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Analysis and Design of Reinforced Concrete Structural Building (G+6) By Using Etabs 2015

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Abstract: In order to compete in the ever growing competent market it is very important for a structural engineer to save time. As a sequel to this an attempt is made to analyze and design a multistoried building by using a software package ETABS 2015

For analyzing a multi storied building one has to consider all the possible loadings and see that the structure is safe against all possible loading conditions. There are several methods for analysis of different frames like kani's method, cantilever method, portal method, and Matrix method. The present project deals with the analysis of a multi storied residential building of G+6 consisting of 5 apartments in each floor. The dead load &live loads are applied and the design for beams, columns, footing is obtained

ETABS 2015 with its new features surpassed its predecessors and compotators with its data sharing capabilities with other major software like AutoCAD, and MS Excel.

We conclude that ETABS 2015 is a very powerful tool which can save much time and is very accurate in Designs. Thus it is concluded that ETABS 2015 package is suitable for the design of a multistoried building.

Assumptions Regarding Design:

i) Slab is assumed to be continuous over interior support and partially fixed on edges, due to monolithic construction and due to construction ofwalls over it.
ii) Beams are assumed to be continuous over interior support and they frame in to the column at ends.

Assumptions on design:

1. M-20 gradeis used in designing unless specified.
2. Tor steel Fe 415 is used for the main reinforcement.
3. Tor steel Fe 415 and steel is usedfor the distribution reinforcement.
4. Mild steel Fe 230 is used for shear reinforcement.

key skills:

- ✓ Auto Cad 2016
- ✓ Etabs 2015
- ✓ MS Office 2010

I. INTRODUCTION

Building construction isthe engineering deals with the construction of building such as residential houses. In a simple building can bedefine as an enclose space by walls with roof, food, cloth and the basic needs of human beings. In the early ancient times humans lived in caves, over trees or under trees, to protect themselves fromwild animals, rain, sun, etc. as the times passed as humans being started living in huts madeof timber branches. The shelters of those old have been developed nowadays into beautiful houses. Rich people live in sophisticated condition houses.

Buildings are the important indicator of social progress of the county. Every human has desire to own comfortable homes on an average generally one spends histwo-third lifetimes in the houses. The security civil sense of the responsibility. These are the few reasons which are responsible that the person do utmost effort and spend hard earned saving in owning houses.

Nowadays the house building is major work ofthe social progress of the county. Daily new techniques are being developed for the construction of houses economically, quickly and fulfilling the requirements ofthe community engineers and architects do the design work, planning and layout, etc., of the buildings. Draughtsman is responsiblefor doing the drawing works of building as for the direction of engineers and architects. The draughtsman must know his job and should be able to follow the instruction of the engineer and should be able to draw the required drawing of the building, site plans and layout plans etc, as for the requirements.

A. Early modern and the industrial age:

With the emerging knowledge in scientific fields and the rise of new materials and technology, architecture engineering began to separate, and the architect began to concentrate on aesthetics and the humanist aspects, often at theexpense of technical aspects of building design. Meanwhile, the industrial revolution laid open the door for mass production and consumption. Aesthetics became a criterion for the middle class as ornamental products, once within the province of expensive craftsmanship, became cheaper under machine production.

Vernacular architecture became increasingly ornamental. House builders could use current architectural design in their work by combining features found in pattern books and architectural journals.

B. Statement of project

Salient features:

Utility of building: Residential Apartment

No of stories : G+6
No of staircases : 1
No. of flats : 20

Type of construction: R.C.C framed structure

Types of walls : Brick wall
Ground floor : 3m
Floor to floor height: 3m.
Height of plinth : 0.6m
Depth of foundation: 5m
Concrete grade : M30
All steel grades : Fe415 grade
Bearing capacity of soil: 300KN/M^2

C. Literature review:

Method of analysis of statistically indeterminate portal frames:
1. Method of flexibility coefficients.
2. Slope displacements methods (iterative methods)
3. Moment distribution method
4. Kane's method
5. Cantilever method
6. Portal method
7. Matrix method
8. ETABS 2015

Advantages:

It is used for side way of frames.

