SRI VIDYA COLLEGE OF ENGINEERING & TECHNOLOGY

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QUESTION BANK WITH ANSWER

DEPARTMENT: CIVIL SEMESTER: 06

SUBJECT CODE /NAME: CE 6601/DESIGN OF REINFORCED CONCRETE AND BRICK MASONDRY STRUCTURES

YEAR: III

UNIT V – BRICK MASONRY

Introduction, classifications of walls, lateral supports and stability, effective height of walls and columns, effective length of walls, design loads, load dispersion, permissible stresses, design of axially and eccentrically loaded brick walls.

PART - A (2 marks)

1. What is effective length of brick wall when the wall is continuous? (AUC May/Jun 2013)

The effective length of the wall is continuous=0.8L

2. What is the allowable compressive stress in brick masonry? (AUC May/Jun 2013)

Permissible compressive stress in masonry shall be based on the value of basic compressive stress as given in table 8 and multiplying this value by factor known as

- Stress reduction factor
- Area reduction factor
- Shape modification factor

3. How the brick masonry walls are classified? (AUC Nov/Dec 2011)

- Load bearing wall
- Non load bearing wall

4. How will you determine the permissible stress in masonry? (AUC Nov/Dec 2011) (AUC May/Jun 2012)

Permissible compressive stress in masonry shall be based on the value of basic compressive stress as given in **table 8 (IS: 1905-1987)** and multiplying this value by factor known as stress reduction factor (k_s),area reduction factor (k_a) and shape modification factor (k_p) as detailed in 5.4.1.1 to 5.4.1.3.

5. What is mean by slenderness ratio of a masonry wall? (AUC Nov/Dec 2012)

The slenderness ratio of a masonry wall is defined as the effective height divided by the effective thickness or its effective length divided by the effective thickness, whichever is less.

6. Name the various types of masonry walls used in building construction. (AUC Nov/Dec 2012) (AUC May/Jun 2012)

- Partition walls
- Party walls
- Separating walls

7. Obtain the stress reduction factor for an eccentrically loaded masonry member with slenderness ratio of 12 and eccentricity to thickness ratio of 1/12. (AUC Nov/Dec 2013)

From table 9 (IS: 1905-1987) stress reduction factor for slenderness ratio and eccentricity. The stress reduction factor for slenderness ratio is 12 and eccentricity is 1/12 is **0.81**.

8. Why is it intended to limit the slenderness of the load bearing masonry wall?
(AUC Nov/Dec 2013)

Load bearing masonry walls the slenderness ratio is the important design criteria, so to limit we limit the slenderness of the load bearing wall.

9. What is cross sectional area of Masonry unit?

Net cross sectional area of a masonry unit shall be taken as the gross cross sectional area minus the area of cellular space. Gross cross sectional area of cored units shall be determined to the outside of the coring but cross sectional area of groves shall not be deducted from the gross cross sectional area to obtain the net cross sectional area.

10. What is bond in brick masonry?

Arrangements of masonry units in successive courses to tie the masonry together both longitudinally and transversely the arrangement is usually worked out to ensure that no vertical joint of one course is exactly over the one in the next course above or below it, and there is maximum possible amount of lap.

11. How will you calculating effective length, effective height and effective thickness?

The height of a wall to be column to be considered slenderness ratio. The length of a wall to be column to be considered slenderness ratio. The thickness of a wall or column to be considered for calculating slenderness ratio.

12. What meant by lateral support?

A support which enables a masonry element to resist lateral and/or restrains lateral deflection of a masonry element at the point of support.

13. What is the slenderness ratio for walls?

For a wall, Slenderness ration shall be effective height divided by effective thickness or effective length divided by the effective thickness is less.

14. What is the slenderness ratio for walls and columns?

For column slenderness ration shall be taken to be the greater of the ratios of effective heights to the respective effective thickness in the two principal directions. Slenderness ratio for a load-bearing column shall not exceed 12.

