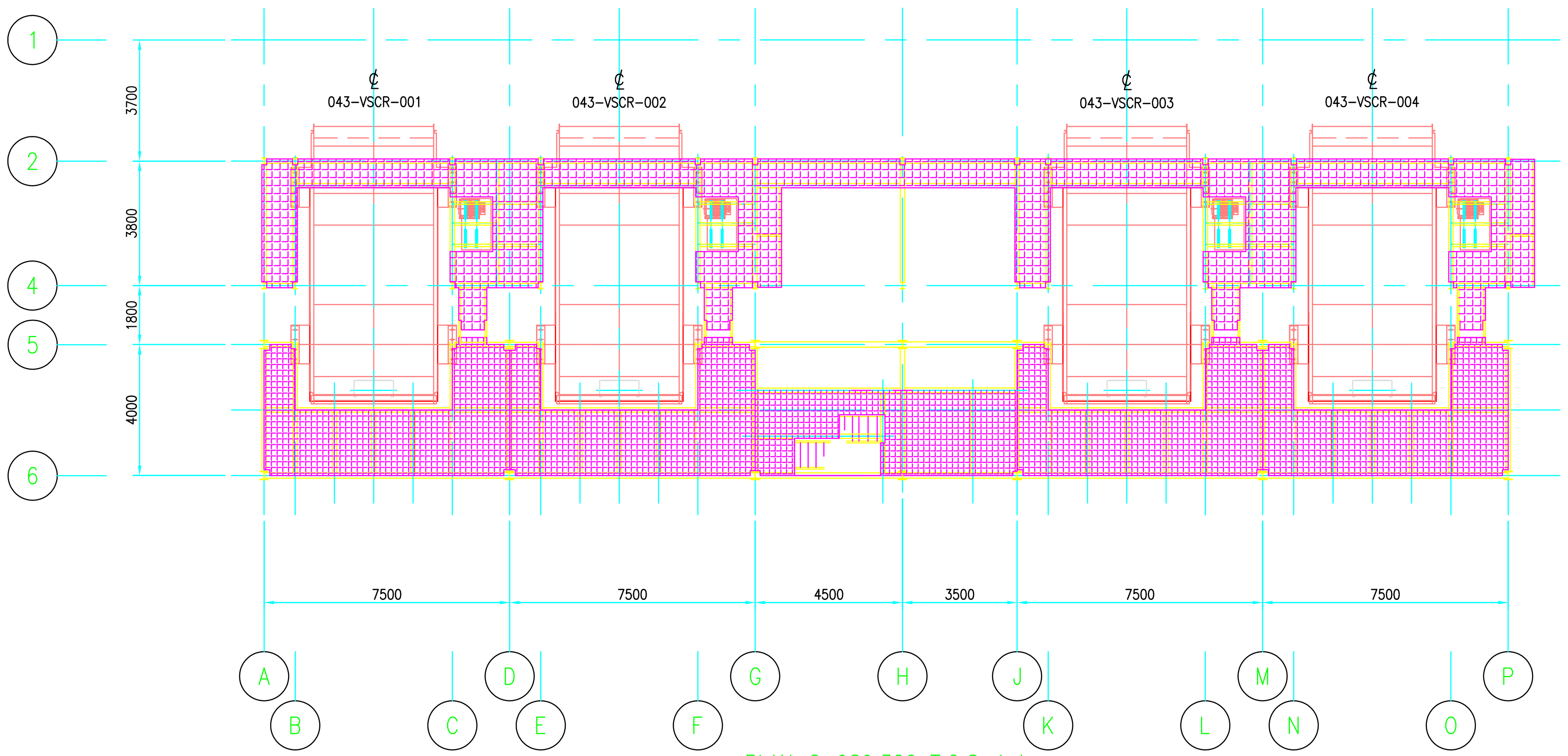
2 | GA Drawing 2



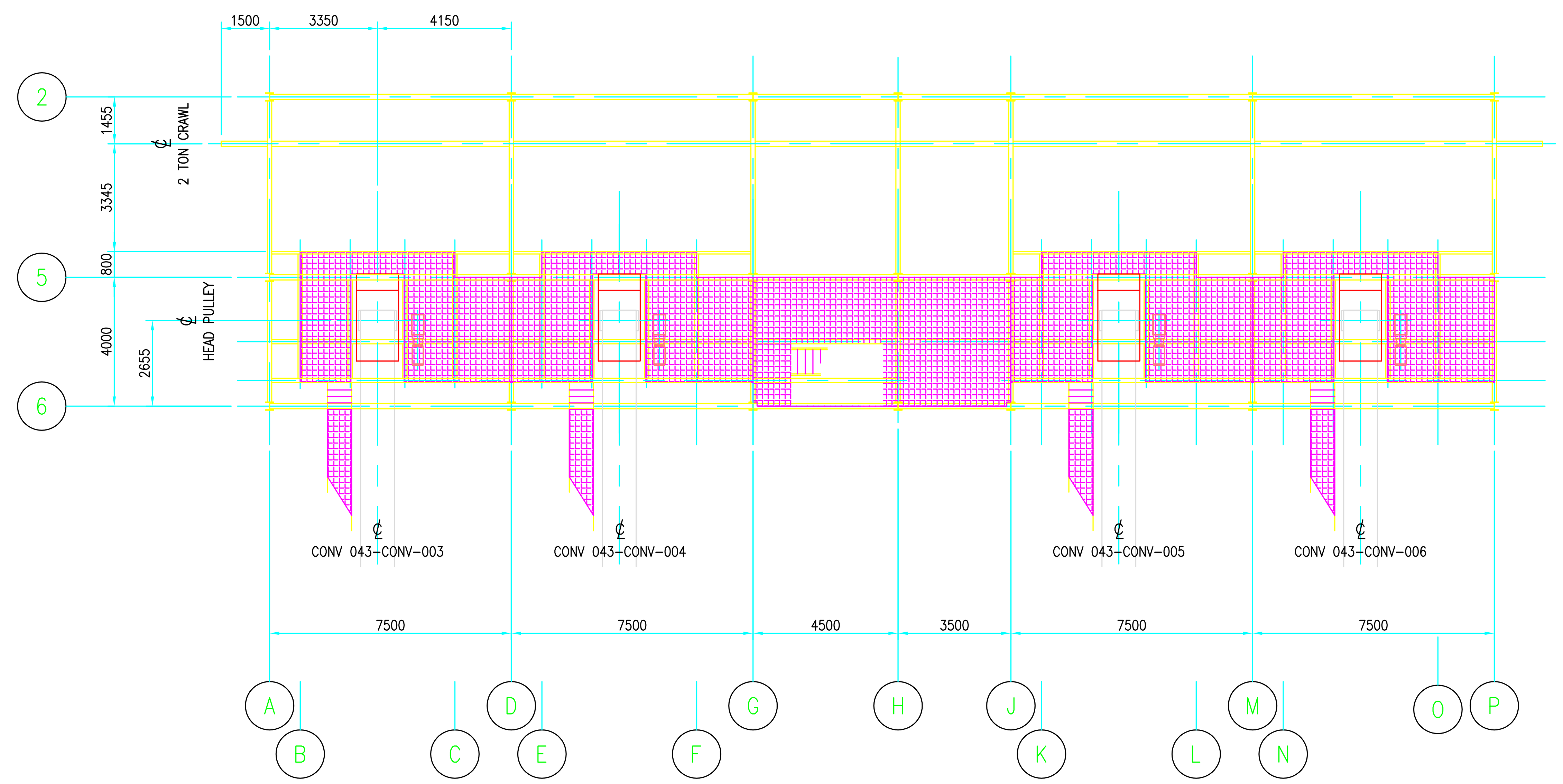
PLAN @ 980.550 T.O.C & 982.920 T.O.S. LvL