Limitations:

The rotational of columns of any storey should be functioning a single rotation value of same storey. The beams of storey should not undergo rotation when the column undergoes translation. That is the column should be parallel. Frames with intermediate hinges cannot be analysis.
The main object of reinforced concrete design is to achieve a structure that will result in a safe economical solution.
The objective of the design is

1. Foundationdesign
2. Column design
3. Beamdesign
4. Slab design

These all are designed under limit state method

1. Limit state method:

The object of design based onthelimit state concept isto achieve an acceptability that a structure will not become unserviceable in its lifetime for the use for which it is intended. I.e it will not reacha limit state. In this limit state method all relevant states must be considered in design to ensure a degree of safety and serviceability.

Limit state:

The acceptable limit for the safety and serviceability requirements before failure occurs is called a limit state.

Limit state of collapse:

This is corresponds to the maximum load carrying capacity. Violation of collapse limit state implies failures inthe source that a clearly defined limit state of structural usefulness has been exceeded. However it does not mean complete collapse.

This limit state corresponds to:

a) Flexural
b) Compression
c) Shear
d) Torsion

Limit state of survivability:

This state corresponds to development of excessive deformation and is used for checking member in which magnitude of deformations may limit the rise of the structure of its components.

a) Deflection
b) Cracking
c) Vibration

A. Software

This project is mostly based on software and it is essential to know the details about these software's.

List of software's used

1. Etabs 2015
2. Etabs foundations
3. Auto cad

ETABS 2015

Etabs is powerful design software licensed by ETABS 2015 stands for structural analysis and design

Any object which is stable under a given loading can be considered as structure. So first find the outline of the structure, whereas analysisis the estimation of what are the type of loads that acts on the beamand calculation of shearforce and bending moment comes under analysis stage. Design phase is designing the type of materials and its dimensions to resist the load. This we do after the analysis.

To calculate s.f.d and b.m.d of a complex loading beamit takes about an hour. So when it comes into the building with several members itwill take a week. ETABS 2015 is a verypowerful tool which does this job in just an hour's ETABS 2015is a best alternative for high rise buildings.

Now a day's most of the high rise buildings are designed by etabs which makes a compulsion for a civil engineerto know about this software.

This software can be used to carry rcc, steel, bridge, truss etc according to various country codes.

This software can deal different types of foundations

SHALLOW FOUNDATION (D<B)

1. Isolated (Spread) Footing
2. Combined (Strip) Footing
3. Mat (Raft) Foundation

DEEP FOUNDATION (D>B)

1. Pile Cap
2. Driller Pier

1. Isolated footing is spread footing which is common type of footing.
2. Combined Footing or Strap footing is generally laid when two columns are very near to each other.
3. Mat foundation is generally laid at placeswhere soil has less soil bearing capacity.
4. Pile foundation is laid at places with very loose soils and where deep excavations are required so depending on the soil at type we have to decide the type of foundation required. Also lot of input data is required regarding safety factors, soil, materials used should be given in respective units.

After input data is give software design the details for each and every footing and gives the details regarding

1. Geometry of footing
2. Reinforcement

3. Column layout
4. Graphs
5. Manual calculations

These details will be given in detail for each and every column. Another advantage of foundations is even after the design; properties ofthe members can be updated if required.

The following properties can be updated

- Column Position
- Column Shape
- Column Size
- Load Cases
- Support List

III. ANALYSIS & STRUCTURAL MODELLING

A. Plan And Elevation

The auto cad plotting no.1 representsthe plan of a G+6 building. The plan clearly shows that it is a combination of five flats. We can observe there is a combination between each and every flat. The Apartment is located at gachibowli which is surrounded by many apartments.

