STRUCTURAL DESIGN OF ELEVATED STEEL WATER TANK FOR F.U.T GIDAN KWANO CAPMPUS

BY

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DECLARATION

I hereby declare that this thesis has no bearing to any work done by any person or group of individuals. It has been written by me and it is a record of research work.

s and references are dully acknowledged.

Student's Signature Date

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CERTIFICATION

We certify that this project is the original work of Mr. Odeyemi Abdulrazaq of the Department of Civil Engineering, Federal University of Technology Minna, Niger State. In partial fulfillment of the award of Post Graduate Diploma (PGD) in Civil Engineering.

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ABSTRACT

Choleral epidemic has killed nearly 800 Nigerians in two months due to lack of clean drinking water which has allow the water borne bacterial disease to bloom. 13,000 people have been sickened, according to nation's health ministry, CSC News September 10, 2010. An elevated steel water tank is a product of Immense Important and necessity so, as to avoid the spread of cholera to Gidan Kwano Campus. Clean water is a universal solvent and have been proved through ages to have no substitute. This work entails the determination of various loading conditions, the analysis of the effect of these loads on the individual members and the design proper. The design is from the steel tank plates to concrete foundation.

DEDICATION

This Project is dedicated specially to the Almighty God.

ACKNOWLEDGEMENT

I thank the Almighty God for the grace and knowledge he bestowed on me to have been able to write this report and of course, I must acknowledge some people who have directly and indirectly contributed to the success of this report.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background/Preamble

This project is the design of an elevated steel water tank for the Federal University of Technology Minna, Gidan Kwano Main Campus.

A tank or reservoir is a receptacles or enclosed space for the collection or retention of water (or other liquid) which is supplied to it by natural spring, drainage (vertical pipe, often of sheet metal or PVC used to conduct water from roof drain to reservour/tank or gutter or other artificial means). A tank may be made of steel as in this case of the project or concrete.

For any living being air, water and food are essential requirements. With the urbanization and industrialization, national water, fit for drinking, is not available, because of various causes of its pollution. And as such, drawing water directly from a stream or other sources may be unable to satisfy the demands of its consumers during low flow and after heavy rain. It may become hazardous to almost all activities.

The rate of water demand during different period of the day and year varies in Minna. Hence, the main forestation of a tank is to stabilize flow of water either by regulating a varying supply in a natural stream or by satisfying a varying demand by the ultimate consumer.

A water tank can be placed directly on the ground surface, buried underground or elevated depending on the situation of the area.

There are different types of elevated water tank the most common once are either reinforced concrete or steel namely:-

1. The cylindrical tanks with flat or spherical bottom.
2. The Rectangular or Square tanks
3. The conical or funnel shaped tanks
4. The Intze type tanks

But for the purpose of this project emphasis is laid in elevated steel water tank and are of the following types:-

a. Riveted rectangular tanks
b. Pressed steel tanks

The Riveted rectangular elevated tanks are made from plates, generally 1.25m in width. The thickness of the plate is not less than common. The tank supported on two tiers of beams. The lower tiers of beams are supported on columns, which are property braced to form a staging.

The pressed steel elevated tanks are either square or rectangular tanks made of pressed steel pates (1.25m x 1.25m) of thickness 3,5,6, and 8mm; jointed by bolting the dimensions of the tank in multiples of 1.25m.

The cylindrical tank with a horizontal or flat floor slab is only economical for large overhead storage capacity of about 2000,000 liters (53,000 gallons) with diameter in the range of 5 to 8m and the depth of storage is usually 3 to 4m for such tanks. While the rectangular or square shaped tank is often common to building where storage capacity is about 60,000 liters.

For a highly Academic Environment that is made up of largely educated elite with high water demand, coupled with her population growth rate, a rectangular elevated steel tank with welded connection/rivet is the most appropriate.

To construct an elevated water tank, tower frameworks, composing of columns, beams and braces are generally used to support it. The columns are symmetrically arrange to resist the dead, imposed and wind loads.

1.1 PURPOSE OF THE PROJECT

The main propose of this project is to design an elevated steel water tank to cushion the effect of water scarcity in the Federal University of Technology Main Campus Gidan-Kwano, Minna, and the following objectives govern the above purpose.

1. To determine the expected volume of water require through the expected population.
2. To determine member sizes through the expected load.
3. To analyze all the structural frame works using relevant codes such as:

8S1564:	Pressed steel design
BS 449:	Steel design
BS5950:	Composite Steel Design
BS 8110:	Concrete design
CP 2004:	Foundation design
(NCP):	Nigerian Code Practice

4. To recommend and adopt maintenance culture for the research project.

1.2 AIM AND OBJECTIVES

The aim and objective of this project is to:

a. Analyze and design a structure that is stable and will stand the test of time.

b. Design a water tank that will be structurally safe and economical to its users.

c. Design a water tank that will meet its functional and aesthetic requirement.

d. Analyze and design a water tank that will be able to carter for the water need of the campus community.

1.4 DESIGN CRITERIA

A structure is an assembly of member, which is subjected to bending or to direct forces (either tensile or compressive) or to a combination of both bending and direct forces. These primary influences may be accompanied by sharing force and sometimes torsion.

Structural design is largely controlled by regulations or codes but, even with such bond, the designer must exercise judgment in the interpretation of the requirements, endeavoring to grasp the spirit of the requirements rather than to design the minimum allowed by the latter of clauses in the design code. The design, therefore include the calculation of or other means of assuming and providing resistance against the moments, forces and other effects on the members.

Hence, in this project, the limit state theory of design is used which conformed with the British Standard Institution (BSI) code of practice for structural use of concrete (CP 2004 Foundation design) and BS 8110, BS 449 and BS 1564 (concrete design, steel design and pressed steel design) respectively.

The design of individual members or a section of a member must satisfy two separate criteria;-

1. Ultimate limit state, which is the maximum load a structure can carry or can be subjected to before failure will occur.

2. The serviceability limit state, which ensures satisfactorily behavior under service (Le. working) load. The principal criteria relating to serviceability are:-

a. Deflection: The deflection of the structure or any part adversely affect the appearance and efficacy of the structure.

,

b. Vibration: Vibration from forces due to wind or machinery may cause discomfort or alarming damage to the structure or interface with its proper functioning.

c. Shear: This usually affects the appearance of the structure.

d. Fatigue: where loading is predominantly cyclic in character, this effect has to be considered.

In order to design water for the area under study in proper population survey was carried out and water consumption pattern of the campus is determined. This consumption pattern can be determined if a knowledge of the population and the rate of water usage is known.

Beside the fact that, water tank must be able to store adequate water for the people in the area, it must also be able to distribute the water to where it is needed in order to meet the requirement of good distribution of water, the tank must be high (elevated) enough so as to be able to distribute the water freely, by gravity through the pipe network for the area.

In the design of the structure, a high crude steel strength, and moderate concrete grade strength is chosen. This is to cater for in availability or poor workmanship in the construction.

The wed strength and concrete bond must be high to facilitate good grip of steel to steel and concrete to reinforcement respectively.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Computation of Various Loadings:

Throughout recorded history, various places, towns and cities have been concerned with water supplies. In the design of any water supply system to a community, it is of paramount importance, to estimate the amount of water that is required. This is generally done by the help of two factors such as;

i. Probable population estimation for the lifespan;

ii. Rate of water consumption per capital per day

Choice of relevant lifespan is generally based on the following:-

a. The useful life of component structures;

b. The ease or difficulty of enlarging contempted work including consideration of either location.

c. The anticipated rate of population growth and water use by the community.

d. The initial cost of construction

e. The performance of the work during its early years when it is expected to be under the minim load.

The per capital consumption of water is the total consumption divided by the population and the number of days in a year. It is generally expressed as liters/capital/day or cubic meter/capital/day. Thus per capital consumption in liters/ per day is given by the expressions. The total consumption in liters/ (population x 365/366 days)

2.1.1 WATER: SOURCES AND ITS USES

Water is a renewable resource and is naturally recycled in the hydrological cycle. Water can be broadly classified into rain water, surface water and grand water.