PLAN @ 986.120 T.O.S. LvL



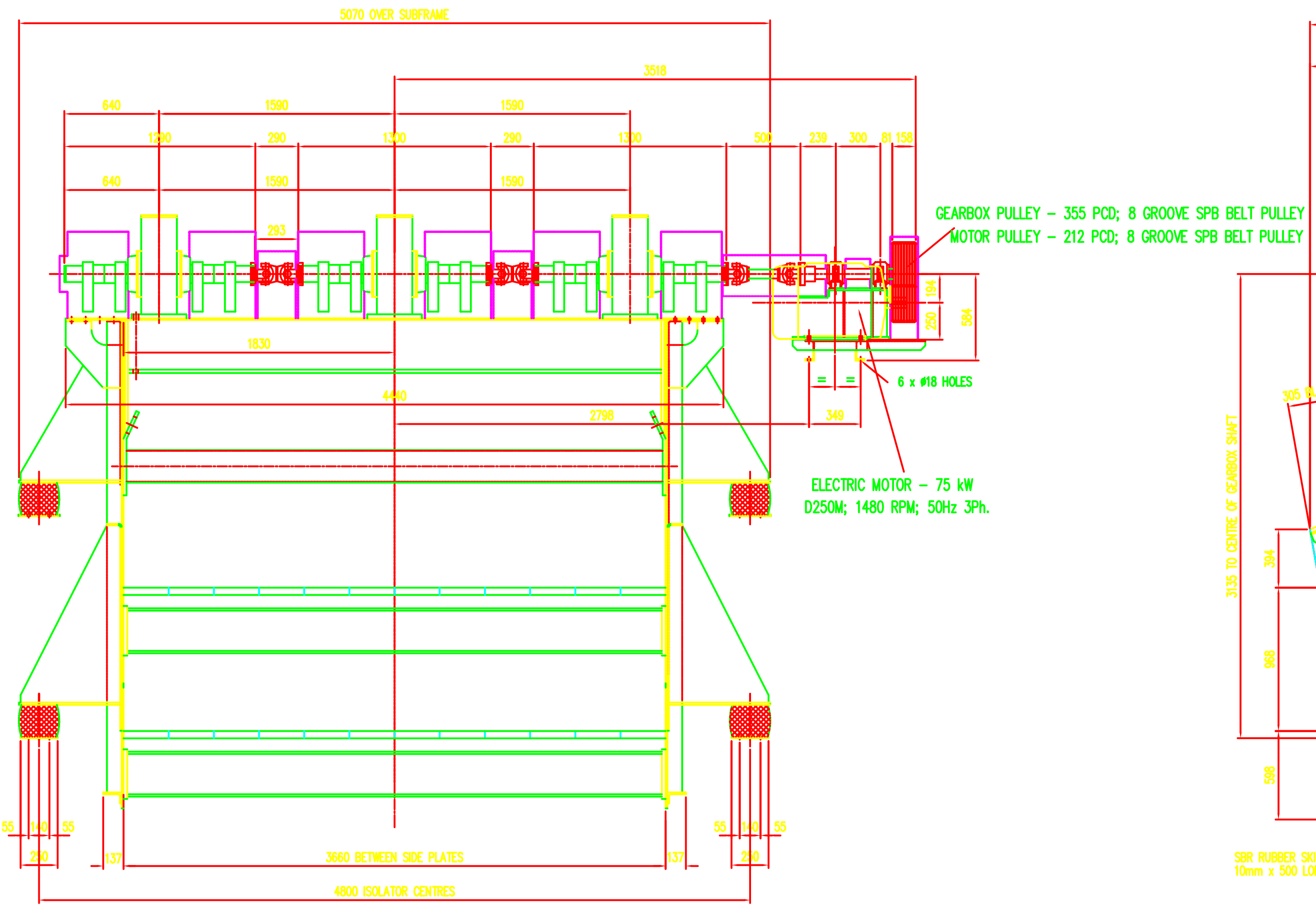
PLAN @ 989.320 T.O.S. LvL



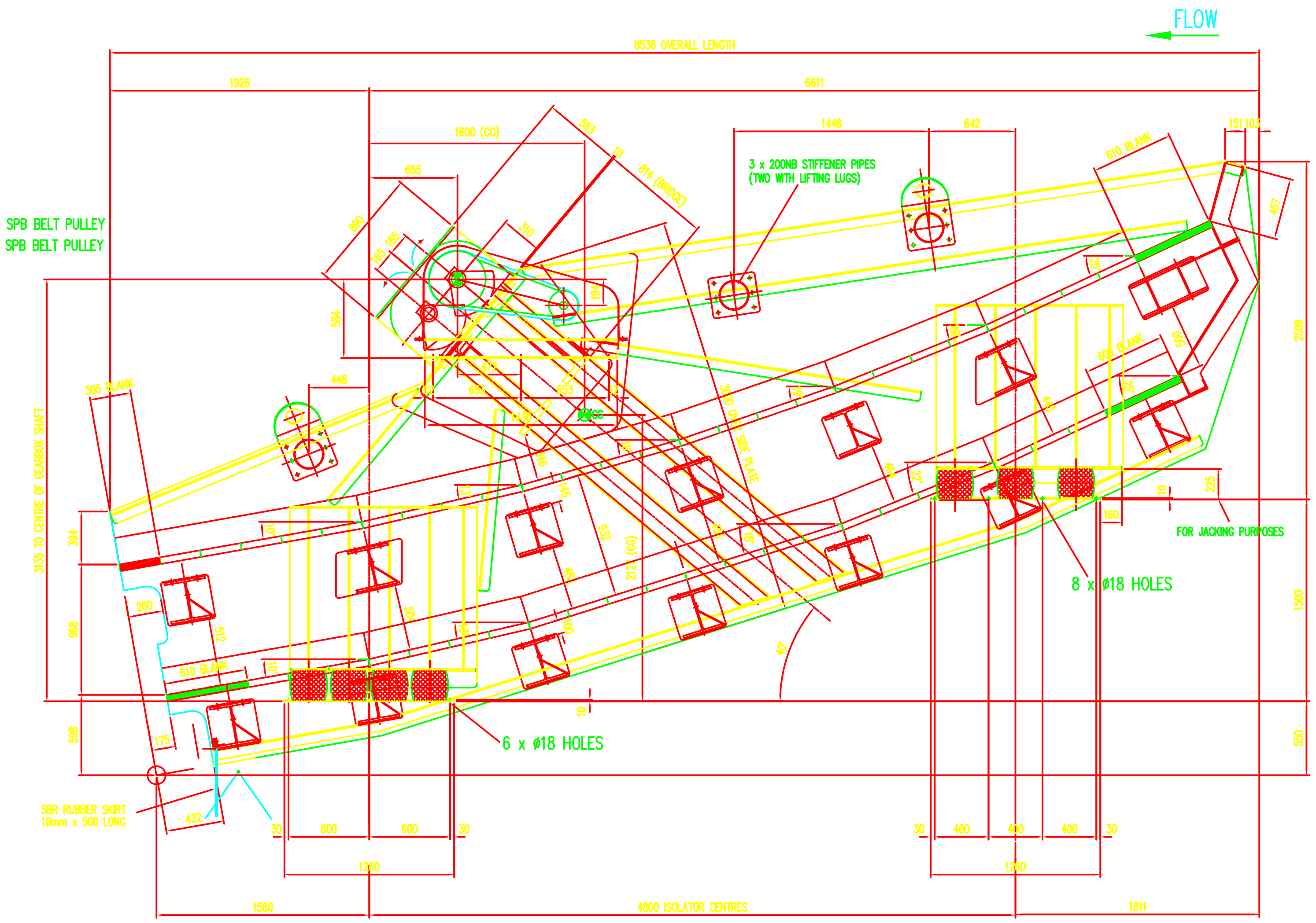
PLAN @ 991.720 T.O.S LvL

ALL DIMENSIONS ARE IN MM

3 Machine Details



VIEW ON DISCHARGE



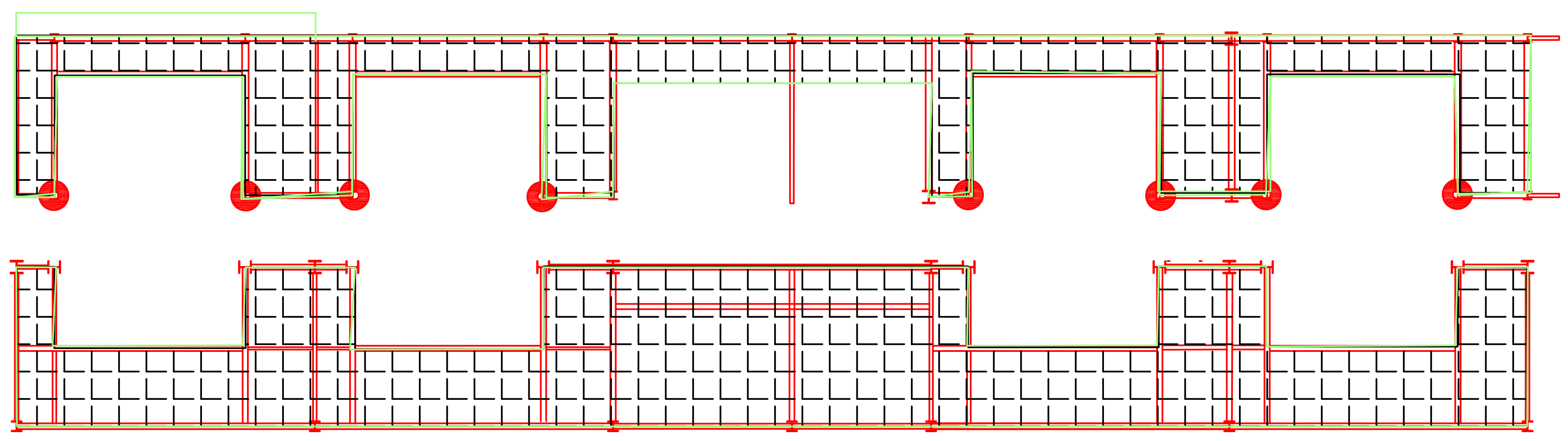
SIDE ELEVATION

GENERAL NOTES!

MASS OF SCREEN – 26000 kg.
DRIVE MECHANISM – 3 x MK4 GEARBOXES
GEARBOX SPEED – 875 RPM. ±10%
ELECTRIC MOTOR – 1 x 75 kW; D250M; 1480 RPM; 50Hz 3Ph.
SCREEN ISOLATORS – 14 x REF. VB70 RUBBER BUFFERS
VERTICAL DYNAMIC COMPONENT PER RUBBER BUFFER : 2609 N
HORIZONTAL DYNAMIC COMPONENT PER RUBBER BUFFER : 1095 N
ALLOW 75mm OPERATING CLEARANCE.

TERTIARY CRUSHER SIZING
TAG No: 043-VSCR-01
TAG No: 043-VSCR-02
TAG No: 043-VSCR-03
TAG No: 043-VSCR-04

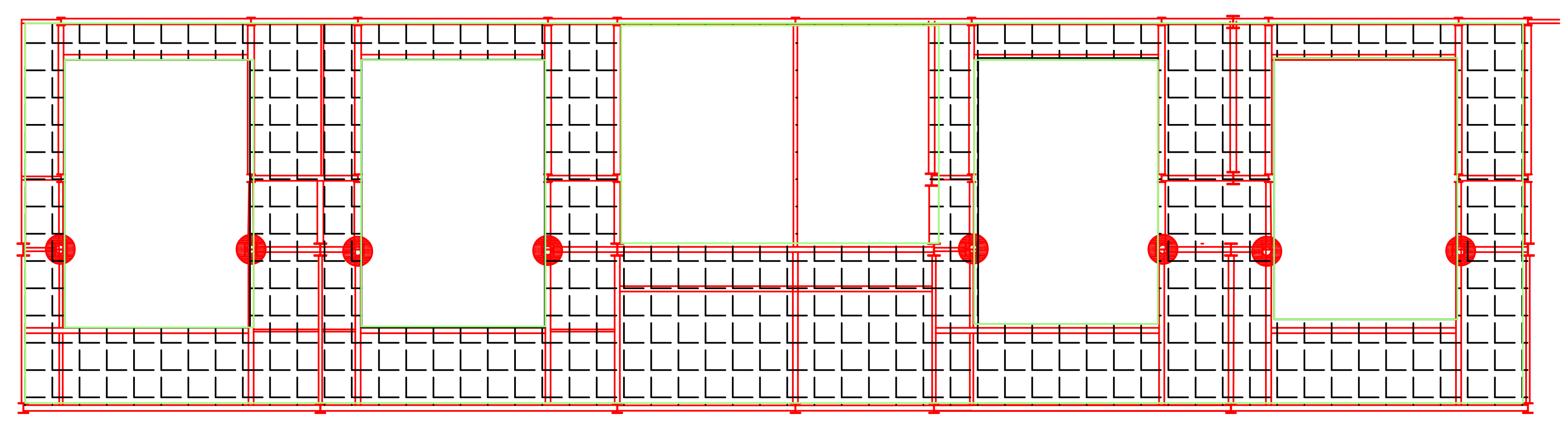
4 Load Details



● – Reaction of Crusher Unit

Static Forces	Dynamic Forces
Self Weight of Crusher = 95 kN (Per Node)	Vertical Dynamic Compomonant Fv ; 2.609 kN
Crusher Weight in Full Condition = 69.16 kN (Per Node)	Horizontal Dynamic Componant Fh ; 1.095 kN
	875 RPM

989.320 tos lvl



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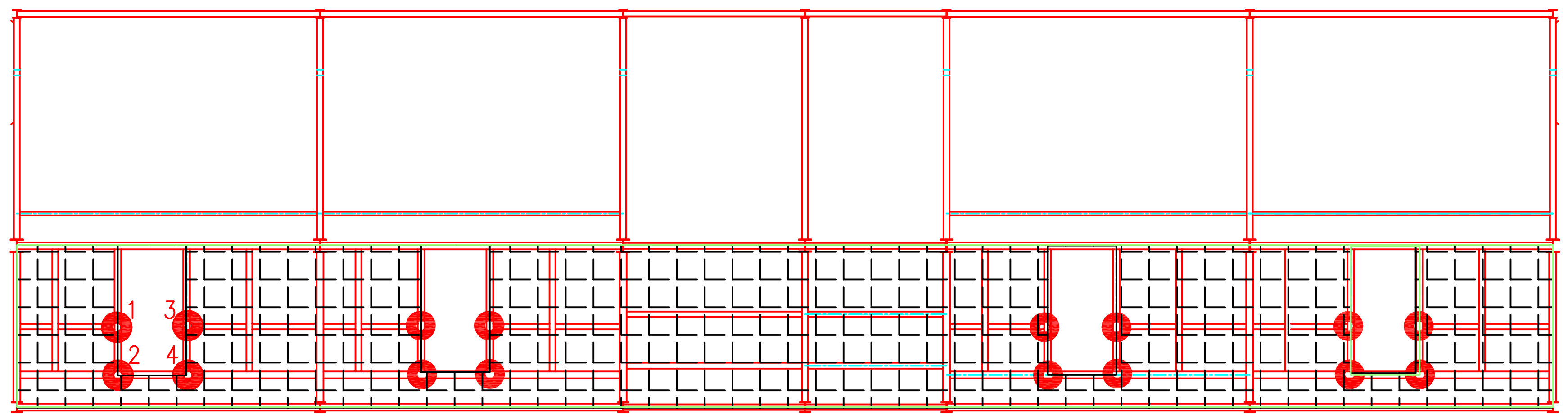
Static Forces	Dynamic Forces
Self Weight of Crusher = 95 kN (Per Node)	Vertical Dynamic Compomonant Fv ; 2.609 kN
Crusher Weight in Full Condition = 69.16 kN (Per Node)	Horizontal Dynamic Componant Fh ; 1.095 kN
	875 RPM

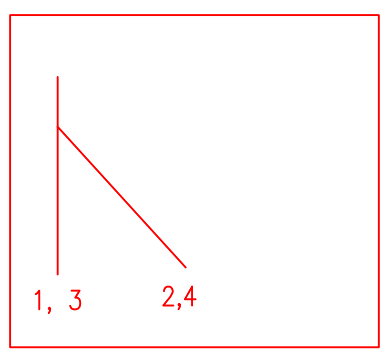
986.120 TOS LVL.