15. What is slenderness ratio in brick masonry structures?

In brick masonry structures, for a wall slenderness ratio shall be the effective height divided by the effective thickness or effective length divided by the effective thickness whichever is less.

16. What is slenderness ratio in brick column masonry structures?

For a column slenderness ratio shall be taken to be the greater of the ratios of effective height s to the respective effective thickness in the two principal directions. Slenderness ratio of a load-bearing column shall not exceed 12.

17. What is reinforced brick work?

Reinforced brickwork is a typical type of construction in which the compressive strength of bricks is utilized to bear the compressive stress and steel bars are used to bear the tensile stresses in the slab.

18. What is the thickness adopted for reinforced brick slab?

The thickness of slab may be kept as 100mm to 200mm.

PART-B (16 MARKS)

1. Determine the allowable axial load on the column of size 30cmx60cm constructed with first class brick work in 1:6 cement mortar using modular bricks size of 200x100x200, height of pier between the footing and tough slab 5.1m strength of unit may be taken as 10Mpa. (AUC Nov/Dec 2013)

Data:

Column size=300x600mm
Height of pier=5.1m
Strength of unit=10N/mm^2
Cement mortar=1:6

Step-1

Effective height of column=1.00H **(from page no 11 table 4 (IS: 1905-1987)**
=1.0X5.1
= 5.1m

Step-2

Basic compressive stress **(from page no 16 table 8 (IS: 1905-1987)**

From table no 1 the grade of mortar was confirmed to M_2

Basic compressive stress=0.81N/mm^2

Step-3

Area reduction factor=300x600
=180000mm^2=0.18m^2 **(from page no 16)**

K_a=0.7+1.5A
=0.7+1.5(0.18)
=0.97

Step-4

Shape modification factor **(from page no 16)**
Height to width ratio=200/200=1 **(from table 10)**
Shape modification factor=1.1

Step-5

Load factor
For axial load=1
For eccentric load=1.2
K_L=1 (for axial column)

Step-6

Stress reduction factor **(from page no 16 table 9 (IS: 1905-1987)**
Slenderness ratio=effective height/least lateral dimension
=5.1/0.3=17
Stress reduction factor=0.7

Step-7

Fca=f_bx K_ax K_px K_LX K_{sf}
=0.81x0.97x1.1x1x0.7
=0.604N/mm^2

Axial load

Fca=P/A
P= FcaXA
=0.604X(300X600)
=108.72kN

2. A column of size 300x550mm constructed in first class brick in 1:6 cement mortar using modular bricks size of 200x200x100 height of pier between footing and top slab is 4.5m.the strength of the unit may be taken as 10N/mm² calculate compressive stress for applied at eccentricity of 100mm. (AUC Nov/Dec 2012)

Data:

Size=300x550mm
Height=4.5m
Strength=10 N/mm²
Cement mortar=1:6

Step-1

Effective height=1x4.5 **(from page no 11 table 4 (IS: 1905-1987)**
=4.5m

Step-2

Basic compressive stress=0.81 N/mm²

Step-3

Area reduction factor
=300x550=165000mm²=0.165m² **(from page no 16)**
K_a=0.7+1.5A
=0.7+1.5(0.165)
=0.94

Step-4

Shape modification factor **(from page no 16)**
Height to width ratio=200/200=1 **(from table 10)**
Shape modification factor=1.1

Step-5

Load factor
For axial load=1
For eccentric load=1.2
K_L=1.25 (for eccentrically loaded column)

Step-6

Stress reduction factor **(from page no 16 table 9 (IS: 1905-1987)**
Slenderness ratio=effective height/least lateral dimension
=4.5/0.3=15
Stress reduction factor=0.66