Water is very important to life without it life is not possible. It is known to be an essential resource for survival of plants and animals as well as development in any developing nation. It supply in sufficient quantity, adequate quantity and at the appropriate time is critical to all aspects of life.

Water can be obtained from various sources such as:-

1. Rainwater: This is obtained when there is perpetration and it is collected from roof and stored in cisterns for small individual

supplies. It can also be collected form catches and stored in tanks or reservoirs for large communal supplies.

2. Surface Water: This is water that is retained on the surface of the earth when there is perception; it exists as surface run off, or stream, natural ponds and lakes.

3. Ground Water: This is the amount of water from precipitation that infiltrate into the ground and stays as reserve in the zone of saturation, where the void are completely filed with water below the water table. Water is such a valuable resources that communities uses it for human consumption and sanitation (cooking and bathing), production of many industrial goods, commercial uses (hotels and restaurants), public uses (hospitals and schools) irrigation, recreation, transportation and hydroelectric power development.

2.1.2 MUNICIPAL USES OF WATER

Municipal usage of water is the water usage connected with a district, town or city. It can be broken down into four general classes such as:

i. Domestic Use: This include, water furnished to Houses for drinking, Bathing, Culinary, Sanitary and other purposes. It varies according to the living condition of its consumers.

ii. Commercial and Industrial use: This includes water used by Commercial establishments and industries for various purposes. Its use depends on existence of large industries. Hence, in small residential communities it is low while in industrial cities it is high.

iii. Public Use: This include water furnished to public building such as city halls, schools, prisons, protection, street washing etc and

iv. Loss and Waste: This is sometimes classified as "unaccounted" for it include water that leaks from the pipe network, unauthorized commercial connections etc. In meeting the demands for the desired quantity and quality of water at a particular location and time, certain factors have to be considered before selecting a particular source of water for supply. These factors include:

a. Quality of water in the source

b. Seasonal availability of water in the source

c. Rate of which the source is polluted

d. Nearness of the source to storage tank and treatment plant

e. Cost of treatment of water in the source

2.1.3 PER CAPITAL CONSUMPTION OF WATER

There are various factors that affect per capital consumption of water in a city or a high residential community like the schools. Such factors and the way they affect per capital consumption are:-

a. Size of the city: This coupled with the activities going on in the city, affect, greatly the per capital consumption.

b. Characteristic of population: Per capital consumption is influenced by the economic static of the users. It is much lower in poor areas than in wealthy areas.

c. Climate: More water is used in worm day climate than in humid climate for bathing, watering and air conditioning etc. In extremely cold climate, water may be wasted as faucets to prevent freezing of pipes.

d. Water rate and metering: it water cost is high, people may be more conservative in water use.

2:1:4 VARIATIONS IN WATER CONSUMPTION

Water consumption does not remain constant yearly, Monthly, weekly, daily and hourly, variation is also observed. Certain dry year cause more consumption, in hot months, more water is consumed in drinking, bathing, watering lawns and garden. On holidays, weekends, the water consumption may be high, even during the day, water uses varies. The use is high during the morning and evening times (peak period) while is reduced at night. The average value of domestic water consumption is about 100-120 liters/capital! day for some cities in Nigeria particularly 89 liters/capital! day in Ibadan.

2.2. REVIEW OF LITERATURE ON WELDING AND BOLT CONNETIONS.

2.2.1 WELDED CONECTIONS

Welding is a process of joining metal parts in the molten state, without application of any mechanical pressure. The metal of the part is melted by means of electric arc or oxy- acetylene flame, along with weld rod which adds metal to the joint.

Welded structures are usually lighter than riveted use as gussets are not used. Full use of sectional area is made to make it more efficient. In structural steel work; fillet and butt welds are used.

?fOrCement

/-+-~ ... Throat thickness

~ Throat thickness

t Reinforcement

Size=minimum ea lenzth

BUTIWELD

Type of welds are mainly Butt and fillet weld, others are Single V-Butt joint, Double V-Butt joint, single U-butt joint, single bevel butt joint, double U-Butt joint and double bevel but joint.

The strength of a weld is the product of (permissible stress) (throat thickness) (length of the weld). The size of a normal filled weld is it minimum leg-length and throat thickness is 0.7 times of the size of the weld for 60 - 90°

2.2.2 BOLTED CONNECTION

Bolts are manufactured from mud steel or high strength steel. They consist of the head and the shark. The length of the shanks is different for different jobs. The size of the bolt is the diameter of the shank. The shank is threaded at the end to receive the nut. Recently high strength bolts are being used having yield strength of 5000 to 6000 kg/ em^2 as shown below (a) shows a bolt connection between two plates (lap joint) in single shear and (b) shows butt joint in double shear.

Washer Head Shank

=>-p

(b)

=>-P

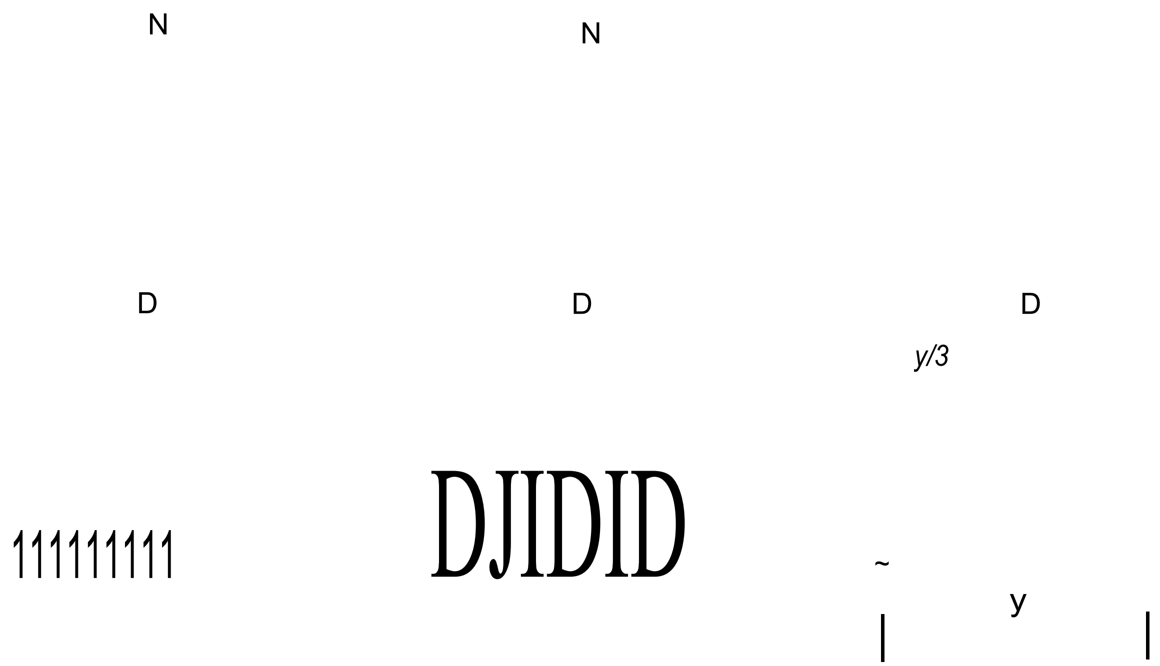
-

LAP JOINT IN SINGLE SHEAR

2.3 REVIEW OF LITERATURE ON PAD FOUNDATION: (COLUMN BASES AND FOUNDATION)

There are two types of column bases, (1) slab bases and (2) gusted bases; (1) slab base, in the design of foundation it is assumed that the foundation is rigid so that the pressure distribution at the base is uniform. The footing for a single column may be made square in plan, but where large moment is acting about one axis. It is more economical to have a rectangular base. When there is a linear distribution the bearing pressures across the base will take one of the three forms shown below.