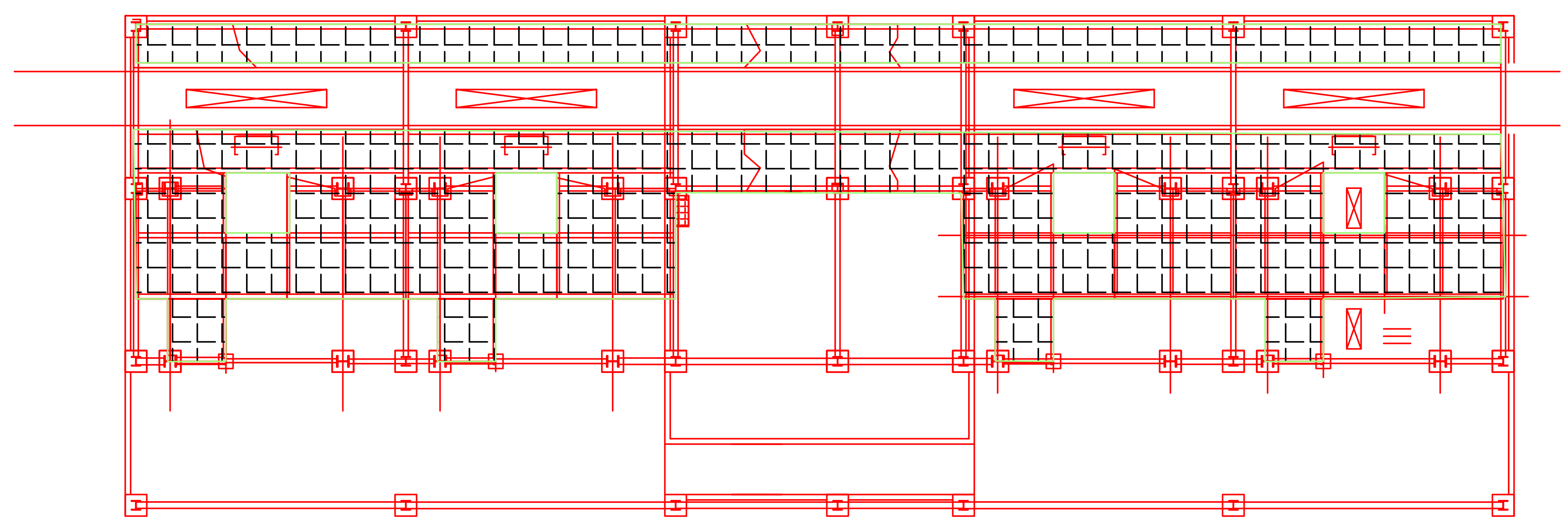
● – Reaction Of Head End

991.720 TOS LVL

Node	L/C	Horizontal Fx kN	Vertical Fy kN	Horizontal Fz kN	Moment Mx kNm	My kNm	Mz kNm
1	1 DEAD LOAD	0	1.487	0	0	0	0
	2 LIVE LOAD	0	0	0	0	0	0
	3 CONVEYOR LOAD	0	-82.383	0	0	0	0
2	1 DEAD LOAD	0	0.955	0	0	0	0
	2 LIVE LOAD	0	0	0	0	0	0
	3 CONVEYOR LOAD	-79.25	87.213	0	0	0	0
3	1 DEAD LOAD	0	1.487	0	0	0	0
	2 LIVE LOAD	0	0	0	0	0	0
	3 CONVEYOR LOAD	0	-82.383	0	0	0	0
4	1 DEAD LOAD	0	0.955	0	0	0	0
	2 LIVE LOAD	0	0	0	0	0	0
	3 CONVEYOR LOAD	-79.25	87.213	0	0	0	0



Nodes on Head End



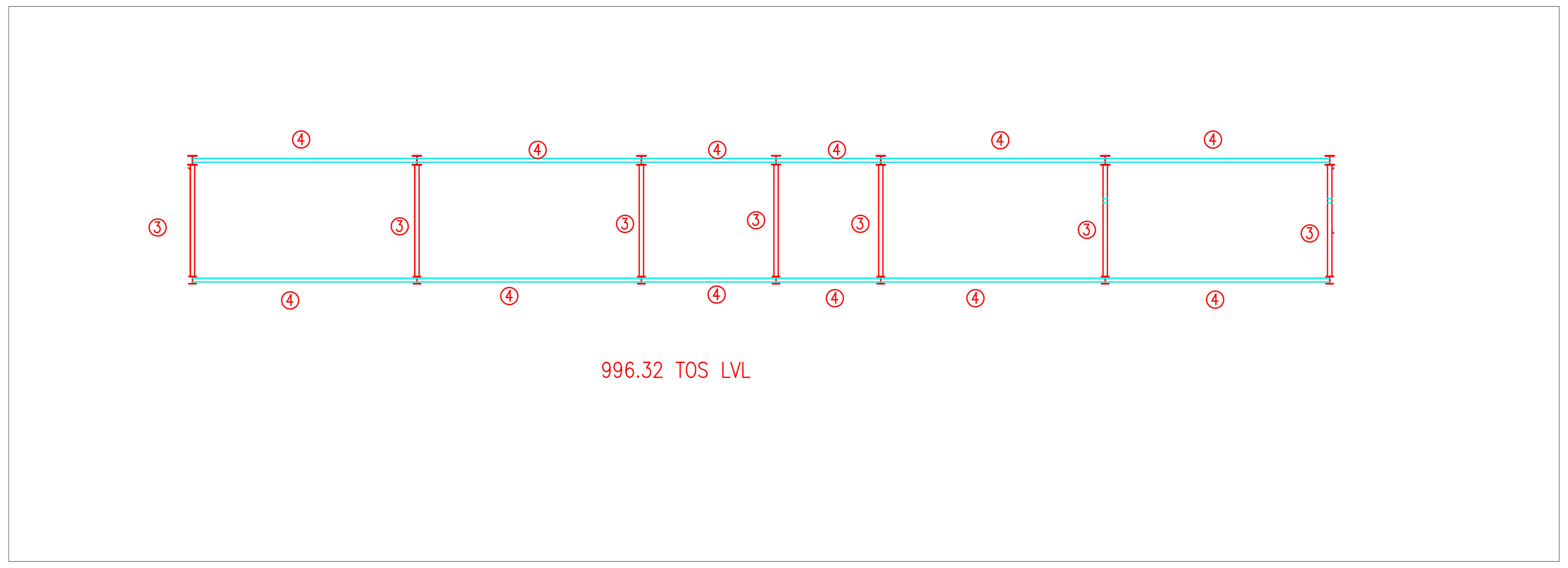
980.550 & 982.920 TOS LVL

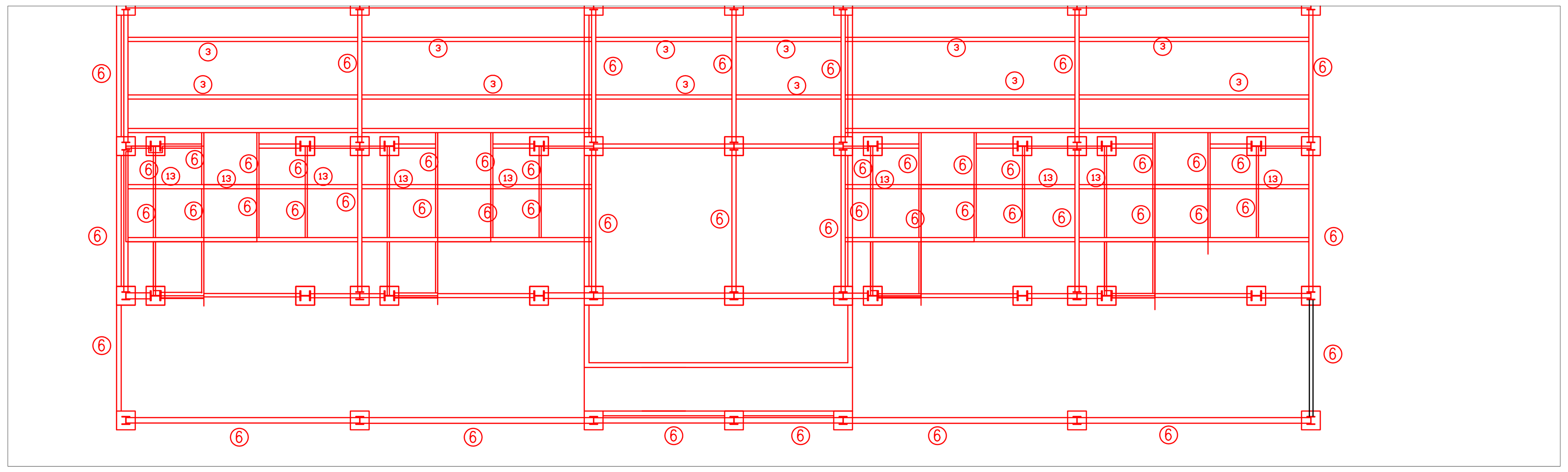
Live Load = 5 kN / m^2

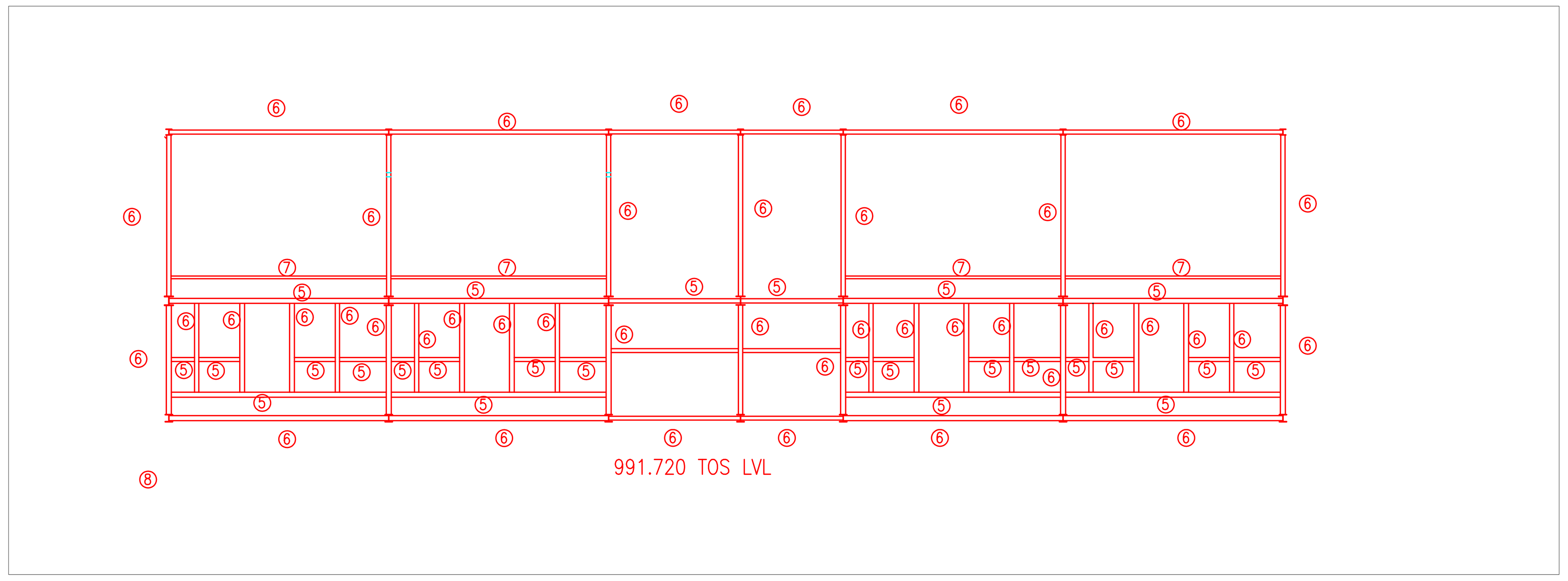
Weight of Chequired Plate (6mm Thk) = 0.596 kn /M^2

