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Structural Feature of A Multi-Storey Building of Load Bearings Walls

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ABSTRACT

The idea of the research is that there is no systematic design of load-bearing walls building how to find out the structural details of it ,where this idea was to analyze and design a multi-storeys building of load bearing walls accordance with the recommendations given in **BS 5628-1-1992:**code practice for use masonry, this cod divided into three parts:- **part1:** structural use of unreinforced masonry,**Part2:**Structural use of reinforced masonry and prestressed masonry , **Part 3 :** Materials and components ,design and workmanship, By using **BS5628 part 1** and **ETABS** program analysis and design two models of residential buildings are **A (GR +3)** and **B (GR + 4)** , the structural system consists of solid slab, beam ,walls and strip foundations of unreinforced concrete ,on the other hand; all these models are different in dimension of floors and structural elements and depended in design on characteristic compressive strength of Masonry fk

Keywords : unreinforced masonry , mortar , structural units , brick , compressive strength of masonry units (fk) .

INTRODUCTION

Despite the use of masonry for construction during many centuries , design techniques based on well-established scientific principles have only been developed during the latter part of the 20th century , the mechanization and development of brickmaking occurred in the mid -19th century , Structural masonry was traditionally very widely used in civil and structural works including tunnels bridges, retaining walls and sewerage. However , the introduction of steel and concrete with their superior strength and cost characteristics led to a sharp decline in the use of masonry for these applications .So that ,the most important reason for this is the lack of a systematic design no it , it was necessary to draw attention to this system of building in scientific means and systematic design method in light of the development of technology, and this is represented in the British specifications and CSI program ETABS .

MATERIALS

Structural masonry basically consist of brick or block bonded together using mortar .

BRICK :in civil engineering projects which Require high strength characteristics , high Density **engineering bricks** are frequently used ,whilst in general construction ,**Common brick (commons)** are used where appearance is a prime consideration, **Facing bricks** are used combining attractive appearance colour and good resistance to Exposure. bricks which are non-standard size and/or shape are increasingly being used by architects and are known as **Specials** .

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Structural Units

There are seven types of structural unit referred to in BS 5628 (Clause 7 and Section 2 Clause 5 of BS 5628: Part 3), the specification for each of these unit types is given in the appropriate British Standard as indicated .

The selection of a particular type of unit for any given structure is dependent on a number of criteria ,e.g. strength, durability, adhesion ,fire resistance,thermal properties , acoustic properties and aesthetic ,the structural units may be solid ,solid with frogs , perforated , hollow or cellular as indicated in Figure (1).

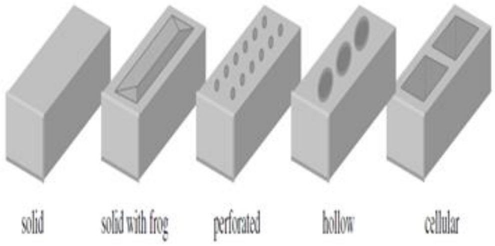

Figure (1) Types of structural unit

The sizes of bricks are normally referred to in terms of work sizes and co-ordinating sizes, as shown in Figure (2).When using clay or calcium bricks the standard work sizes for individual units are 215 mm length 102.5 mm width 65 mm height ,200*100*50 that is the clay brick use it on design .

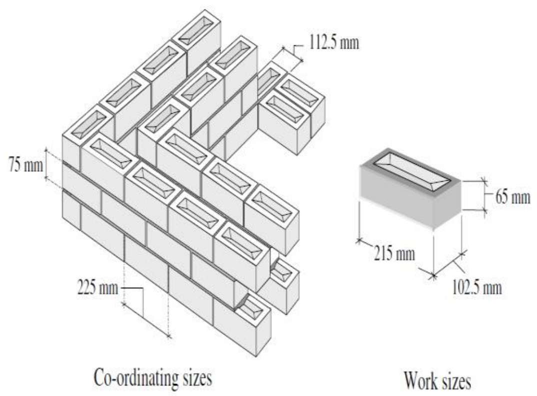

Figure (2) work and co-ordinating sizes

Mortar

Mortar is the medium which binds together the individual structural units to create a continuous structural form , e.g. brickwork , stonework, etc. Mortar serves a number of functions in masonry construction , i.e. to:

- bind together the individual units .
- distribute the pressures evenly throughout the individual units .
- infill the joints between the units and hence increase the resistance to moisture Penetration .
- maintain the sound and thermal characteristics of a wall .