(a)



e=O

P = N/BO

e=O

P = N/BO ± 6M/B/0$_2$

e = 06

P = 2N/BY Where

Y=3(0/2 - e)

Assuming a relative magnitude of the axial load N and the moment M acting on the base;

(1) In fig. (a) there is no moment and the pressure is uniform P = N/BD

(2) With a moment M acting as in fig. (b) the pressure are given by the equation for axial load plus bending. This is provided there is positive contact between the base and the ground along the complete length 0 of the footing I.e, P= (N/BD + My/I)

Where I is the second moment of areas of the base about the axis of bending and Y is the distance from the axis to where the pressure is been calculated. Substituting for I, = (BD3)/12 and y = (D/2) the maximum pressure is P1 = (N/BD) + 6N/3D2 and minimum propel P2 = (N/BD) - (6M/BD2)

(3) When the eccentricity e is greater than D/6 there is no longer positive pressure along the length D and the pressure diagram is triangular as in fig. c above. Balancing the downward load and the upward pressures % P By=N therefore

Maximum pressure P = 2N/By where y is the length of positive contact.

The centroid of the pressure diagram must coincide with the electricity of loading in order for the load and reaction to be equal and opposite. Thus y/3 = (D/2- e) or y = 3(D/2 - e) therefore in the case of e > D/6, maximum pressure P= 2N/ 3B (D/2 -e)

(ii) Gusseted abase:

For columns carrying heavy loads, gusted bases are used where ends of columns shaft and gusset plates are not faced. For complete bearing, the fastening connecting them to the base plate shall be sufficient to transmit all the forces to which the base is subjected too.

1----+ Column

r--'--.......__--......__-____._.___.__.--------.Base Plate

---.. ...Slab-Base

FOUNDATION

A steel elevated water tank comprises of a super-structure above the ground and a sub-structure which form the foundation below the ground. The foundation transfer and spread the loads from a structure via beams and columns into the ground.

The safe bearing capacity of the soil must not be exceeded otherwise excessive settlement may occur, resulting on damage to the steel tank and its facilities, such as pumps and pipes. Foundation failure can also affect the overall stability of a structure so that it is liable to slide to life virtually or even overturn.

The earth under the foundation is the most variable of 'all the materials that are considered in the design and construction of engineering structures under a small structure such as tank, the soil may vary from soft clay to a dense rock. Also, the nature and properties of the soil will change with the seasons and the weather. For example Keuper Marl, a relative common soil, is hard like rock when dry but when wet, it can change into an almost liquid state.

It is important to have an engineering survey made of the soil under a proposed structure so that variation in the strata and properties can be determined.

In the design of foundation, the area of the bases in contact with the ground should be such that the bearing pressure will not be receded. Settlement takes place during the working life of structure; therefore the design loading to be considered when calculating the base areas should be those that apply to service ability limit state, and typical values that can be taken are:-

(1) Dead load plus imposed load=1.0gk + 1.0qk.

(2) Dead load plus wind load =1.0gk + 1.0wk

(3) Dead plus imposed plus wind load =1.0gk + O.8qk + O.8wk.

These partial factors of safety are suggested as it is highly unlikely that the maximum imposed load and the worst wind load will occur simultaneously.

The calculated to determine the structure strength of the foundations, that the thickness of the bases on the loading and the resultant grand pressure corresponding to the ultimate limit state. With structure such as this case study, it may be necessary to check for the possibility of uplifting on the foundations and the stability of the structure when it is subjected to lateral loads. To ensure adequate safety, the stability calculation should also be for the loading arrangements actuated with the ultimate limit state.

PAD FOOTINGS:

This is a footing meant for a single column which may be square in plan, but where there is a large moment acting absent one axis it may be more economical to have a rectangular base.

RAFT FOOTINGS:

A rate foundation transmits the loads to the ground by means of reinforced concrete slab that is continuum over the base of the structure. Therefore is able to span over any areas of weaker soil and it spread the loads over a wide area.

Heavily loaded structures are often provided with one continuous base in preference to many closely spaced; separate footings. The simplest type of raft in a feet slab of uniform thickness supporting the columns. Other heavily loaded rafts require the foundation to be strengthened by beams to form a ribbed construction. Which may be down standing its upstanding.

2.4 REVIEWS ON THE DESIGN OF STEEL WATER TANK

The people of old, due to population increase couple with intermitted availability of water, have devised various means of either improving water or store it in reservoir, tanks to mention but few: to cater for the supply when the need arises. This has resulted in various ways of impounding, storing water like the use of dams, reservoir tanks etc.

Several examples abound in the National Campuses where scarcity of water is been rearded or inadequate either due to increase in population of the school or is completely absent and a new tank is being designed and constructed.

Thus:

CASE I: UNIVERSITY OF ABUJA MINI AND MAIN CAMPUSES

MINI CAMPUS

University of Abuja mini campus is located in Gwagwalada Area Council of Abuja and the main campus is located around Giri area along Airport Road which is about five kilometers off Abuja-Kaduna Road.

This project was born out of the increase in population of the school which is beyond the scope of the projected existing water supply in the two campuses i.e Mini and Main Campuses. The following volume of water was arrived at for both mini and main campuses.

1). Main Campus:

Male Hostel ~ *4.B* x *4.B* x 3.66m with B3,400liters Elevated

~6.1 x 6.1 x 3.66m with 131,1401itersGround Tank

2). Mini Campus:

~6.1 x 4.66 x 3.66 with 10B,9501itersGround tank

~ 6.1 x 4.66 x 3.66 with 10B,9501itersGround tank

CASE: II LAW SCHOOL BWARI AREA COUNCIL ABUJA

Law school Abuja is located in Bwari Area Council Abuja and the project was born out of scarcity of water even thought there is pipe borne water supply in Bwari Area council as a whole but the demand for water on Campus gave rise to a new tank design and constructed with the following provisions:

- ~ 3.0 x 2.0 x 2.0 Elevated with 12,000liters.
- ~ 5.0 x 5.0 x 3.0 Elevated with 75,000liters.
- ~ 6.0 x 6.0 x 3.0 Ground Tank with 10B,000liters.
- ~ 3.0 x 2.0 x 3.0 Ground tank with 1B,000liters.

CASE III FEDERAL UNIVERSITY OF TECHNOLOGY MINNA NIGER STATE.

This is the case study which gave rise to the research project. The project is born out of the present epidemic cholera outbreak in some Northern part of the country this year due to adequate clean water supply and storage facilities to prevent people from going to the stream/burrow pits to fetch drinking water. The campus cannot afford to lose any of her students or subject them to any disease or scarcity of water as it is an essential ingredient for human sustenance.

Therefore, an elevated and ground water steel tanks have been designed and provided for construction.

The following parameters were arrived at fter all the projections from the present student population and relevant laboratory analysis:

Tank Capacity:

Elevated Tank = Capacity = 225,OOOliters.

Ground Tank = Capacity = 1,700,OOOliters.

2.5 FACTORS AFFECTING THE DESIGN OF WATER TANK

Water tanks are ordinarily designed to adequately satisfy the water requirements for some combination of domestic, commercial, industrial and other purpose. The tank should be capable of meeting the demand placed on it at all times and at satisfactory pressure in order to functions well, the tank must be design with the following in mind:

i. The design period chosen should not be too small, so that the tank will not result in economic wastage and it should not be too long to avoid shifting burden on the present generation.

ii. The design pressure, which must ensure that the tank distributes the water to the furthest point in the study area without causing any damage to the distribution pipes.

iii. The design population, which if coupled with the per-capital consumption will determine the size of the tank after projection into the future.

2.6 POPULATION ESTIMATION

Most water supply schemes are designed for a period of 20 to 30 years, by which it is presumed that the system would be modified to meet the requirement of growing population. It is therefore necessary to forecast the population at the end of the period, for which the system is proposed to be design. This forecast is made by one of the following methods:

i) Arithmetic mean method

ii) Geometric increase method

iii) Incremental increase method

iv) Decreased rate of growth method

v) Graphical method

vi) Comparative method

But for this case study geometric increase method is adopted. This method takes the average percentages of growth of the list few decades and forecast is done on the basis of that percentage increase per decade if P is present Population

Ic = percentage Increase per decade *Irate* of yearly increase.

P_n = population at the end of n decades; then

N= number of years

$P_n = P (I + Ic/100)n$

2.7 CAPACITY OF TANK

Since the tank is designed to serve certain areas, it means that it capacity must be able to meet the water consumption of the University community. In order to know the water consumption, the population of the area must be known therefore, volume of tank is given by:

Population P per capital per day, which is usually expressed in liters per-cubic meter.