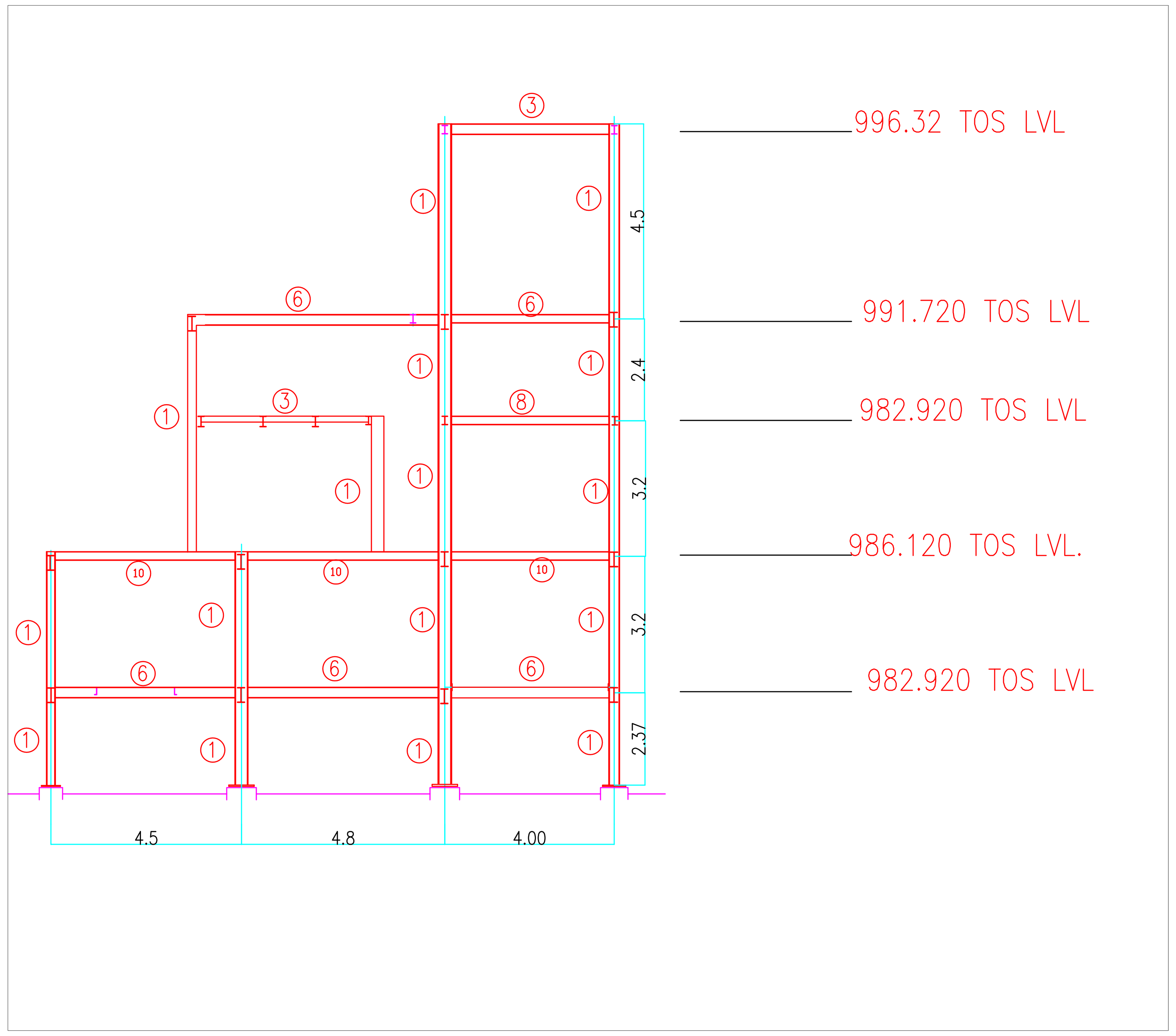
Walk Way

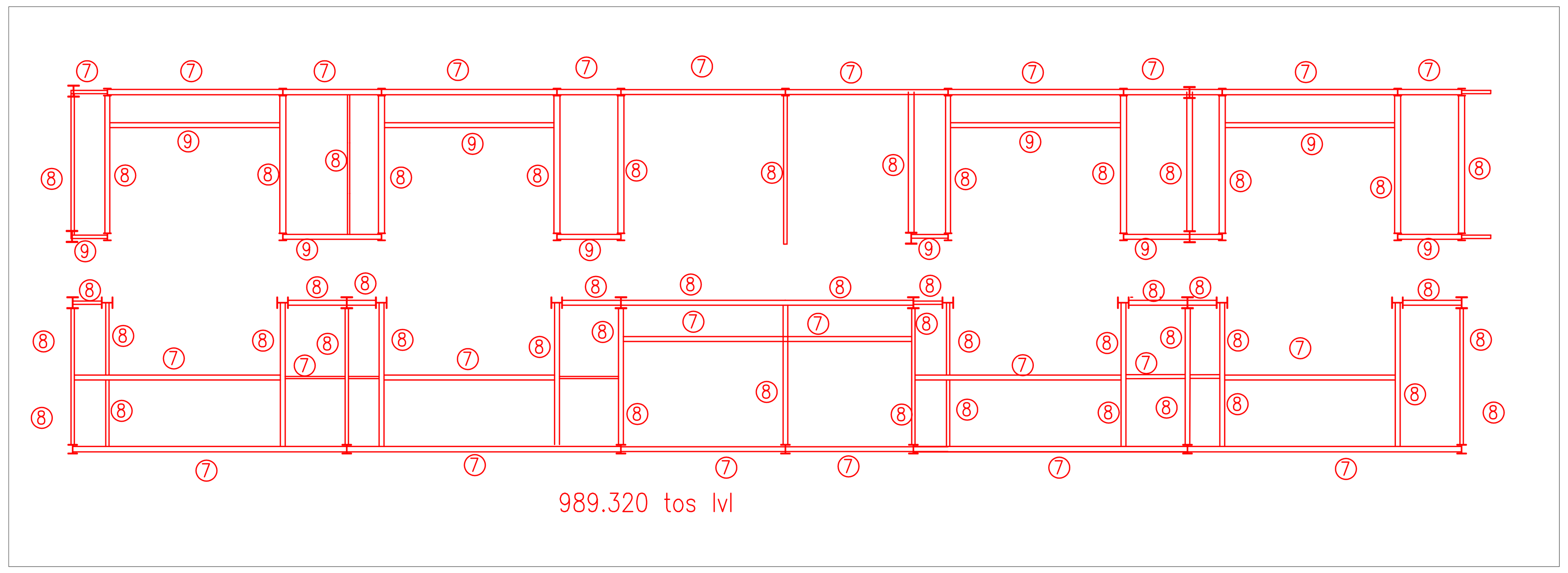
5 Without Bracings

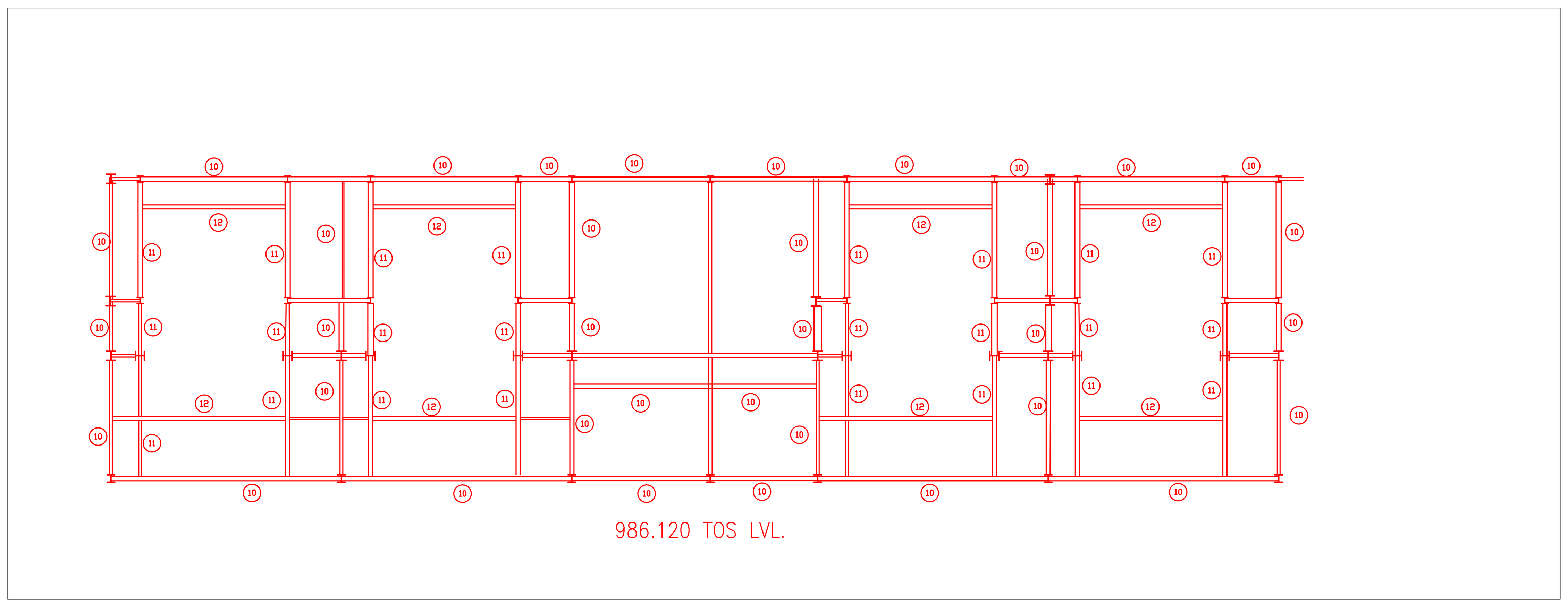








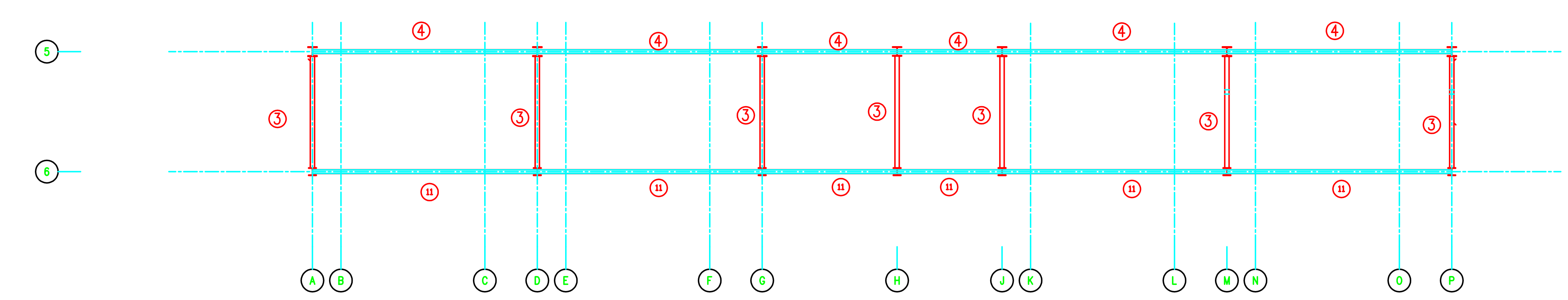




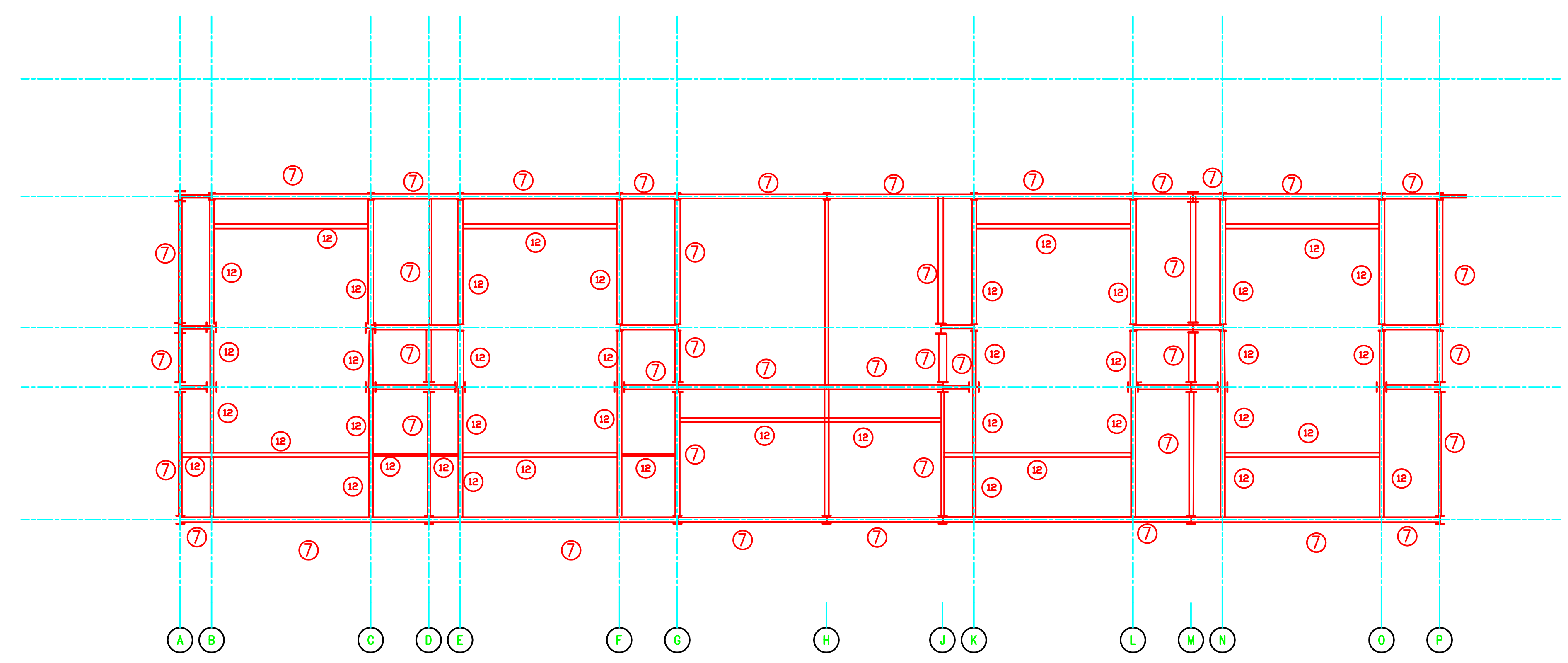
Property Details

1	ISMB550	cover plate 150 mm width 12 mm thick
2	ISMB450	cover plate 150 mm width 12 mm thick
3	ISMC150	
4	ISMC200	back to back
3	ISMC300	
5	ISMC350	back to back
6	ISMC300	back to back
7	ISMC250	back to back