The requirements for mortars in relation to strength , resistance to frost attack during construction , and improvement in bond and consequent resistance to rain penetration, are given in table1 of *BS 5628:Part 1*.

	Mortar designation	Type of mortar (proportion by volume)			Mean compressive strength at 28 days	
		Cement : lime : sand	Masonry cement : sand	Cement : sand with plasticizer	Preliminary (laboratory) tests	Site tests
					N/mm^2	N/mm^2
↑ Increasing strength; Increasing ability to accommodate movement, e.g. due to settlement, temperature and moisture changes ↓	(i)	1 : 0 to ¼ : 3	—	—	16.0	11.0
	(ii)	1 : ½ : 4 to 4½	1 : 2½ to 3½	1 : 3 to 4	6.5	4.5
	(iii)	1 : 1 : 5 to 6	1 : 4 to 5	1 : 5 to 6	3.6	2.5
	(iv)	1 : 2 : 8 to 9	1 : 5½ to6½	1 : 7 to 8	1.5	1.0
Direction of change in properties is shown by the arrows		Increasing resistance to frost attack during construction → ; Improvement in bond and consequent resistance to rain penetration ←				

Table (1) Requirements for Mortar

Types of mortar :

Four mortar designation types, **(i) , (ii) ,(iii)** and **(iv)** are specified in terms of their cement , lime , sand and plasticizer content and appropriate 28 day strengths are given,the mortar type is subseq -uently used in design calculations to determine characteristic masonry strengths (fk), are given in Table (2) of BS5628: Part 1.

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a) Constructed with standard format bricks									
Mortar designation	Compressive strength of unit (N/mm²)								
	5	10	15	20	27.5	35	50	70	100
(i)	2.5	4.4	6.0	7.4	9.2	11.4	15.0	19.2	24.0
(ii)	2.5	4.2	5.3	6.4	7.9	9.4	12.2	15.1	18.2
(iii)	2.5	4.1	5.0	5.8	7.1	8.5	10.6	13.1	15.5
(iv)	2.2	3.5	4.4	5.2	6.2	7.3	9.0	10.8	12.7

b) Constructed with blocks having a ratio of height to least horizontal dimension of 0.6								
Mortar designation	Compressive strength of unit (N/mm²)							
	2.8	3.5	5.0	7.0	10	15	20	35 or greater
(i)	1.4	1.7	2.5	3.4	4.4	6.0	7.4	11.4
(ii)	1.4	1.7	2.5	3.2	4.2	5.3	6.4	9.4
(iii)	1.4	1.7	2.5	3.2	4.1	5.0	5.8	8.5
(iv)	1.4	1.7	2.2	2.8	3.5	4.4	5.2	7.3

c) Constructed with hollow blocks having a ratio of height to least horizontal dimension of between 2.0 and 4.0								
Mortar designation	Compressive strength of unit (N/mm²)							
	2.8	3.5	5.0	7.0	10	15	20	35 or greater
(i)	2.8	3.5	5.0	5.7	6.1	6.8	7.5	11.4
(ii)	2.8	3.5	5.0	5.5	5.7	6.1	6.5	9.4
(iii)	2.8	3.5	5.0	5.4	5.5	5.7	5.9	8.5
(iv)	2.8	3.5	4.4	4.8	4.9	5.1	5.3	7.3

d) Constructed from solid concrete blocks having a ratio of height to least horizontal dimension of between 2.0 and 4.0								
Mortar designation	Compressive strength of unit (N/mm²)							
	2.8	3.5	5.0	7.0	10	15	20	35 or greater
(i)	2.8	3.5	5.0	6.8	8.8	12.0	14.8	22.8
(ii)	2.8	3.5	5.0	6.4	8.4	10.6	12.8	18.8
(iii)	2.8	3.5	5.0	6.4	8.2	10.0	11.6	17.0
(iv)	2.8	3.5	4.4	5.6	7.0	8.8	10.4	14.6