2.8 TANK LOCATION

In view of the overall cost of the project, both pipe network and uniform distribution of pressure. The tank should be located near the center of the area, and even if the area is not feat, can be fettered with the aid of earth cutting equipment before it constructed while in an undulating areas, with uniform terrene, it is advantageous to select the highest point for the construction of the water tank. Hence for this case study it is better sited between the sensate building and faculty of agriculture or in front of the faculty of engineering block particularly around the shopping complex.

CHAPTER THREE

3.1 MATERIALS

3.1.1 Study Area

The case study under consideration, Federal University of Technology Main Campus, Gidan Kwano,-Minna - Bida road, Minna Niger State, which lies between latitude 10^{o} - 11^{o} N and longitude 7^{o} - 8^{o} E.

3.1.2 Sampling Plan.

1) A soil sample of the proposed location of the overhead water tank which is located between faculty of Agriculture and the Administrative block. Both disturbed and undisturbed (block) samples are collected from the pit sample at a depth of 1.5m.

3.1.3 Laboratory Equipment

Measuring Cylinders, Specific Gravity bottles, Compaction Moulds and Hammers. Triaxial machines with accessories, differentially Thermal Analysis CBR Moulds, Unconfined Compressive, Strewth Test Moulds, Electric Oven and Soaking Tanks.

3.0.4 Materials Required

- Sample Collection bags and accessories.

3.0.5 Contribution to Knowledge.

With the immense importance of the use of friction and steel as a container in the expanding population and human activities on campus, there has been an urgent need for continuous and up to date review of elevated/ground water storage tanks on campuses. Thus, it is hope that at the end of this research, one would have contributed his own quota to this laudable exercise.

3.1 METHODOLOGY

3.1.1 Computation of Soil Data (Shear box Test)

Formulas:

i). $$\text{Shear-Stress} = \frac{\text{Proving Ring Reading x Calibration Factor}}{\text{Area of Mould}}$$

ii) $$\text{Normal Stress} = \frac{\text{Load x Acceleration due to gravity}}{\text{Area of mould}}$$

SAMPLE ONE

PROJECT NO.: FUT/CE/03/028

PROJECT NAME: DESIGN OF AN ELEVATED STEEL WATER TANK.

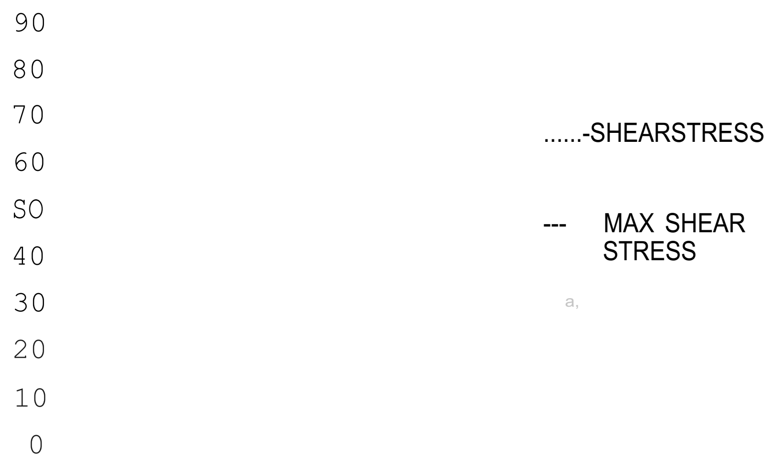
BORE HOLE NO.: ONE

DEPTH OF SAMPLE: 1.2m - 1.5m

DESCRIPTION OF SAMPLE: GREY-REDDISH SOIL

TABLE 3.1

TEST NO.	NORMAL LOAD KG	PROVING RING READING	SHEAR STRESS KN/m2	MAX. SHEAR STRESS KN/m2	DIAMETER (100mm)
1	10	7.00	41.22	25.50	HEIGHT OF MOULD = 200mm
2	20	8.85	52.12	54.50	WEIGHT OF CORE X SAMPLE= 4420g
3	30	12.20	71.83	81.75	CUTIER = 794g



From graph in Appendix:

Angle of internal friction = O = 25.50

Cohesion C = 28.50KN/m^2

SAMPLE TWO

PROJECT NO:

PROJECT NAME:

BORE HOLE NO: TWO

DEPTH OF SAMPLE = 1.2 - 1.5M

DESCRIPTION OF SAMPLE: GREY REDDISH SOIL

TABLE 3.2

TEST NO.	DIAL READIN '''	NORMAL LOAD (1\\2-,	SHEAR STRESS ~1~/nl	NORMAL STRESS I\rt/m	DIAMETER (100mm ,
1	8.90	10	52.39	25.50	HEIGHT OF MOULD = 200mm
2	14.00	20	52.44	54.50	WEIGHT OF CORE X SAMPLE = 4437g
3	13.83	30	81.56	81.75	CUTIER = 774g

From graph 2 in Appendix.

Angle of Internal Friction $\emptyset = 26.50°$

Cohesion C $= 40KN/m^2$

SAMPLE THREE.

PROJECT NO:

PROJECT NAME:

BORE HOLE NO: TWO

DEPTH OF SAMPLE = 1.2 -1.5M

DESCRIPTION OF SAMPLE: GREY REDDISH SOIL

TABLE 3.3

TEST NO.	DIAL READING	NORMAL LOAD (KG)	SHEAR STRESS KN/m^2	NORMAL STRESS KN/m^2	DIAMETER (100mm)
1	15.90	10	93.64	25.50	HEIGHT OF MOULD = 200mm WEIGHT of COREX SAMPLE= *4727g*
2	19.80	20	116.60	54.50	CUTTER = 780g
3	19.50	30	114.80	81.75	

3.1.2 MOISTURE CONTENT

From graph 1 - 3 in the Appendix, the values of 0, that is the angle of cohesion C = Internal Friction for the three samples from holes 1 to 3.

HOLES	HOLE NO. O
1	25.50
2	26.50
3	20.50

HOLES	HOLE NO. O
1	28.50
2	40.00
3	83.50

Therefore the average values of C & O are

$$1).\ C = \frac{28.50 + 40.00 + 83.50}{3} = \frac{152}{3} = 50.67\ KN/m2$$

$$0 = \frac{25.50 + 26.50 + 20.50}{3} = \frac{72.5}{3} = 24.17°$$

From Tarzanghi Table (see Appendix) using 0 = 24.17°, we have the following soil parameters by interpolation:

O	O	5	10	15	20	25	30
Nc	5.7	7.3	9.6	12.9	17.7	25.1	37.2
N .q	1.0	1.6	2.7	4.4	7.4	12.7	22.5
Ny	0.0	10. 5	1.2	2.5	5.0	9.7	19.7

Tanzeghi's bearing capacity coefficient

Square footing: $q, = 1.3CNc + YZNq + O.4YBN_y$

$Ne = 23.87$

$Nq = 11.82$

$N_r = 8.92$

3.1.3 Determination of Moisture Content/Density Relation of the Soil

3.2.2.1 Moisture Content of the Soil.

Sample Number One.

Weight of Container = One.

Weight of Container = We = 5.50g.

Weight of Container + Wet Sample W_1 = 68.69g.

Weight of Container + Dry Sample W_2 = 61.60g.

Calculation:

$$\text{Moisture Content } Wa = \frac{W_1 - W_2}{W_2 - We} \times 100$$

Where: Wa = Moisture Content in 0/0

W_1 = Weight of Container + Moist Soil sample.

W_2 = Weight of Container + Oven Dry Sample.

We = Weight of Container.

Wa = 68.69 - 61.60 x 100 = 11.220/0

61.60 - 5.50

Wb = 60.10 - 54.30 x 100 = 10.48%

54.30 -4.75

The Average Moisture Content=(11.22 + 10.48) = 21.68 = 10.48%

2 2

Sample Number: Two.