Step-7

Fca=f_bx K_ax K_px K_LX K_{sf}
=0.81x0.94x1.1x1x0.66
=0.552N/mm²

3. Design an interior cross wall of two story building to carry 100m thick R.C.C. slab with 3m ceiling height the wall is stiff and it support 2.65m wide salb.the live load on roof and floor is 1.5kN/m² and 2 kN/m² weight of floor finish and lime terrace is 0.2 kN/m² and 2 kN/m² adopt crushing strength 10Mpa mortar M_1. (AUC May/Jun 2013) (AUC Nov/Dec 2012)

Data:

No of story=2
Slab thick=100mm
Live load on floor=2 kN/m²
Weight of floor finish=1.5 kN/m²
Weight of lime terrace=2 kN/m²
Crushing strength=10Mpa.

Step-1

Basic compressive stress

fc=0.96 N/mm^2

Step-2

Load calculation

Self weight of roof slab=1x0.1x25=2.5 kN/m^2

Live load =1.5 kN/m^2

Self weight of floor slab=1x0.1x25=2.5 kN/m^2

Live load =2 kN/m^2

Weight of lime terrace =0.2 kN/m^2

Total load =4.7 kN/m^2

Wall adopt thickness of wall=100mm

Weight of wall =1x0.1x3x2x20

=12.

Total load on wall

= (6+4.7) x2.65) +12

=40.35kN/m

Step-3

Effective height Both ends fixed Effective height=0.75H

=0.75X3000

=2250mm.

Step-4

Slenderness ratio=effective height/thickness

=2250/100=22.5

From table 7 the max slenderness ratio for two story building should not be greater than 27.

Step-5

Stress reduction factor=0.53 N/mm^2

Step-6

Permissible compressive stress

Fac=$k_s x f_c$

=0.53x0.96=0.508N/mm^2

Actual compressive stress=P/A

=40.3/(1000X100)

=0.403 N/mm^2

0.4<0.508

Hence safe

4. Design exterior wall of a building to carry 100mm thick R.C. slab 3m ceiling height support condition is fixed, live load on roof is 2 kN/m^2, adopt crushing strength of brick units as 10 N/mm^2, use M_1 mortar. (AUC May/Jun 2013)

Data:

Height=3m

Live load on roof=2 kN/m^2

Strength=10 N/mm^2

100mm thick R.C. wall

M_1 mortar

Step-1

Basic compressive stress=0.96 N/mm^2

Step-2

Load calculations
Self weight=1x0.1x25=2.5 kN/m^2
Live load =2 kN/m^2
Total load =4.5 kN/m^2
Wall thickness=230mm
Self weight =1x0.1x3x2x20=12 kN/m^2
Total load=((4.5+4.5)3)+12=39 kN/m

Step-3

Effective height=0.85H=2.550m.
Slenderness ratio=2550/230=11.08<27
Hence safe

Step-4

Stress reduction factor=0.86
Permissible compressive stress=0.86x0.96=0.82 N/mm^2
ρ=P/A=39X10^3/(1000X230)=0.16<0.86

Hence safe

5. Design an exterior wall of two storied building using nominal bricks of 230x100x75mm.the wall supports R.C.C. roof slab of 100mm thick. Clear height of each floor is 3m.center to center distance between cross wall is 2.8m and continuous along one direction only, effective width of slab supported by the wall is 1.7m.live load from roof slab is 1.5 kN/m^2 and live load from slab is 2.5 kN/m^2. (AUC Nov/Dec 2011)

Data:

Type of brick=nominal brick
Size=230x100x75mm
R.C.C.slab thick=100mm
Clear height=3m
Center to center distance=2.8m
Effective width=1.7m
Live load=1.5 kN/m^2
Floor slab live load=2.5 kN/m^2