In each block the entire floor consistsof a three bed roomhouse which occupies entire floor of a block. It represents a rich locality with huge areas for each house. It is a G+6 proposed building, so for 5 blocks we have5x6=30 flats.

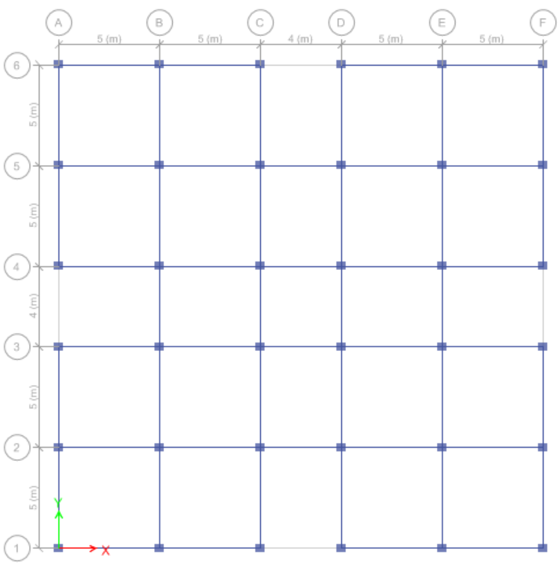


Figure 3 Typical floor Column & Beam Layout

Figure 3.2a Elevationof the building

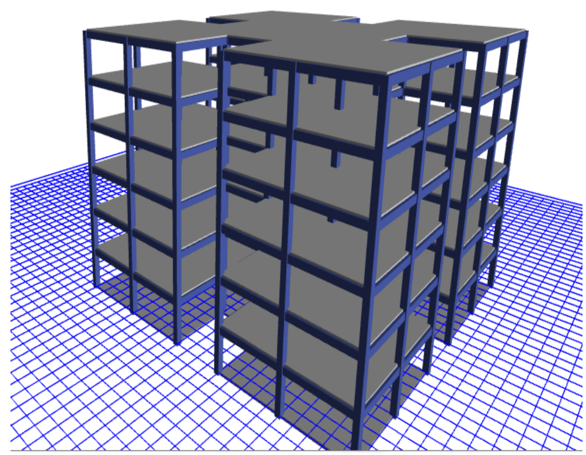


Figure 3.2b skeletal structure of the building

IV. ANALYSIS OF STRUCTURES

A. Load Conditions and Structural System Response:

The concepts presented in this section provide an overview of building loads and their effect on the structural response of typical wood-framed homes. As shown in Table, building loads can be divided into types based on the orientation of the structural action or forces that they induce: vertical and horizontal (i.e., lateral) loads.Classifications of loads are described in the following sections.

B. Building Loads Categorized by Orientation:

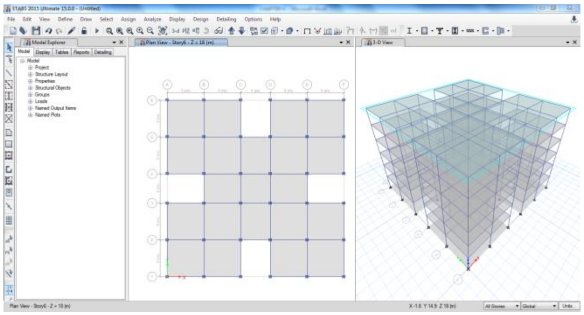
Types of loads on a hypothetical building are as follows.

- ¾ Vertical Loads
- ¾ Dead (gravity)
- ¾ Live (gravity)
- ¾ Snow(gravity)
- ¾ Wind(uplift on roof)
- ¾ Seismic and wind (overturning)
- ¾ Seismic(vertical ground motion)

1.Horizontal(Lateral)Loads:

Direction of loads is horizontal w.r.t to the building.