Weight of Container We = 8.75g

Weight of Container + Wet Sample W_1 = 73.60g

Weight of Container + Dry Sample W_2 = 64.70g

Wa = 73.60 - 64.70 x 100 = 13.72%

64.70 - 8.75

Wb = 64.25 - 57.70 x 100 = 11.020/0

57.70 - 4.79

The Average Moisture Content ={ 13.72 - 11.0t = 12.37%

2

3.24 Computation of Soil Bearing Capacity.

Moisture Content - Density Relatni

r = Unit Weight of Soil.

rb = Bulk Density (rb) = Mass =

Volume

1). 4420 - 794 = *3626g/1000* = 3.63kg

2). 4437 - 774 = *3663g/1000* = 3.66kg

3). 4222 - 780 = 34 *42g/1000* = 3.44kg

Volume = D2h = 1002 x x 200 = 7.85 xO.2 = 1.57 x 10^{-3}

Average Mass = 3.63 + 3.66 + 3.44 = 10.73 = 3.58kg

3 3

rb = 3.58 *kg/m3*

1.57 x 10^{-3}

= *2280.25kg/m2*

r = [b x Acceleration due to Gravity KN/m2

1000

= 2.28 x 9.81 = 22.40 KN/m2

1000

For Square Base the bearing Capacity Computation

= q_n = 1.3CNc = YZNq = O.4YBN_r

∴ q_n = 1.3x50.67x23.87+22.40x1.5x11.82+0.4x22.40xO.5x8.92

1572.34 + 397.152 + 39.96

2009.45KN/m2

3.1.5 DESIGN ANALYSIS

The tank is expected to supply water to the University Community by gravity, hence, the height need to be determined to be able to perform its function satisfactorily.

3.1.6 BASIC DATA AND ASSUMPTIONS

Since water will be required at the topmost, water service tank on top of the building around which the highest is four story building. Hence, the height from the center of service water to this level is computed thus.

$P_n = P(1+Ic)_n$

P_n = Future population

P= Present Population

Ie= probability rate of yearly increase say 0.50/0

:. P_n = 4495 (1+*0.5/100)25*

= 5092

Using Nigeria water consumption standard Capital/day for an individual which is 120-litre *l* capital *l* day

Optimum water demand *lday* = 5092x120=611, *040/day.* Account is taken of period demand together with loss and waste consider 5% wastage

5% of 611,040 = 30, 552

Total = 30,552, + 611,040

= 641,592 + 611,040 liters

The main source of water supply to the campus community is through boreholes and is subjected to intermittent supply which may occur as a result of breakdown of one kind or the other and it takes two or three days before re-adjustment. In view of this. The tank is designed for (3) days storage period.

Therefore design capacity = 641, 592 x 3

= 1, 924, 776 liters = 1, 925, 000 liters

Since 1000 liters

The design capacity = 1,925,000/1000

= 1,925 m^3

The above is the expected capacity of the tank I.e. volume the volume of water expected is too high and costly to be elevated. Therefore 225,0001itres of elevated tanks is recommended and 1,700, 000 liters ground tank with automatic pumping machine to maintain constant water supply in the elevated steel tank.

Volume of elevated tank = 225m^3

⊄ Recommend this size of tank thus.

Length = 10m

Breadth = 2m

Height = 2.5m

225, 000 liters = (10 x 9 x 2.5) m

Since water will be required at the topmost water service, tank on top of the building which is a three story- building. Hence, height from the center of service water to this level is computted thus:

Depth of Main = 1.5m

German floor building (ground floor) = 0.5m

1st floor height = 3.0m

2nd floor height= 3.0m

3rd floor height =3.0m

Height of service tank = 1.5m

Total = 12.5m

Applying factor of safely of 1.1=12.50 x 1.1

Therefore, total effective pressure head = 13.75m

Assuming the existing gravity fall = 2.75m

Net head required = 13.75 - 2.75 = 11.00m

3.1.7 DESIGN DATAS

Required Capacity = 10m length x 90m widths and 2.5m depth with 225, 000 liters capacity

8.54m length by 7.32m widths, 3.0m deep with 229,118 liters is recommended at 12, 496 kg greater than required.

Fire resistance moderate 35mm for 2 hours cover to mild exposure 20mm

Wind speed for Minna Niger state = 135km (hr) factors S =1.0, S2 = 1.0, S3 =1.0, K1 = 1.0 K2 = 1.04

Isolated pad footing Bean/slabs raft footings

High yield

Reinforcement fy = 460 N/mm2

Mild Rolled fyv =250 N/ mm2

Concrete grade = 20N/ mm2

Steel grade =43

Stress of steel Pc =165N/mm2

Soil Bearing capacity = 150kN/ m3

A 4.27m B 4.27m C

---+I1----------H---------H- 0.915

3.6b--1H---------4+--------1+_ 0.905

----H- 1+- -tt---'0.915

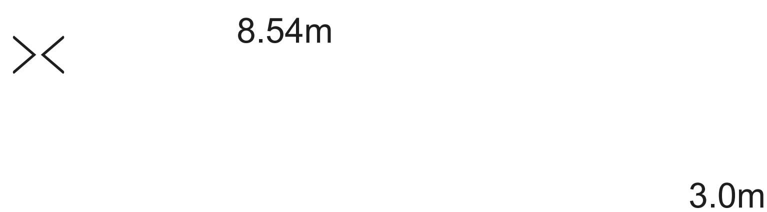
3.66~-------_f+_--------+t-°·915

— * — — — — — — — — ~ — — — — — — — 0.915 ~

A B C

The figure above show, the loading diagram and the effect of hydrostatic forces acting in the interior of the tank and the wind load acting outside the tank. The maximum wind loads occurring at the height of 12.00m

It will be seen, that the external surface of the tank provides a large area for the wind to act. This further explained in the calculation Iwind analysis below;



Density of water P_W = 1000 kg m_3 Tank loa

Acceleration due to gravity = *10m/s2*

Height of water ftank = 3.0m

Pressure of water on tank wall = P = Yh

P =(1000 x 10 X *3.0)/10₃*

= 30 KNfm2

110 Design velocity for Minna Niger state I.e, area within Nigeria middle belt zone with design velocity of 135km/hr

NCP

Nigeria

⊄ 135 x *1000/3600* = 37.5mfsec.

Basic wind pressure at height of 12.00m maximum wind gust speed =

Bs 5400

part 21978

5, table 2

Funneling factor S1= 1.00

Wind coefficient related to return period K =1

Hourly speed factor K2=1.014

Structural height above ground H =12.00m

Vc = VXK1XS1XK2

Bs 5400

part2

1978

5:3:2:4

Where K2 = the hourly speed factor

S1= the funneling factor

V = the mean hourly speed

K = the return period factor

Vc= (37.5 x 1.0 x1.0x1.04) = 38.025 *m/sec*

Bs 5400 part2 1978 5:3:2:4

Nominal transverse wind load:

Pt = q A Co

Where q = the dynamic pressure head

q = 0.613 Vc2 in *N/m2*

CD = the drag coefficient

Load need in KN/m 2 pressure load is far considered

q= 0.613 x 38.0252

q= *886.34N/m2*

q= *886.34/1000* =0.886 KN/m2

Tributary areas = 8.54x3 =25.62

F = 0.886 x25.62 =22.70KN

3.1.7 DEAD AND LIVE LOAD ANALYSIS

Dead load of tank with capacity = 229, 118 liters

=12,496kg

(12,496 x 10) *1* (10^{3}x 8.54 x7.32) = 1.998 =2.0KN/m2

Imposed load = Y h = 10^3 x 10 x 3.0 *110^3*

= 30 KN/m2

Total load = 1.93 + 30 = 31.93 KN/m2

From the above load analysis, the calculated loads which happen to give the highest is when the tank is full with water, with load equal to 31.93 KNI m2 while the wind load is 22.70KN and Tributary area of 25.62 m2

31.93KN/m2>

22.70KN.

3.1.8 PLATE DESIGN

p= 2.0m 3.0m

1.0m

p= $h_2/2$ = 10_3 x $3_2/2$ = $4500x10/10_3$ = 4.5KN

Moment about base = 45 x 1 = + 4.5 KN m

THE ROD DESIGN

Since the free acting in the plate is in tension, F = 4.5 KN

858110 Fy = 460 using high yield steel for inertial process.

part-t- Stress = *Forcel* Unit area

1997

table 3.1 ~ Fe= F/A; fe = fy=460

F = 4.5 K N

A=?