8	ISMC175	back to back
9	ISMC175	
10	ISMC225	back to back
11	ISMC150	back to back
12	ISMC100	back to back
13	ISMC100	
14	ISA75X50X 6	Long Length Back to Back
15	ISA125X75X 8	Long Length Back to Back

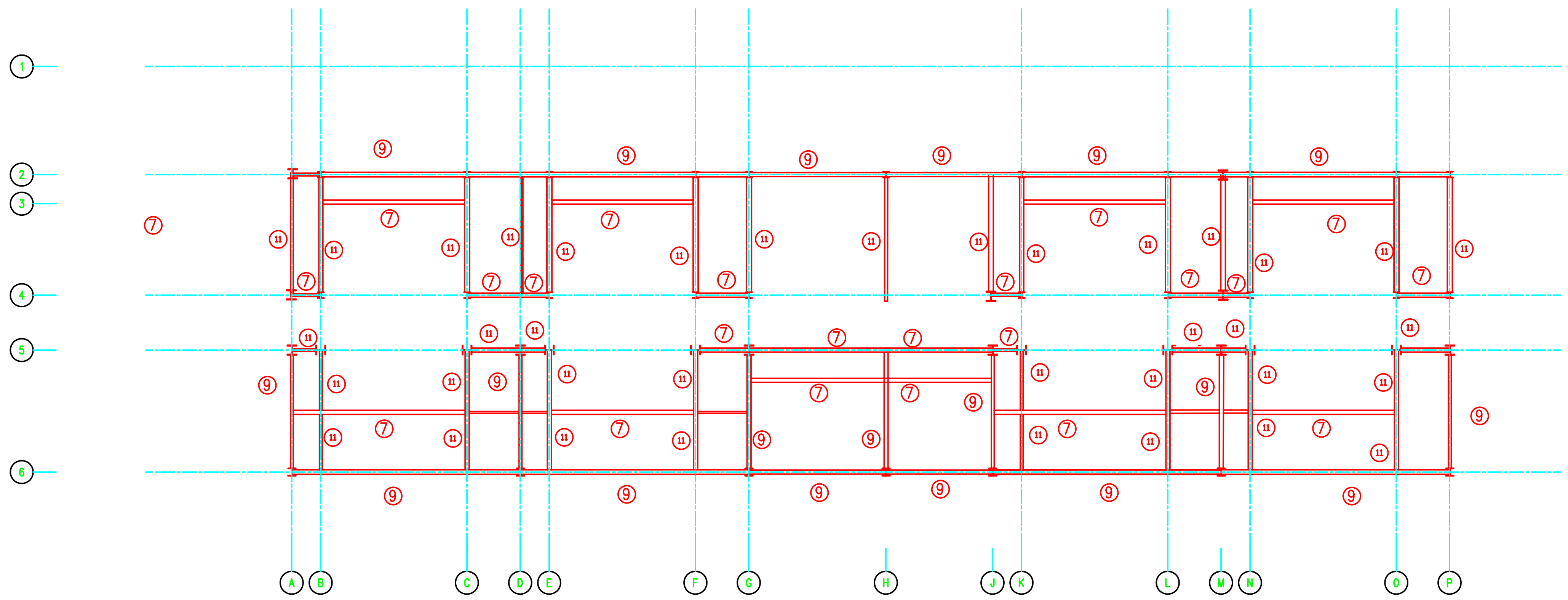
6	With x bracings



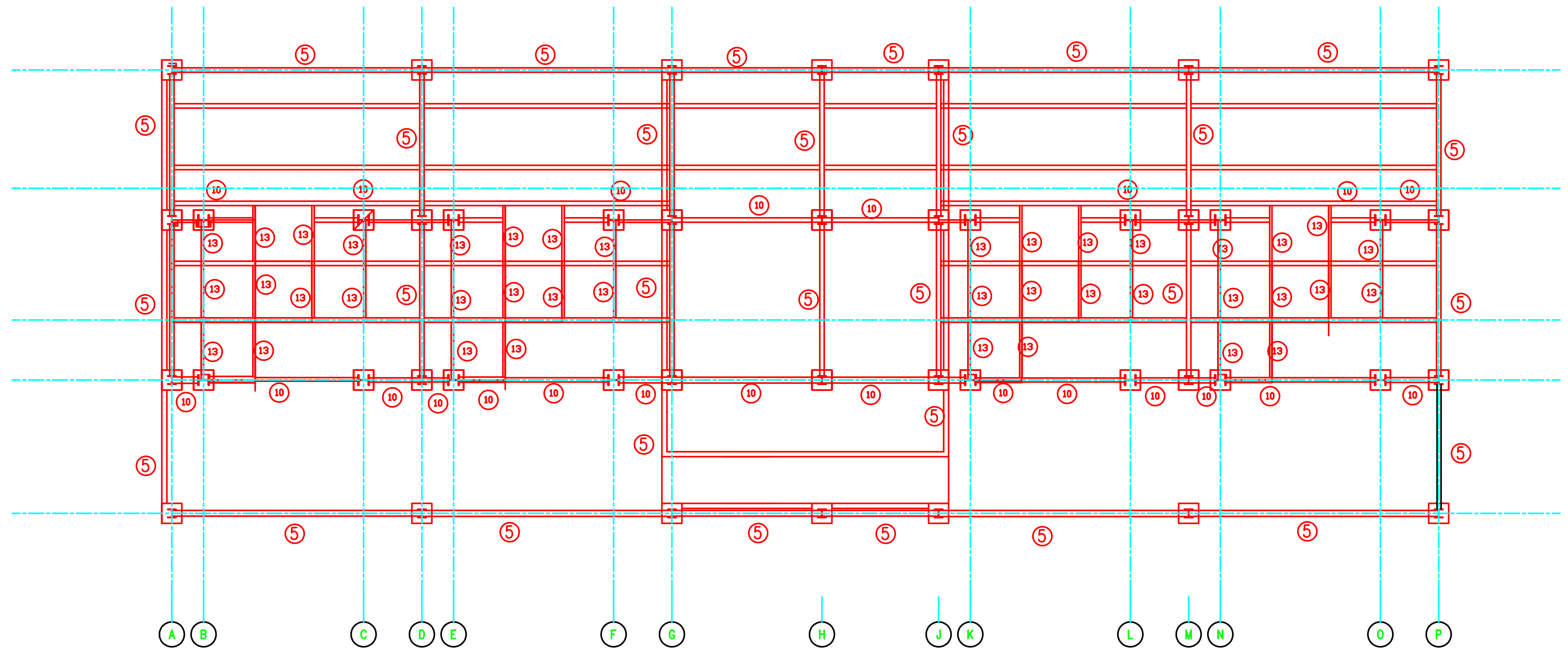
996.32 TOS LVL



986.120 TOS LVL.



989.320 tos lvl



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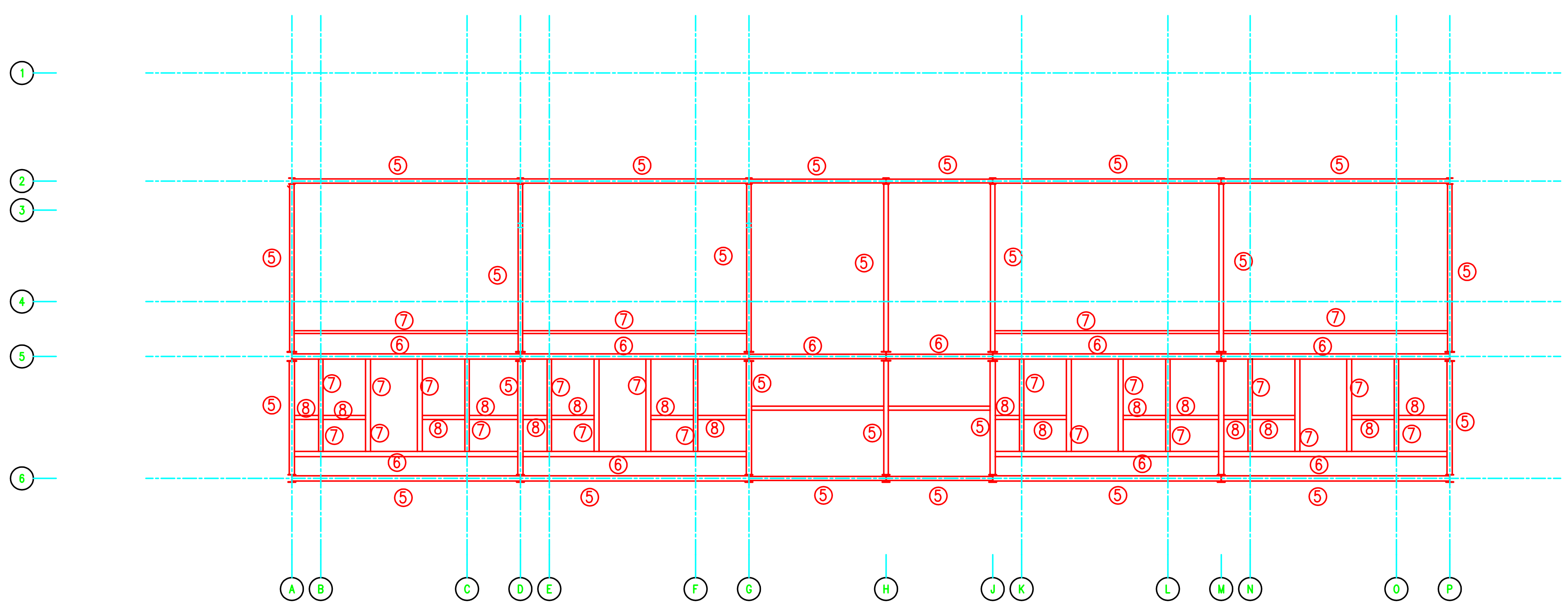