- ¾ Wind
- ¾-Seismic(horizontalgroundmotion)
- ¾ Flood(static and dynamic hydraulic forces
- ¾ Soil(active lateral pressure)



Structural View of G+6 Building

2. Dead Loads

Dead loads consist of the permanent construction material loads compressing the roof, floor, Wall, and foundation systems, including claddings, finishes and fixed equipment. Dead load is the total load of all of the components of the componentsof the building that generally do not Change over time, such as the steel columns,concrete floors, bricks, roofing material etc.

In etabs assignment of dead load is automatically done by giving the property of the member. In load case we have option called self-weight which automatically calculates weights using the properties ofmaterial i.e., density and after assignment of dead load the skeletal structure looks red in color as shown in the figure.

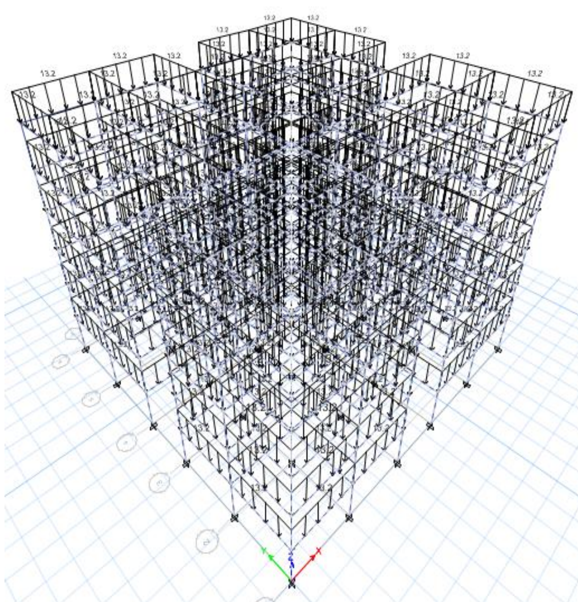


Fig4.4.1aDeadload

3. Windloads

In the list of loads we can see wind load is present both in vertical and horizontal loads. This is because wind load causes uplift of the roof by creating a negative (suction) pressure on the top of

4. Design wind speed:

The basic wind speed (Vb) for any site shall be obtained the following effects to get design wind velocity at any height (Vz)for the chosen structure.

a) Risk level

b) Terrain roughness, height and size of the structure and

c) Local topography

It can be mathematically expressed as follows: $V_{s}.=V_{b}x\ K1x\ K2xK3$

Where
V_z= design wind speed at any height Z in m/s
K_1= probability factor (risk coefficient)
K_2=terrainheightandstructure size factor and
K_3=topography factor

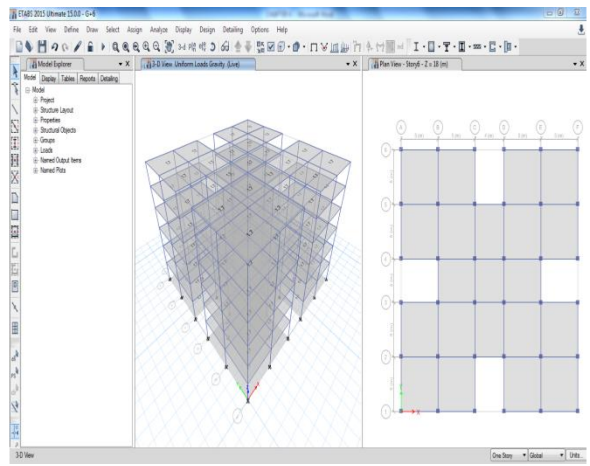


Fig 4.4.4.a Diagram of floor load

5. Load Combinations

All the load cases are tested by taking load factors and analyzing the building in different load combination as per **IS456**and analyzed the building for all the load combinations and results are taken and maximum load combination is selected for the design Load factors as per **IS456-2000**

Live load	Dead load	Wind Load
1.5	1.5	0
1.5	1.5	0
1.2	1.2	1.2
0.9	0.9	0.9

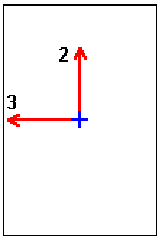
V. DESIGN OF BEAMS

Beams transfer load from slabs to columns .beams are designed for bending. In general we have two types of beam: single and double. Similar to columns geometry and perimeters of the beams are assigned. Design beamcommand is assigned and analysis is carried out, now reinforcement details are taken.