⊄ A = Flfe = 4.5 x 10 3 1460 N/N/mm2

A = 97.8m2for circular steel

⊄ n 0 2 14 = 9B.8 rnrrf 9.8mm2

⊄ O2 = 4x97.81 n = 124.55 mm 12.46mm

O = "-'12455 -\}12.46

0= 11.16mm 0=3.53

Adopt O = 6mm

Adopt

D=6mm

Check for sagging

Maximum Ur = 240

But r (ll A) 112 where L = Sad Length

r = radius of gyration

Table 11 part 1 BS 5 950. 1990

⊄ r= ((3.14 O4 164) 1(3.14 O214)) 1/2

r= (O2 116) 1/2

r=O/4:. L (014) = 240

L = 240 x 12/4 = 720mm

Fb= M/Z, Z= l/c.

b and I = be 112, c = tl2

Substituting in the value of 1& C

-. t._ We have Z = (bt' 112)(tl2)

Z = bt3 112 x 2/t = bfl6 substitute in the value of Z

Fb= M I(bt2/6)

Fb= *6ml bel6)* consider a mater strip of plate, b = 1m = 1000m

BS 5950 part 1 table 6, 1990

BS 449 part 2 1969 table 2

Using pressed grade 43 steels so that the plate will yield at *275N/mm2,* M =45KNM

Then 275 = 6 (4.5 x 106) *1103* x e

e = 6 (4.5 x 106) *1103x 275*

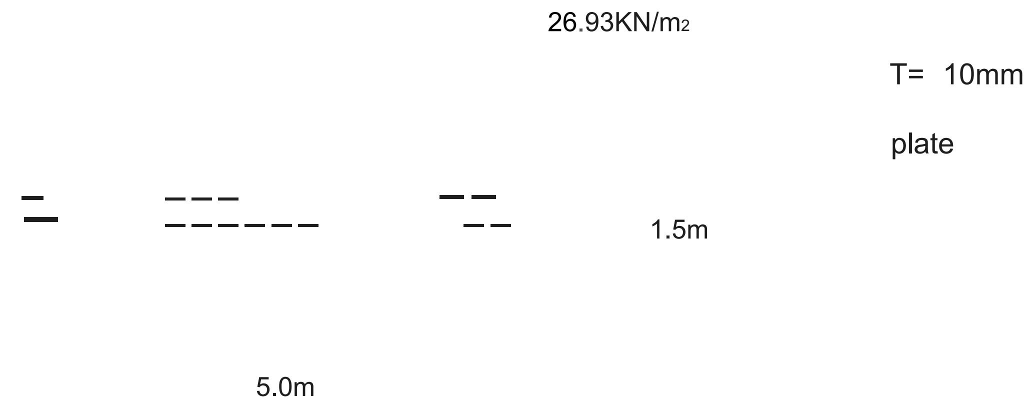
e = 98.18

t = ~98.18 = 9.91 mm > 5mm specifies

t = 9,9mm adopt 10mm plate for the tank body which include sides, bottom & top cover.

3.1.9 BEAMS DESIGN

3.31 GRILLAGE BEN\S



Loading:Assume 2.5 % beam weight = 0.73 *KN/m*

Total = 29.95 *KN/m*

Moment = 10 L^{218} = 29.95 x *4.27218* = 68.26

M = 68.26KNm

Shear force = wll2 = 29.95 *x4.27/2* 63. 94

V = 63. 94KN 29.95KN/m

4.27m

63.94 68.26

63.94

M=68.~
6km.

V=63.9
4km

Elastic modules Z = MIPs grade 43 Ps = 165

:. Z = 08. 26 x *10₃/165* = 413.696 = 413.7

Use 305 x 102 x 33 Kg/m Z = 415cm3

Shear V = 63.94 KN

Vm = *V/Dt,* => Vm =*63.94x10₃/312.7* x 6.6 = 30.

98< 100

Therefore, shear Vm = 30.98 *N/mm2* < 100 *N/mm2*

Ps=16~
N/mm2

BS 449
part 2
table 2.

Shear is okay

Deflection = *5wl₄/384* EI

= 5x29.95x4.274x 100₃ = 0.952

Use;30
5x102)(
33kg/rr

384x21000x6487 | Z =415cm3

BS 4 part 1 table 2 1993.

D =312.7mm

Permissible deflection p = 4.27 *x100/360*

= 1.186

t = 6.6mm

T = 10.8mm

Ud = 4.27 x *10₃/312.7* = 1.366

ry= 2.15cm

:. < 16.97 permissible for grade 43 steel

Vm=30.98N/m m2

Flange stability

Le/ry = *362.95/2.15* = 168.81 -169.

E= *21000N/mm2*

Drr = *312.7110.8* = 28.95 - 29

Grade 43 by interpolate Pc =93.1Ci65 *N/m2*

1=6487cm4

Adopt 305 x 102 x33 *Kg/m* universal beam for all grillage beams

Defection oka;

Flange stabilit: is okay

Bs 449 table 2, & 3a part 2 1969

3.3.2 MAIN BEAMS MBM

Considering the critical beam which is on grid line B -8

GBM;305X10~ X33kg.

Therefore:- loading: - (i) point loads from grillage

Beams = 63.94KN

(ii) Self weight of beam (assume 2.5g KN/m)

63.94KN 63.94KN 63.94KN

B

-110

Steel designers manual 4th Edition pg. 35	Mc = ME = *3/8* PL, MD = PII2 PA = PB= 3pU2
	max = 19PL3/384 EI
	RA = RB = 1.5 x (63. 94 + 9.48)
	= 110.13KN Mc = ME = *3/8* PL = 0.375 x 73.42 x 3.66
	MD = PU2 = 73.42 x 3.66 *12* = 134.36 KNm
	Elastic Modules Z = MIPs = 134.39 x *10₆/165*
	= 814. 3cm3
BS449 Part 2	Use 356 x171 x *57Kg/m*
	Shear: Vm = *VIDt* where V = 110.13KN
	⊄ ...Jm = 110.13 x *103/358.6* x 80= 38.39 N / mm2
	< 100N/M2 permissible

BS4 part 1 Table 2, 1993

Share is okay

Max Deflection &max = 19Pl3 1 384EI

=> *(19x63.94x366₃)1* (384x21000x 16077)

X *(10₉/10₄)* = 45.94mm x 10-₃or 0.046cm

Permissible =Ud = 3.66 x *100.1360* = 1.02

Actual Ud = 3.66 x *10₃/358.6* = 10.2K16.97

Deflection is okay

Flange stability:

Le. = 0.85 x 3.66 x 100 = 311.1cm

ry = 3.92cm, D = 358.6mm, T 13.0mm

Le/ry 311.1/3.92 = 79.36

OfT = *358.6/13.0* = 27.58

Pc = 165 = permissible

Grade 4:

ps=165NI m 2

1=16077cm4

Z=896.5cm3

D=358.6mm

T=8.0mm

T=13.0mm

6y=3.92cm

E=21 *OOOn/m2*

Vm=ok

Sp=ok.

3.1.10 COLUMNS DESIGN (STEEL)

Considering the external column which is considered to be the most critical located on grid lines (1-1) (8-8)

110.13

63.94 "| 63.94

1 0.13

Total = 348.15

63.94 ·1 ·r 63.94

JO.13

Total = 238.02

1 10.13

·r 63.94

Total = 174.07

Total loads on columns = 348.15 KN

Height of columns =12m

Try U.C = 356 x 358 x 129 kg/m

Le = 12 x 100 = 1200cm

Le/ry = 1200/9.39 =127 .8- 128

DfT = 355.6/17.5 = 20.32 - 20

By interpolating Pbc = 146.2Nlmm2< 165

Therefore the section selected is adequate

Load capacity = Pbt x A= (146.2 x 164.9)/10

= 24108. 38/10 =

2410.84KN.>348.15KN

Actual load on columns.

BS 449-1969

table 2 & 3a

›› 330.40KN the section is okay

3.1.11 COLUMN DESIGN (CONCRETE)

Axial load from steel = 348.15KN.