Table (2) characteristic compressive strength of Masonry *fk* N\ mm^2

For three models *fk* to foundation walls = 20 N\$mm^2$ and to walls for all floors=13.79 N\$mm^2$ with mortar designation (iii) masonry : cement 1 : sand 4 to 5.

DESCRIPTION OF ANALYSIS AND DESIGN MODELS

The main objective of the analysis process is to extract the results of the considered storeys for each floor and thus calculate the total building mass . As for the design process ,the aim is to reach the details of the reinforcing steel that is resistant to the loads placed on it , for beams . the loads exposed to these models is gravitational loads include live load = 1.5 KN\ mm^2 and dead load .

Design information's :

Density of concrete =24 KN\$mm^2$, dimeter bar = Q12mm , allowable bearing capacity = 160KN\$mm^2$, Fcu = 30N\$mm^2$, Fy = 460N\ mm^2 ,Fyv = 250 N\$mm^2$, *fk* =20N\$mm^2$ for foundation, *fk* =13.79 N\$mm^2$ for floor walls , height of storey = 3 m , height of foundations walls and parapet = 1m , thickness of solid slab = 150 mm .

Model	Thickness of masonry wall			Beam (B*H)	
	W1	W2	W3	Beam1	Beam2
A	400	300	200	500*350	300*300
B	500	400	300	400*400	300*300

Table (3) indicate to dimensions of the components of the models .

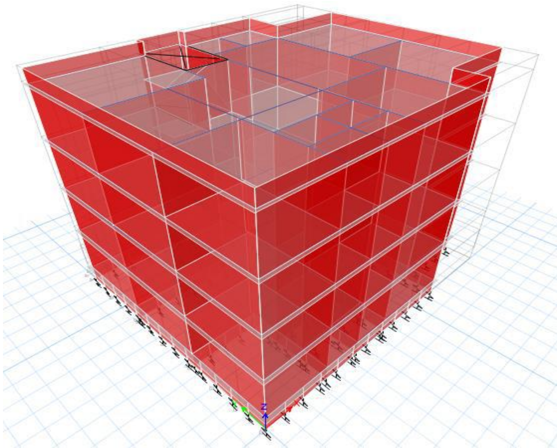

Figure (3) 3D for Model A (Gr+3)

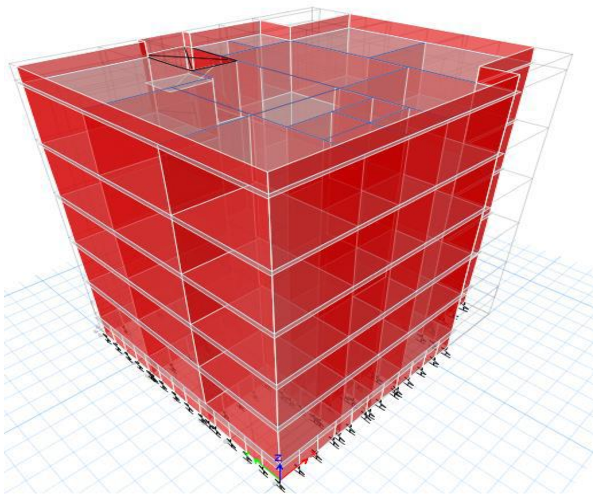

Figure (4) 3D for Model B (Gr+4**)**

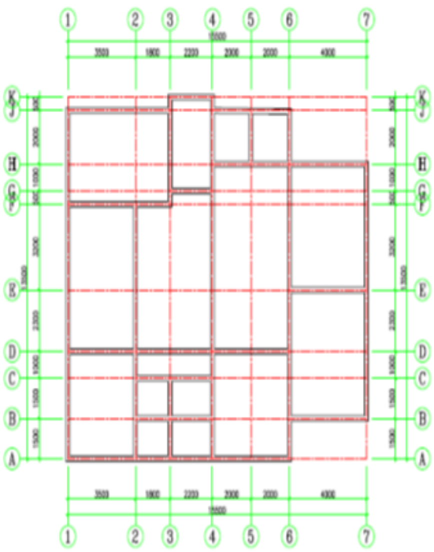

Figure (5) plan of grade beam and floor

RESULTS

Analysis result :