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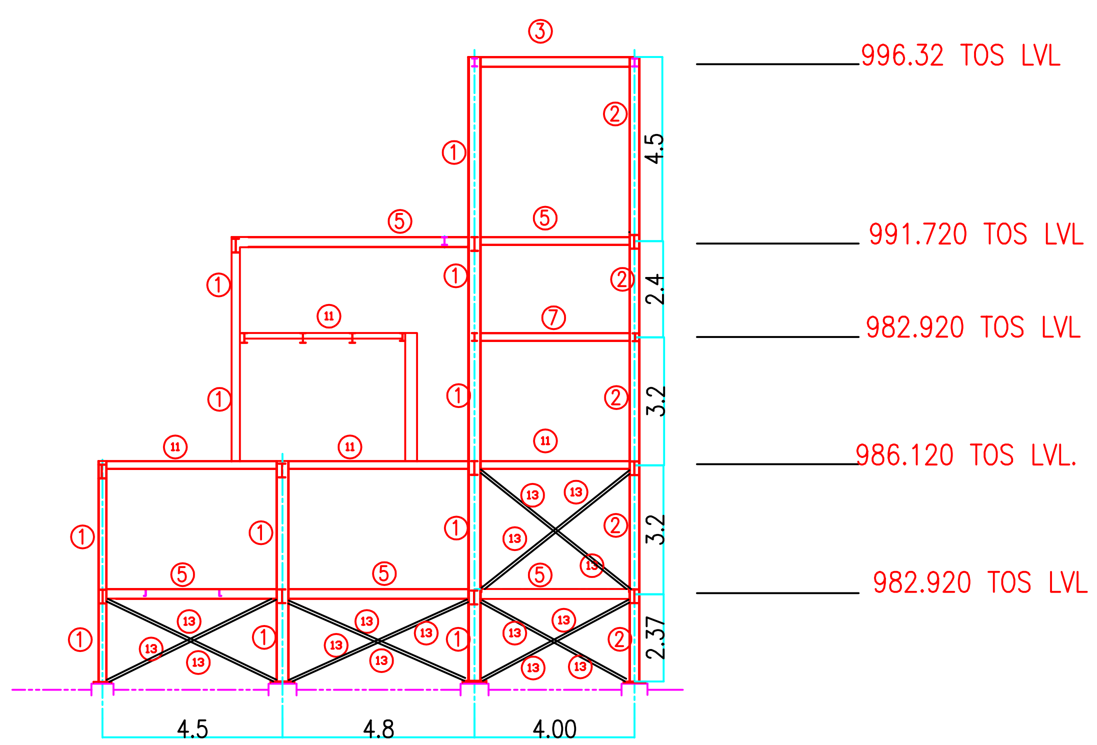
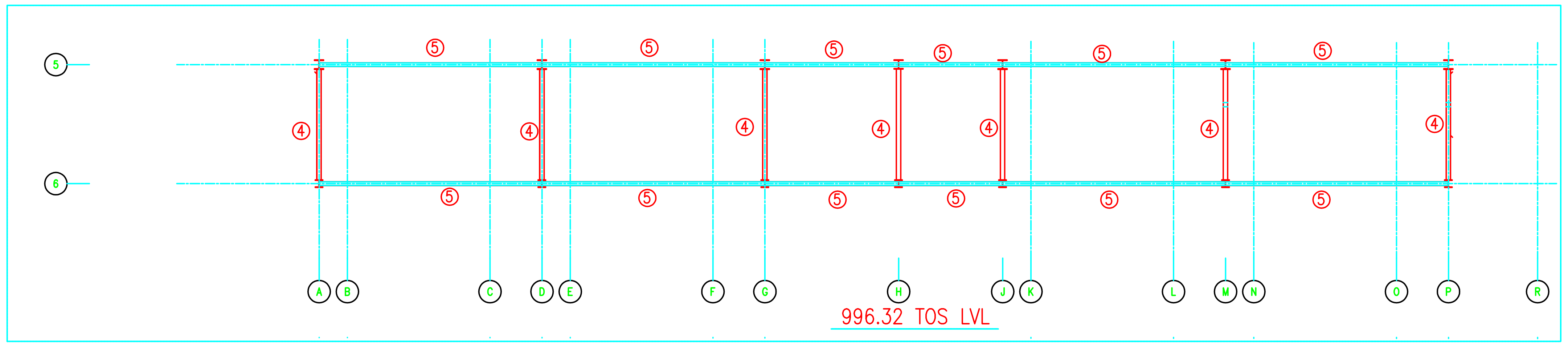


Frame on Section1

Section Details		
No	Section Name	Property
1	ISMB350	
2	ISMB550	
3	ISMC125	
4	ISMC200	
5	ISMC300	Back To Back
6	ISMC400	Back To Back
7	ISMC225	Back To Back
8	ISMC150	
9	ISMC250	Back To Back
10	ISMC175	Back To Back
11	ISMC200	Back To Back
12	ISMC150	Back To Back
13	ISA75X60X6	Long Length Back To Back
14	ISA125X75X8	Long Length Back To Back

7 K Bracings



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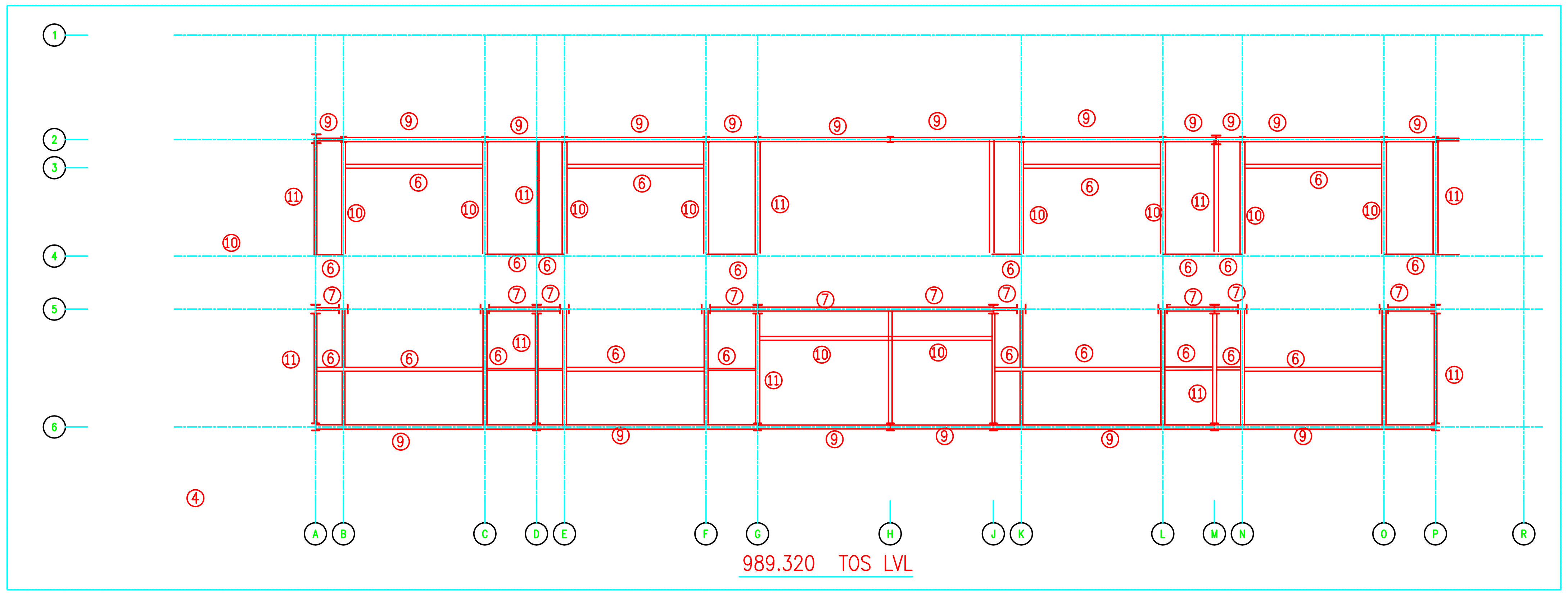

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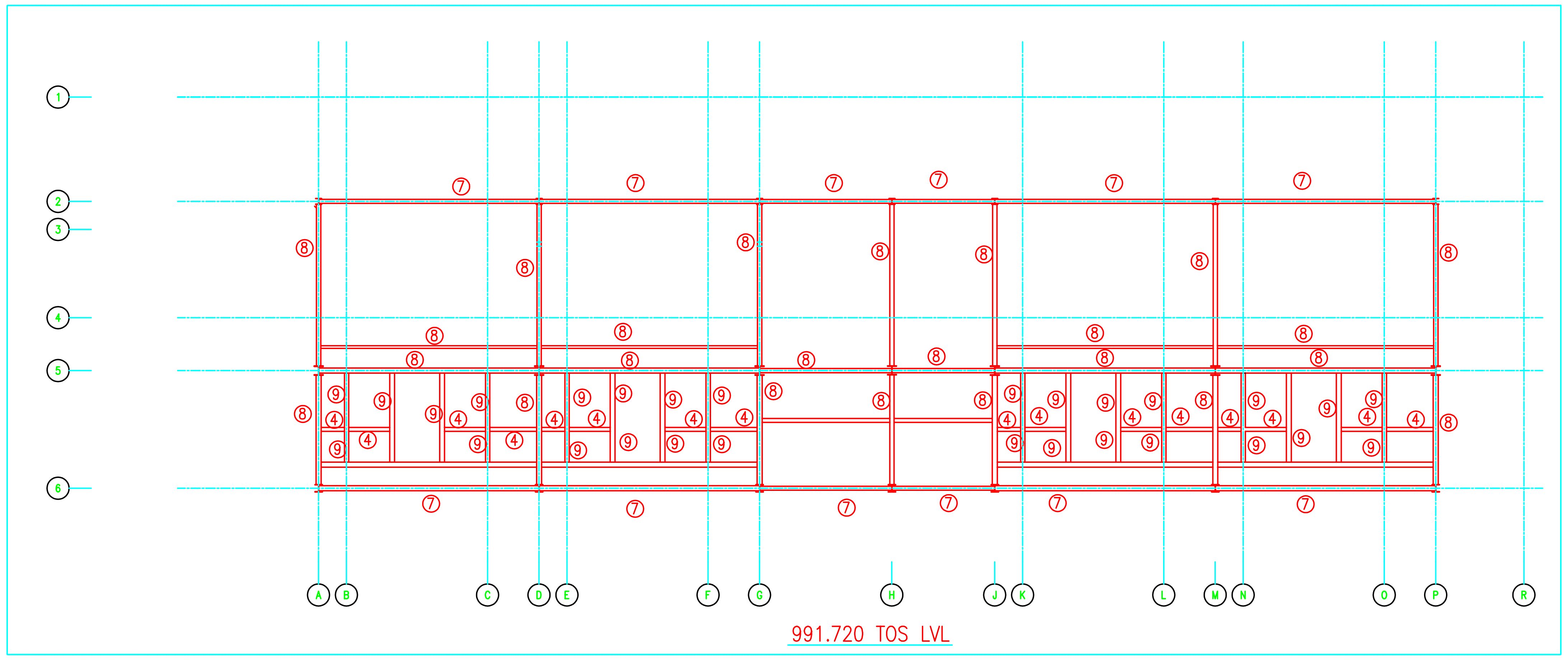