Column (steel)Self weight = 154.8KN

Quit total load =512.10KN

858110-1

1997 Short Column Lex/h and Ley/b > 15.

Table 3.25

Ncal =0.4x fcu x b x d

$=0.4x25x550^2x10^{-3}$

=3025KN

N = (O.4xfcu x Ac) + (0.80 x fy x Asc)

512.10 x 1000 = 3025 + 0.80 x 460 x Asc

Asc = 1383mm2

Nominal Reinforcement Should not be less than

100As/Ac < 0.4

Therefore, Asc= 0.4 x Ac which equal 0.4 x550 x 55

100 100

Asc = 1210mm2

Provide.6Y25 (Asc prov = 2946.24mm2) as starters with 3Y25/face (Asc poor=1472.6mm2)

A=164.9cm2

T= 10.7mm

T=17.5mm.

Ry=9.37cm

1=40246cm4

D=355.6mm

u.c.

356x358x129~ g/m.

3.1.12 BASE PLATE DESIGN

Axial load on column = 348.15KN

Self weight of column =12x129x1Ox1000 = 154.8KN

Assumed Total load on plate = 502.95KN

Using effective area method

The required area = axialload/0.6 fcu

Area = 502.95 x *103/0.6* x 20

BS 5950 part12000

= 41912.5 mm2

Adopt 500 x 493mm size base plate

493mm

X ,---------, X-.---

I-J

500mm

~I

...____-------',__ ......

67.5 358 67.5

The required plate thickness tp = C(3w/Pyp)0.5

Where: w = 0.6fcu

Fcu = concrete cube strength

Pyp = the plates design stre~gth > 270 *N/m2*

Steel designers manual 6th edition pg 827

Adopt pyp=270N/mrr 2Adopt bas: plate sizi 500x493x25m m thick

C = plates projection

tp = {67.53XO.6x20}0.5

270

= 67.5 x (0.133) 0.5

= 67.5 x 0.3651

tp = 24.65mm

3.1.13 PAD FOUNDATION DESIGN

Moderate and mild exposure

Bearing capacity *150kn/m3*

Isolated pad footings

Concrete fcu=25nm2

Reinforcement *fy=460N/m2*

Total axial load from column (load on Base plate)

=512.10KN.

Area of foundation required = *512.10/150*

=3.414m2

Provide base of 2.2x2.2xO.75mm.

The limit state = 512.10 x 1.5 - (0.75 x 24 x 1.4)

2.56

=300.06 - 25.20.

=274.86KN/m2

The ultimate limit state =1.4gk + 16qk=

Average=1.5n

512.10 x 1.5 = 768.15KN

Earth pressure = $\frac{768.150}{2.22}$ = 158.7 KN/m2

The net earth pressure =274.86KN/m2

Since 750mm thick footing is assumed and with the footing constructed on a blinding the minimum concrete cover is taken on 50mm

Therefore, the effective depth d=h-c-0/2

D = 750 - 50- *20/2*

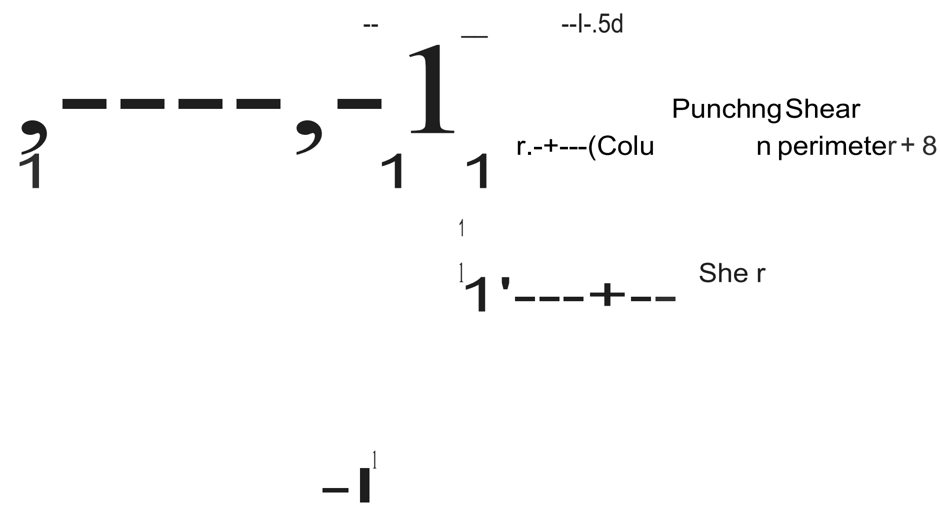
= 750 - 60 = 690mm

The shear stress Vc = *NI* (column perimeter x d)

Vc = 495.60 x *10³/(2200x690)*

Vc = 0.34 < *0.8/fec =4*

0.3 < 4 okay.



Critical perimeter=column per meter + 8 x 1.5d

= 4 x 550 + 8 x 1.5x690

= 2200 + 8280

= 10480mm.

Area with in the perimeter = (550 + 3d) 2

= (550 + 2070)2

=6.86 x 106mm2

Therefore, punching shear force

V = 279.86 (2.22- 6.86) = 565.32KN

Punching shear stress V = V/perimeter x d

= 478.56 x *10₃/10240* x 690 =

0.068n/km2

Bending conferment at the critical column face,

M = 478.56 x 2.2 x 0.8252x 0.5

$M = 358.29KN/m.$

For concrete ultimate

$= 0.156 f_{cu} b d^2$

$Mu = 0.156 \times 25 \times 2200 \times 690^2 \times 10^{-6}$

A=550x550mm

$= 4084.94KNM > 358.29KNM.$

H=900mm

$K = M/bd^2 f_{cu}.$

$= 358.29 \times 10^6 / 2200 \times 690^2 \times 25$

$= 0.00137.$

$Z = 0.985d > 0.95d$ Adopt 0.95d

$Z = 0.95 \times 690 = 655.5$

$Ast = M/0.95 f_y Z$

$= 358.29 \times 10^6 / 0.95 \times 460 \times 655.5$

$= 1250.78 mm^2/m.$

But Min Ast = 0.13%bh,which imply (0.13 x 2200 x 750)/100 = 2145mm2/m

Provide Y25 @ 200 c/c top and bott, both ways.(Ast prov = 2450mm2/m)

Therefore 100Astlbh=100 x 2450/2200 x 750 = 0.15>0.13

Are required and measure specify acquirement in a slab in 750mm, the minimum area and maximum spacing in satisfy.

Final check for punching shear. Fcu=25N/m^2

100 Ast/bd = 0.17, Vc = 0.36.

Punching shear stress was 0.021< 0.36 punching is okay, with h = 750mm thick.

155mm 1.0d=670mm 550mm *y* 825mm

V = 279.86 x 2.2 x 0.155 = 95.43KN

V = v/bd = 34.92 x *10^3/2200x690.*

= *0.063N/mm2*

0.063N/mm2 < *0.36N/mm2* the section in shear

Adequate shear is okay.

3.1.14 SURFACE GROUND TANK

Capacity of Tank = 1,700,000 liters.

Two Number 880,106 liters,13,420 x 13, 420 x 4.88m deep with plate thickness 6mm. And weight of tank 33,782 kg

Loading:

(1) Self weight of tank = $\frac{33.782 \times 10}{(1000 \times 13.42 \times 13.42)}$

= 1.88 KN/m2

(2) Live Load -Weight of Water = 10 x 4.88

= 48.8KN/m2

Design Load: N = 1.4gk + 1.6gk

N = 1.4 x 1.88 + 1.6 x 48.8

N = 80.712KN/m2

BEAMS:

Beams Size: (230 x 600)mm Assumed.

Loading; Self weight = 0.23 x 0.4 x 24 x 1.4 = 3.1OKN/m

Edge of Beams = (0.45+0.5) x 1.342 x 80.712 = 121.42KN/m

Total = 124.52KN/m

Internal Beams = 1.342 x 80.712 = 108.32KN/m2

Add self weight = (3.1*OKN/m2)*

Grand Total = *111.42KN/m*

Total Load on Slab = 124.52 + (111.42 x 10) = *1363.24KN/m*

Load on Slab per m2 = 1363.24 x 13.32

14.32 x 14.32

= *89.22KN/m2*

Self weight of slab = 0.2 x 24 x 1.4 = *6.72KN/m2*

Total load = *95.94KN/m2*

K = M/bdfcu

K = (21.6 x 106)

1000 x 174 x174 x20

=0.036

therefore, K>K' No Compression reinforcement reqd.