A. Beam design

A reinforced concrete beam should be able to resist tensile, compressive and shear stress induced in it by loads on the beam. There are three types of reinforced concrete beams

1.)Single reinforced beams
2.)Double reinforced concrete
3.)Flanged beams



Beam Element Details Type: Ductile Frame (Flexural Details)

Level	Element	Section ID	Combo ID	Station Loc	Length (mm)	LLR F
Story 6	B8	B5 300X450	DL+LL+ LL	4800	5000	1

VI. DESIGN OF COLUMN

A column or strut is a compression member, which is used primary to support axial compressive loads and with a height of at least three it is least lateral dimension. A reinforced concrete column is said to be subjected to axially loaded when line of the resultant thrust of loads supported by column is coincident with the line of C.G 0f the column I the longitudinal direction.

Depending upon the architectural requirements and loads to be supported, R.C columns may be cast in various shapes i.e square, rectangle, and hexagonal, octagonal, circular. Columns of L shaped or T shaped are also sometimes used in multistoried buildings.

The longitudinal bars in columns help to bear the load in the combination with the concrete. The longitudinal bars are held in position by transverse reinforcement, or lateral binders. The binders prevent displacement of longitudinal bars during concreting operation and also check the tendency of their buckling towards under loads.

A. Positioning of columns:

Some of the guiding principles which help the positioning of the columns are as follows:-

1. Columns should be preferably located at ornear the corners of the building and at the intersection ofthe wall, but for the columns on the property line as the following requirements some area beyond the column, the column can be shifted inside along a cross wall to provide the required area for the footingwithinthe propertyline. Alternatively a combined or a strap footing may be provided.

2. The spacing between the columns is governed by the lamination on spans of supported beams, as the spanning ofthe column decides the span of the beam. As the span of the of the beam increases, the depth of the beam, and hence the self- weight of the beam and the total.

B. Axially loaded columns

All compression members are to be designed for a minimum eccentricity of load into principal directions. In practice, a truly axially loaded column is rare, if not nonexistent. Therefore, every column should be designed fora minimum eccentricity .clause 22.4 of IS code

E_{min}= (L/500) + (D/300), subjected to a minimum of 200 mm.

Where L is the unsupported length of the column (see 24.1.3 of the code for definition unsupported length) and D is the lateral dimension of the column in the direction under the consideration.

Column design:

A column may be defined as an element usedprimary to support axial compressive loads and with a height of a least three times its lateral dimension. The strength of column depends upon the strength of materials, shapeand size of cross section, lengthand degree of proportional and dedicational restrains at its ends.

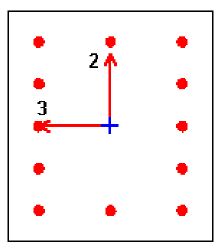
A column may be classify based on deferent criteria such as

1. Shape of the section
2. Slenderness ratio (a=l+d)
3. Type of loading, land
4. Pattern oflateral reinforcement.

The ratio of effective column length to least lateral dimension is released to as slenderness ratio.

In our structure we have 3 types of columns.

- Column with beams on two sides
- Columns with beams on three sides
- Columns with beams on four sides