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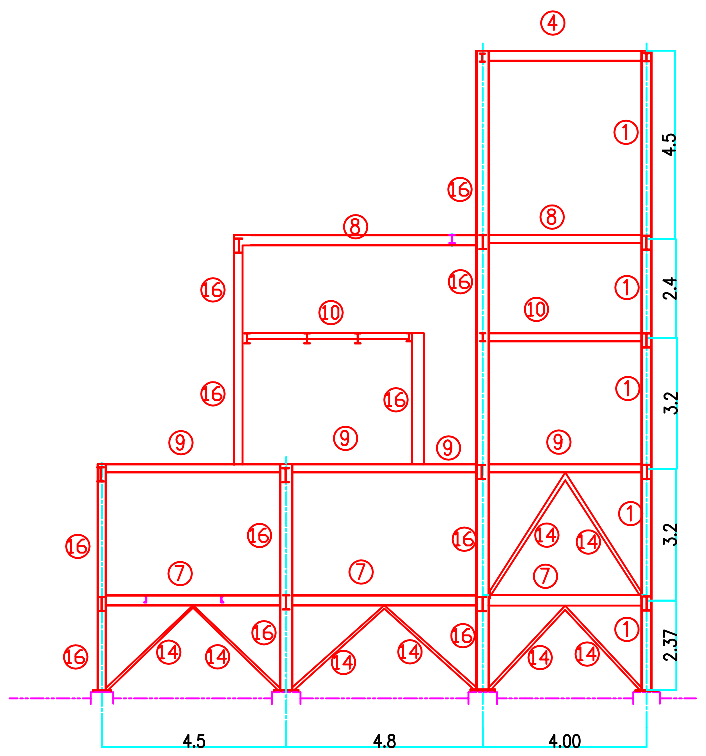
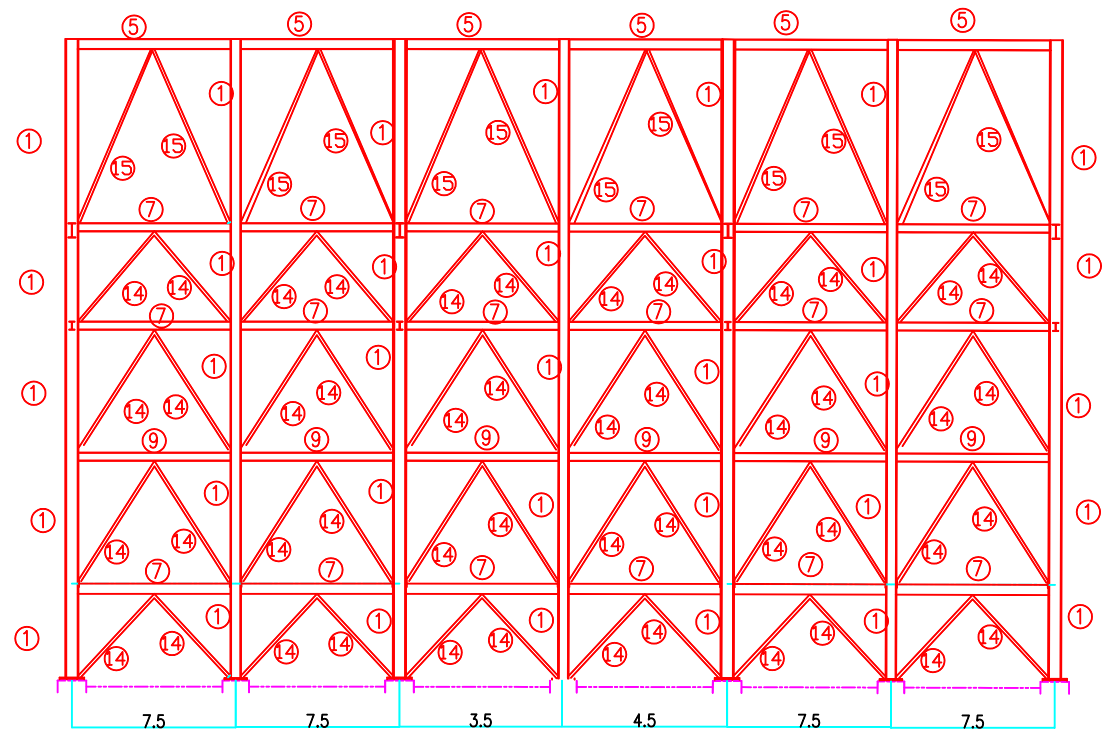
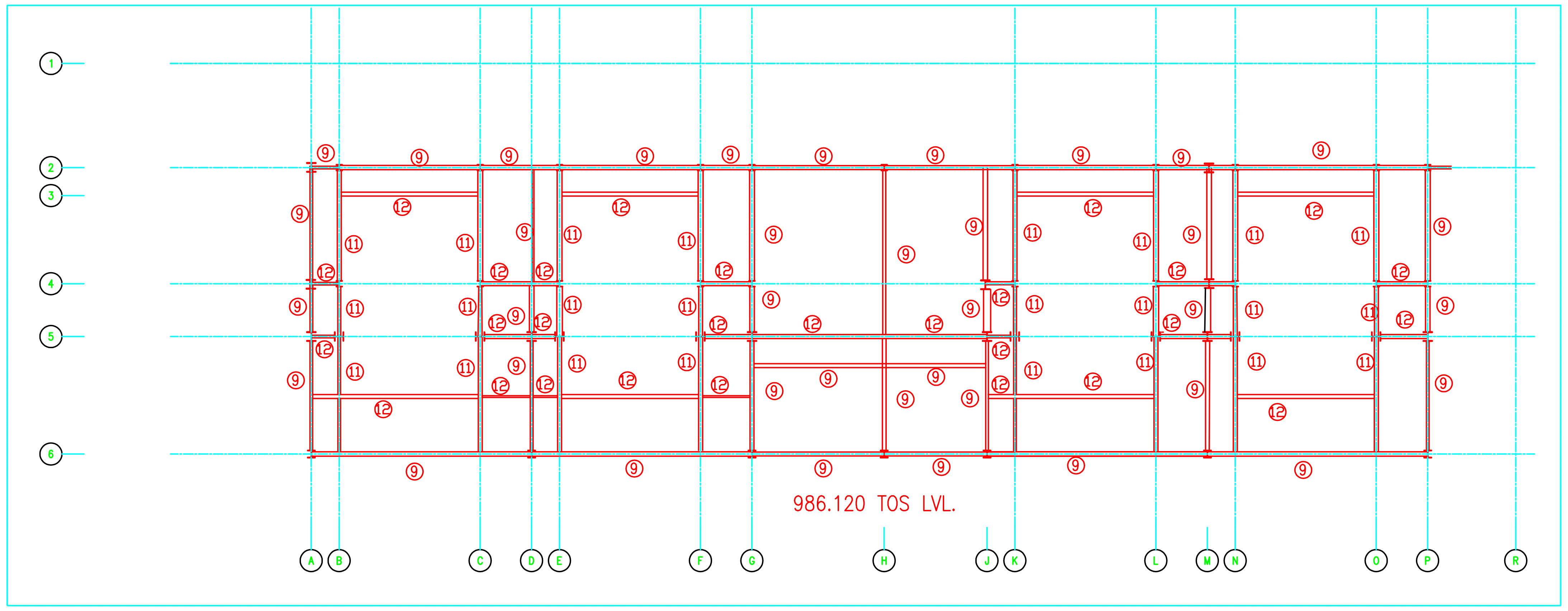


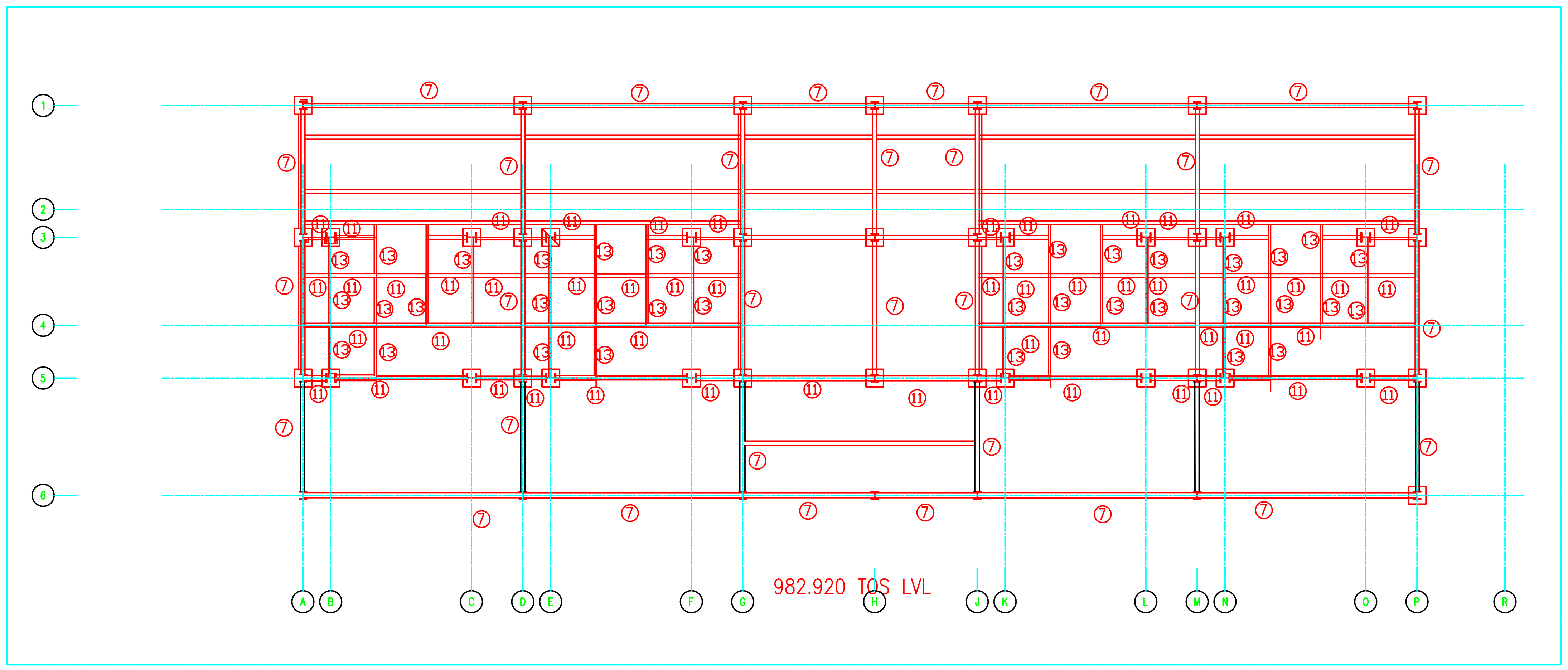
Section on 1



Frame on 6



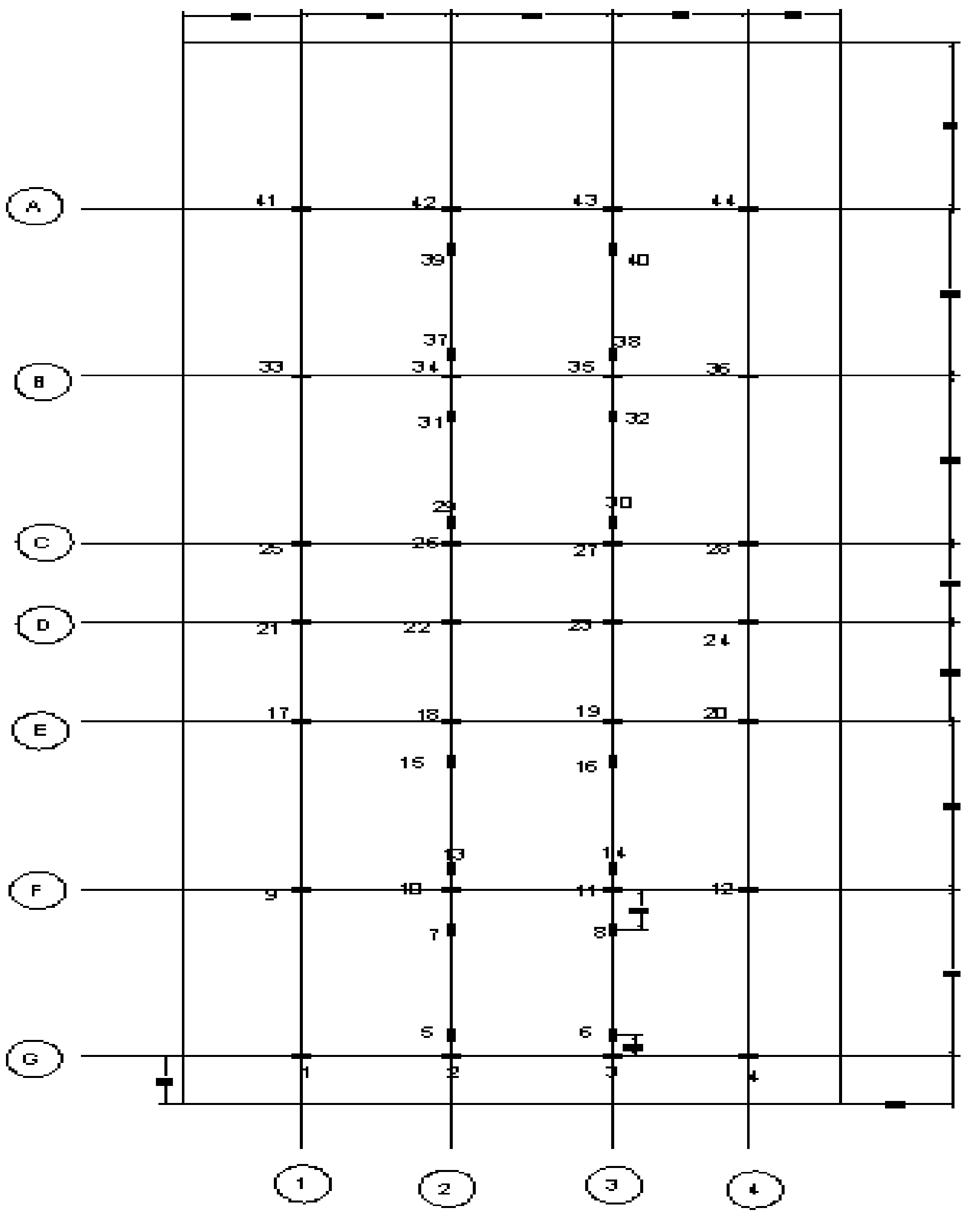
986.120 TOS LVL.