The result of the analysis include the results of masses that make up the floors,as shown in table (4) for model A and (5) for model B.

Storey	Mass Ux	Mass Uy
	Kg	Kg
Roof	14085.86	14085.86
Third floor	232164.23	232164.23
Second floor	336705.59	336705.59
First floor	336705.59	336705.59
Ground floor	298658.7	298658.7
Foundation	52500.87	52500.87
Total mass	$1.27*10^6$	$1.27*10^6$

Table (4) Storey Mass for Model A

Story	Mass Ux	Mass Uy
	Kg	Kg
Roof	14085.86	14085.86
Fourth floor	229618.41	229618.41
Third floor	331654.11	331654.11
Second floor	331654.11	331654.11
First floor	374625.94	374625.94
Ground floor	348271.48	348271.48
Foundation	65626.09	65626.09
Total mass	$1.7*10^6$	$1.7*10^6$

Table (5) Storey Mass for Model B

The bearing capacity of the soil was converted into a unit mass so that we can compare it with the masses of the floors formed by the analysis . Bearing Capacity of Soil = 160 KN/m^2

building Area = 15.5 * 13.5 = 209.25 m^2
Bearing capacity of soil(q) =
160 * 209.25 * 1000 = 33.48 * 10^6 kg

NOT:
From the result on table 4 and 5 not that all masses consisting the floors and the total of masses are largest than bearing capacity of soil **(q) = 33.48 * 10^6 kg** .

Design result :

The result of the design , including the details of the reinforcement of the beams ,and accordingly , the largest length was taken in the direction of X and Y in each model as shown in table (6) .

Model (A , B)	Element			
	Beam1 Q12 mm		Beam2 Q12 mm	
	Flexural mm^2	Shear A_{sv}/s mm^2/m	Flexural mm^2	Shear A_{sv}/s mm^2/m
As required For A	350	644	180	552
As required For B	350	644	299	552
Number of bars	4 bars		4 bars	

Table (6) details of the reinforcement of the beams

CONCLUSION

1.From the results of the analysis ,represented in the masses of floors that make up the buildings A , B and comparing them with the allowable bearing capacity of the soil ,it was found that the total of the masses constituting the buildings A , B dose not exceed the allowable bearing capacity of the soil will bear these on it and was able to bear these masses by a largest difference between them .

2. From the result of design beams , including beam 1 indicated to grade beam and beam 2 indicated to floor beams in both direction X and Y , we find that the number of bars = 4 bars compared to 6 bars used in the outer center .

RECOMMONDATIONS

Through the results and the study that was conducted on the systematic design of the building system of load-bearing walls , we recommend the following :

1.Direction studies , research and supporting them to focus on this system and develop it effectively and ideally , through the use of other techniques , represented in engineering programs , which facilitate the process of analysis and design in an excellent and accurate way , especially programs that depends on theory of finite elements .

2.Adding the effect of wind and earthquake loads in addition to gravity loads , or adding loads that are commensurate with the nature of building under study .

3.On the executive side, it is necessary to take the laboratory tests of bricks , on the basis of which the characteristic compressive strength is determined , because it is one of the most important components of this system .

4.To improve workability , plasticizers can be used with mortars which have a low cement : sand ratio . their use introduces air bubbles into the mixture which fill the voids in the sand and increase the volume of the binder paste. the introduction of plasticizers into a mix must be carefully controlled, since the short-term gain in improved workability can be offset in the longer term by creating an excessively porous mortar resulting in reduced durability, strength and bond.

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