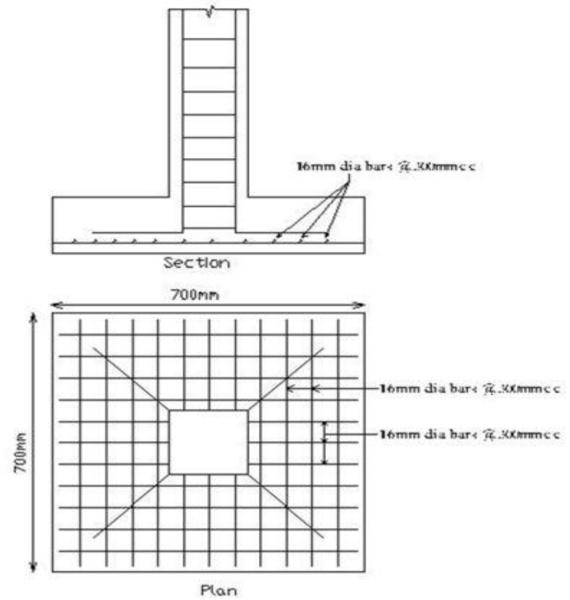


Column Element Details Type: Ductile Frame (Flexural Details)

Level	Element	Section ID	Combo ID	Station Loc	Length (mm)	LLRF
Story3	C28	C6 400X450	DL+LL+LL	2550	3000	0.694

Provided Tie Reinforcement:

Provide 8 mmdia. rectangular ties @ 190 mm c/c



Reinforcement details of the columns

VII. SLABDESIGN:

Slab is plate elements forming floor and roofsof buildings carrying distributed loads primarily by flexure.

Slabs are classified into two types they are:

- One way slab
- Two way slab

Onewayslab:

One way slab are those in which the length is more than twice the breadth it can be simply supported beamor continuous beam.

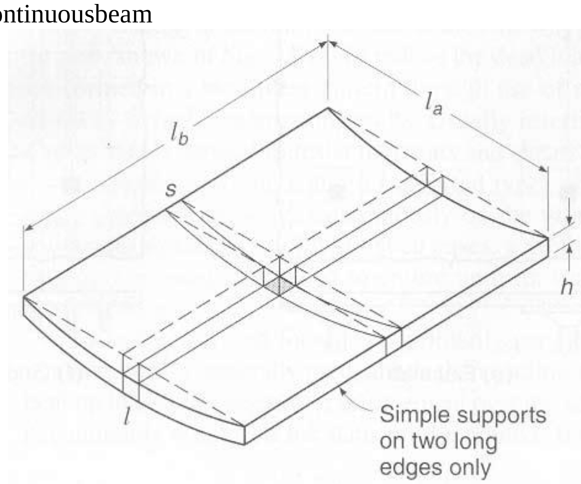
Twowayslab:

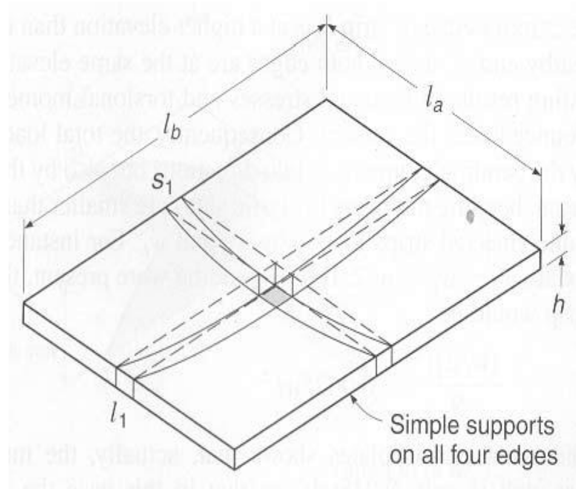
When slabs are supported to four sides twoways spanning action occurs. Such as slab are simply supported on any or continuous or all sides the deflections and bending moments are considerably reducesas compared to those in one way slab.