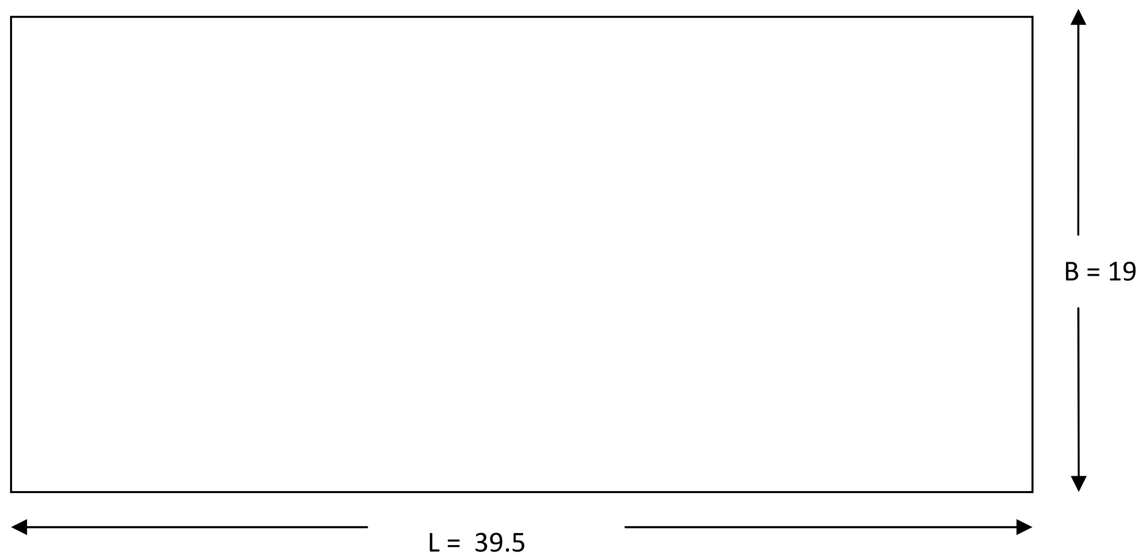


982.920 TOS LVL

Section Property		
No.	Section	Details
1	ISMB500	
2	ISMB400	
3	ISMC100	
4	ISMC150	
5	ISMC200	
6	ISMC300	
7	ISMC250	Double Channel Back to Back
8	ISMC300	Double Channel Back to Back
9	ISMC225	Double Channel Back to Back
10	ISMC200	Double Channel Back to Back
11	ISMC175	Double Channel Back to Back
12	ISMC150	Double Channel Back to Back
13	ISA75X50X6	Long length Back To Back
14	ISA100X75X10	Long length Back To Back
15	ISA110X110X8	Long length Back To Back
16	ISMB300	

APPENDIX-B DESIGN OF RAFT FOUNDATION





Length of Raft L	= 39.50	m
Width Of Raft B	= 19.00	m
Thickness of Raft	= 400.00	mm
Concrete Grade Fck	= 20.00	N / mm^2
Steel Grade Fy	= 415.00	N / mm^2
Density of Concrete W_{conc}	= 25.00	kN /m^3
Depth of Raft Below GL	= 400.00	mm
Density of Soil W_{soil}	= 18.00	kN /m^3
SBC of Soil	= 150.00	kN /m^2

$I_x =$ $L B^3 / 12$
$= 22578$ m^4

$I_y =$ $B L^3 / 12$
$= 97581$ m^4

X = FY*X / ΣFY	= 8.79	m
Y = FY*Y / ΣFY	= 19.70	m

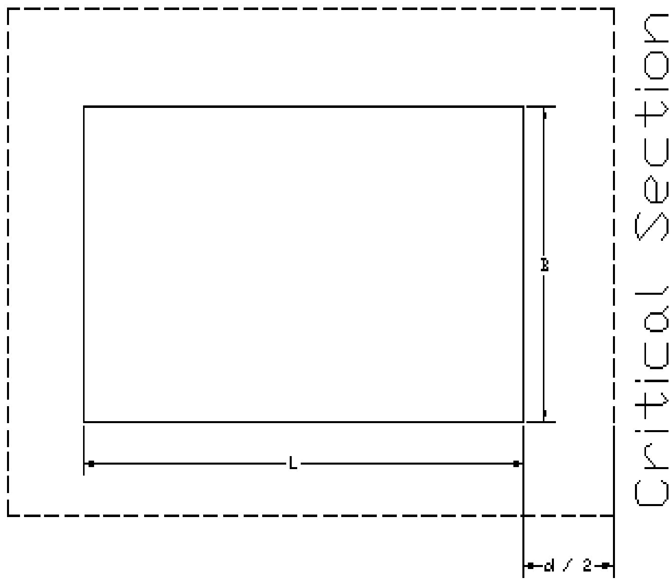
e_y =	B/2 - x	= 0.71	m
e_x =	L/2- Y	= 0.05	m

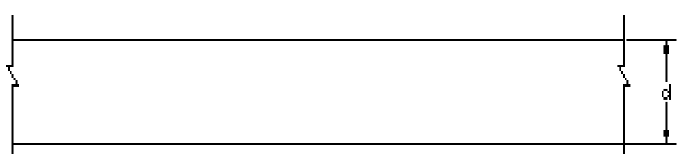
Mz =	$P * e_x$	= 854.57	kN * m
Mx =	$P * e_y$	= 11234.05	kN * m

Check For Punching Shear

Maximum Force on Column :	448 kN	(Colum No : 36)
Effective Depth of Slab =	d	

Check for punching Stress at critical section d /2 from column face (CL 33.2.4.1 IS 456)





Size of Base Plate =

L =	700 mm
B =	400 mm

Perimiter of Critical Section = 2* (700 + 2d + 400)

= 2200 + 4d

Total Resisting Area = d (2200 +4d)

Permissible Shear Stress =
$0.25\sqrt{fck}$ =1.11

Punching Stress = $\dfrac{448000}{d\,(\,2200 \quad +4d\,)}$ = 1.11

Solving

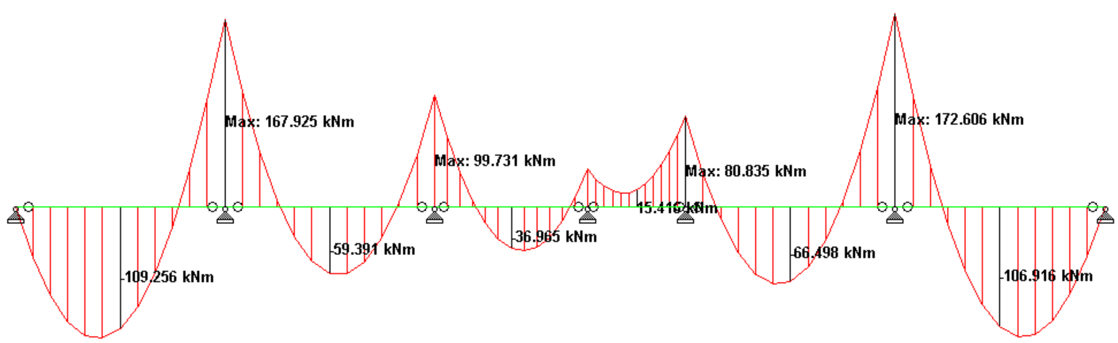
$448000 \quad = 2442\,d + \quad 4.44\,d^2$

Solving We get

d = 145.14 mm

Provide Depth of 400 mm

Stresses is been found as following sheet and the Bending moment in particular Strip is found by staad results. And results of bending moment are given as following table.

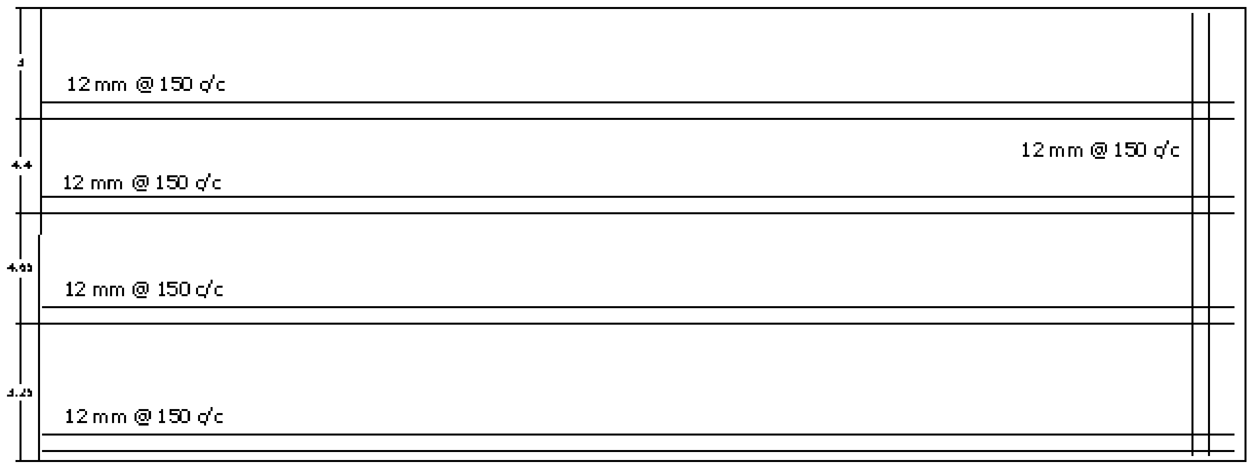


Minimum Reinforcement : 0.15%
Area of Steel : 675.00 mm^2 / meter
Spacing of 12 mm bar 167.41 mm2

	Strip A 4	Strip A 3	Strip A 2	Strip A 1	Strip G 4	Strip F 4	Strip E 4	Strip D 4
	3.25	4.65	4.4	3	4.25	7.5	5	3.25
BM kN *m	304.51	75.77	70.32	172.35	86.69	93.92	44.00	7.66
	26.24	0.00	0.00	0.00	-118.36	-128.23	-60.08	-10.46
	-207.23	-49.21	-43.25	-109.32	118.36	128.23	60.08	10.46
Ast (req) mm^2	1095.16	272.50	252.90	619.85	311.79	337.77	158.25	27.54
	745.30	177.00	155.55	393.17	425.69	461.18	216.06	37.61
Min	600	600	600	600	600	600	600	600
Ast (Provided)	1095.16	272.50	252.90	619.85	311.79	337.77	158.25	27.54
	745.30	177.00	155.55	393.17	425.69	461.18	216.06	37.61
Bar Dia	12	8	8	8	8	8	8	8
	8	8	8	8	8	8	8	8
Nos	10	6	6	13	7	7	4	1
	15	4	4	8	9	10	5	1
Spacing mm	325.00	775.00	733.33	230.77	607.14	1071.43	1250.00	3250.00
	216.67	1162.50	1100.00	375.00	472.22	750.00	1000.00	3250.00

Hence use minimum reinforcement

Reinforcement Details



Top and Bottom Face