Z= 0.968>0.95 Adopt 0.95d

Z= 165.3

Ast = *M/(O.95fyZ)*

Ast = 21.6 x1*06/(O.95x469x165.3)* *=299mm2/m*

But Min Ast = 0.15%bh=> (O.15x1*000x200)/1* 00 = 300mm2

Provide *Y12@200c/c* (Ast = *566mm2/m)*

Distribution *Y19@200c/c* (Ast= *393mm2/m)*

CHAPTER FOUR

1.0 FOUNDATION

1.1 RESULTS

From the analysis of all the structural parameters in chapter three, the following results were obtained both from laboratory analysis and theoretical structural analysis. This is explained thus:

Soil Cohesion C = 50.67KN/m2

Angle of Internal Friction of soil O = 24.17

Moisture Content of the soil sample Mo = 11.97%

Soil density at 1.5m Depth = 22.40KN/m2

Ultimate Bearing Capacity = 2009.45KN/m3

Adopted Bearing Capacity = 150KN/m2

Projected Estimated Population of School Pn = 5,092

Volume of water Vw = 1,925m3 (1.925,000 liters)

Wind load WI = 22.70KN

Dead load of water tank DI = 2.0KN/m2

Live load of water tank (water) LI = 30KN/m2

Design load n = 31.93KN/m2

Plate thickness Pt = 10mm

Tank internal braces (iron rod) = 6mmO

Beams: crillage beams = 305 x 102 x *33kg/m*

Main beams = 356 x 171 x 57kg/m

Columns (Steel) = 356 x 358 x 129kg/m

Columns (concrete) = 550 x 550mm. 6Y12 and Y10 @ 200%

Base plate = 500 x 493 x 25mm

Surface/Ground tank = plate thickness = 10mm

Beams = 230 x 600. 6Y12and Y16 @100%

Slab = Y12@200%B and Y12@200%T

Pad footings. Sizes = 2.2m x 2.2m x 0.75m

Reinforcement = YR5@200% T&B

Provided

Elevated tank size = 8.54m x 7.32m x 3.0m with 229,1181iters

Ground tank size = 2Nm. 13.420m x 13.420m x 4.88m with 880,1061iterseach.

Total = 1,760,00liters

Refined

Elevated tank size = 10m x 2m x 2.5m with 225,0001iters

Ground tank size = 13m x 13m x 10m

1.2 DISCUSSIONS

The chance of the best type of elevated tank to use depends on the type of system being installed. The materials available of skilled labor. Elevated storage tanks are useful to providing water to stand pipes and to large distribution system. and to large distribution system.

One of the cheapest and easiest materials to use for a small capacity tank is steel. Pressed steel plates can be bolted together on top of a tower with little or no skilled labor. Tank size will be influenced by the amount of water that need to be stored and the size of pressed steel sheets available.

Thus from the above discussions, which give birth to this research project, and as such the results are summarized in 4.1.

The soil under the proposed foundation of the elevated tank is a C - O soil with a high bearing capacity which can conveniently carry the load however, the foundation design with double reinforcement to brace against upthrust and punching frees which may be in either cases.

The estimated population of the school which is expected in Gidan Kwano Campus for the next twenty-five years has been taken into consideration and an adequate volume of water has been estimated with a powerful pump to backup the pressure to the elevated tank, not only that the location of the tank is perfectly centralized to supply water all around the school campus with minimum cost of pumping and maximum pressure.

The water tanks which are both elevated and ground supported can sustain the school for at least three days which is adequate to sustain any unforeseen situation and to allow the authority to act before catastrophy can set in.

The design itself has all the members adequate and rugged to sustain any excessive load and the joints are well taken care of. The volume of tank provided is a little above thhhe expected volume required. The members are all tested and checked against any failures. Therefore, the structure is safe for execution and adequate for the intended purposes.

4.3 MAINTANACE OF ELEVATED & GROUND STEEL WATER TANK.

Steel storage tank maintenance and repaired of steel tanks usually is carried out through various inspections and depending on the available season in the area. In Nigeria and Minna as focal points has two major seasons, wet and dry season. Tank inspection should be twice each year, after the raining season, steel storage tank should be inspected for wind and rain fall effect. The tanks walls (exterior and interior and bottom (interior) should be inspected semi annually for rust erosions, loose scale, heavy seams and welds and for the condition of the point (both inside and outside).

Maintenanceproceduresto adhereto are as follows:

(1) Replace rivets, bolts or patch-leaking area, and follow by cleaningand painting.

(2) Check painted surface for rust, corrosion, cracking, peelinq, allegation,caulking,fading or completeloss of paint.

(3) Make certain that hatch covers and man-holes are in place and locked and that screen is in place to prevent the entrance of birds. Insectsand animals.

Tanks should be empty and the interior paint, should be examine, as corrosion is more likely on the inside. When the interior needs paintings, it should be done more often particularly if the stored water is corrosive: unless the tank is equipped with catholic protection.The paint we should be such that will protect the metal against corrosion or an applicable guide specification for point selection and application should be consulted. New coat of paint should be use if the previouslyapplied coat in fair conditions bare spot of steel should be paintedwith a spot or patch coat beforethe finish coat is applied. When the condition of the old paints is bad, usea complete.

primercoat:

Every six (6) months, the roof and its appurtenance screen on overflows, and manholes, as well as the condition of the paints, should be inspected.

Stand pipe:

Every six (6) months joints should be checked for leakage at the juncture of the floor and the walls, and for loose or missing "filler, debris, or trash. They should be cleaned and repaired.

CHAPTER FIVE

5.0 SPECIFICATION RECOMMENDATION CONCLUSION

5.1Specification

1. The minimum size of aggregate to be use for all reinforcement concrete work should be 20mm.

2. All aggregate should be well grade, clean, and free from impurities such as dirt, dust, clay, silt etc.

3. The recommendation Ted mix for the reinforcement concrete is 1:2:4 of cement/sound ground and this have characteristic strength of *25N/mm2* at 28 days.

4. Curing for concrete should be for at least 7 days and this should be under water.

5. All creation of steel work shall be done in accordance with specification.

6. All structural steel member to be use are to be clear properly erection.

7. All steel should be packed or stalked above the ground level to avoid rusting or contact with water.

8. Concrete should be compacted by poker vibrator or any other type but bleeding of concrete should be avoided.

9. Form work to supported concrete should be well tighten at joint to avoid lost of cement slurry and be cleaned and free from dirt..

10. Grade 43 steel shall be used throughout in the steel work.

11. Painting of steel members with anti rust (red oxide) before Aluminum paint.

12. Inspection of all members in every six (6) months should be observed.

13. The wed strength and concrete bond must be high to facilitate good grip of steel and concrete to reinforcement.

5.2 RECOMMENDATION

recommend this project work for construction, because it was carryout with the help of my supervisor, lecturers, and practicing engineers in confirmation with least code of practice.

In the structural design, the following factors were taking care off:

(a) Stability

(b) Conformity

(c) Durability

(d) Accessibility

(e) Aesthetic and Security

(f) Economy.

In the Structure as a whole, safety is the first priority to be consider followed by economy.

5.3 CONCLUSION

The stability of this steel structure under critical or worst condition of loading is ensured and economy was taken into consideration as far as possible. All necessary parameters and condition of loading were consider for stability (under ultimate state design) checks are also made at each stage to ensure the serviceability of the structure under applied load and variation in weather and materials.

However, the most economical design can only be determined by comparing the approximate cost of different similar design. And this includes such an economic comparation as in the area or fire resistance, deterioration appearance confidence of structure and availability of materials.

Having considered safety and economy thoroughly in this project work. I confidently said that the structure will serve the purpose for which it is designed. And all the information and details provided in the drawing will make erection and site supervision easy.

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APPENDIX