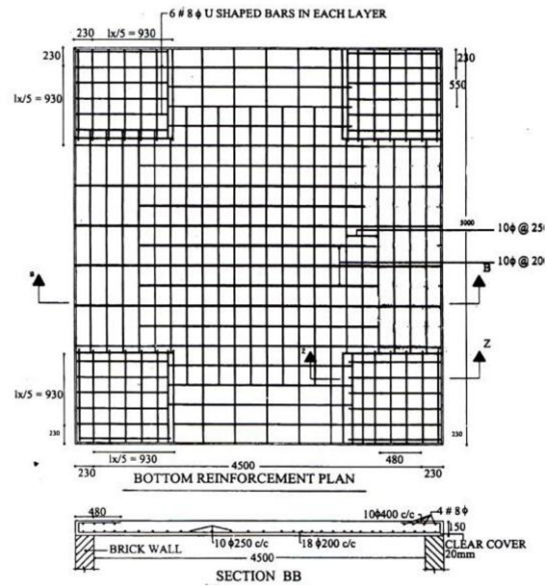
Checks:

There is no need to check serviceability conditions, because design satisfying the span for depth ratio.

a.)Simply supported slab
b.)Continuousbeam







Reinforcement details of the slab

VIII. DESIGN OF FOOTING

Footings are structural elements that transfer loads fromthe building or individual column to the earth .If these loads are to beproperly transmitted, foundations must be designed to prevent excessive settlement or rotation, tominimize differential settlement and to provide adequate safety against sliding and overturning.

GENERAL:

1.)Footing shall be designed to sustain the applied loads, moments and forces and the induced reactions and to assurethat any settlements which may occur will be as nearly uniformas possible and the safe bearing capacity of soil is not exceeded.

2.)Thickness at the edge of the footing: in reinforced and plain concrete footing at the edge shall be not less than 150 mmfor footing on the neither soil nor less than 300mm above the tops of the pile for footing on piles.

BEARING CAPACITY OF SOIL:

The size foundation depends on permissible bearing capacity of soil. The total load per unit area under the footing must be less than thepermissible bearing capacity of soil to the excessive settlements.

A. Foundation design:

Foundations are structure elements that transfer loads from building or individual column to earth this loads are to be properly transmitted foundations must be designed to prevent excessive settlement are rotation to minimize differential settlements and to provide adequate safety isolated footings for multi storey buildings. These may be square rectangle are circular in plan that the choice of type of foundation to be used in a given situation depends on a number of factors.

1. Bearing capacity of soil
2. Type of structure
3. Type of loads
4. Permissible differential settlements
5. Economy

Footing No.	Group ID	Foundation Geometry		
		Length	Width	Thickness
2	8	2.600m	2.600m	0.852m
8	15	3.050m	3.050m	0.551m
14	16	4.100m	4.100m	0.852m
18	17	3.750m	3.750m	0.551m
22	18	3.500m	3.500m	0.652m
23	19	3.350m	3.350m	0.652m
24	20	3.200m	3.200m	0.752m
25	21	2.650m	2.650m	0.501m
26	22	3.500m	3.500m	0.501m
42	36	2.300m	2.300m	0.852m

Soil Properties:

Soil Type: UN Drained
Unit Weight: 22.00 kN/m3
Soil Bearing Capacity: 300.00 kN/m2
Soil Surcharge: 2.00 kN/m2
Depth of Soil above Footing: 0.20 mm
Untrained Shear Strength: 0.50 N/mm2

Sliding and Overturning:

Coefficient of Friction:0.50
Factor of Safety against Sliding:1.50
Factor of Safety against Overturning:1.50

CONCLUSIONS

Housing is widely acknowledged as a human right. At the same time, it is a major driving force of the economy and often an individual's biggest asset. The situation within the housing sector is of high significance for a society's social and economic development and there is a need to openly recognize problems within the sector in order to develop and implement feasible policy options. The importance of addressing problems within the housing sector for the future development of the country has become increasingly recognized by policy makers within the Russian Federation. The President of the Russian Federation, during a speech to the State Duma in December 2003, stressed the importance of tackling the challenges within the housing sector as part of the Government's overall strategy for economic and social development. The Russian Federation's request to UNECE to have a country profile carried out on its housing sector illustrates the preparedness of the Government to discuss, in depth, the current problems within its housing sector and options for improvement. This section summarizes the main conclusions and recommendations which result from the country profile. They are presented in more detail in the respective chapters.

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