Step-1

Load calculations
Unit weight of brick=20N/m^3
Unit weight of R.C.C=25 N/m^3
Dead load of brick in ground floor=3x0.23x20=13.8 kN/m
First floor=3x1x0.23x20=13.8 kN/m
Dead load of brick in parapet=1x0.23x20=4.6 kN/m
Dead load of slab per unit area=0.1x1x25=2.5 kN/m^2
Assume dead load of floor finish=1 kN/m^2
Total dead load in each slab=3.5x2=7 kN/m^2
Load from floor slab=3.5+2.5=6 kN/m^2
Total load for brick wall=6x1.7=10.2 kN/m
Load from roof slab=3.5+1.5=5 kN/m^2
Total load for brick wall=5x1.7=8.5 kN/m

Step-2

Crushing strength of 5Mpa in cement mortar ratio 1:6,M_2 grade mortar
fb=0.44
Slenderness ratio=effective length/thichness
Length=2.8m
Effective length=0.9l=0.9x2.8=2.52m

Effective height=0.75H=0.75x3.05=2.28m

Slenderness ratio=2.52/0.23 (or)2.28/0.23=10

k_{el}=0.89

Step-3

Cross sectional area=1x0.23=0.23m^2

The area is greater than0.2m^2.

k_a=1

Step-4

Shape modification factor=height of brick/width of brick=75/100=0.75

k_s=1.0

Step-5

Stress increment factor

k_i=1

Step-6

fc=0.44x(0.89x1x1x1)

=0.3916N/mm^2

P safe=0.3916x (0.23x1)

=90.068kN.

6. Calculate the safe load carrying capacity of a brick column of size 300x400mm constructed with nominal bricks of basic compressive strength 10Mpa in CM 1:5.The column supports a roof truss in one direction. Show that the load is transferred to the column without eccentricity height of the column from top of foundation to bottom of roof truss is 2.5m. (AUC May/Jun 2012)

Data:

300x400mm size

CM 1:6

Compressive strength=10MPa

Step-1

fb=0.96N/mm^2

Step-2

To find effective height

A column is laterally supported than

xx direction=h=1xH

yy direction=h=1xH

A column is laterally unsupported

xx direction=h=2xH

yy direction=h=2xH

The column is laterally supported

hx=1x2.5=2.5m

hy=2x2.5=5m

Slenderness ratio in x=2500/300=8.3

Slenderness ratio in y=5000/400=12.5

kel=0.825

Step-3

Cross sectional area=300x400=120000mm^2=0.12m^2

The area is less 0.2m^2

k_a=0.7+1.5A=0.7+1.5X0.12=0.88

Step-4

Shape modification factor

Height of brick/width of brick=75/100=0.75

K_s=1,k_i=1

fc=0.96(0.825x0.88x1x1)
=0.726N/mm^2
P safe=0.906x400x300
=87.12kN.

7. Calculate the safe axial load for a brick column of size 300x300mm with an effective height of 3m in both directions. Masonry is made with modular bricks of basic compressive strength 7.5Mpa in cement mortar ratio 1:6.assign that the load acts without eccentricity. (AUC May/Jun 2012)

Data:

Size=300x300mm
Effective height=3m
Brick type=modular bricks(200x200x100)
Basic compressive strength=7.5Mpa

Step-1

Safe axial load
P safe=fb(kelxk_axk_sxk_i)

Mortar 1:6 fb=0.56

Step-2

Slenderness ratio=effective height/thickness or effective length/thickness
Slenderness=3000/300=10mm
Kel=0.89 from table 9 page no 16

Step-3

Cross sectional area of the column is 300x300=0.09m^2
The area is less than 0.2m^2

So k_a=0.7+1.5A=0.7+1.5X0.09=0.835

Step-4

Shape modification factor
Height of brick/width of brick=200/200=1
K_s=1.1 from table 10 page no 17

Step-5

Stress increment factor
K_i=1

Step-6

fc=0.59(0.89x0.835x1.1x1)
=0.4823N/mm^2
P safe=0.4823x(300x300)
=43.407kN.

8. Calculate the allowable compressive stress on a column 30cmx60cm constructed in first class brick work in 1:6 cement mortar. Using modular brick 200x100x100mm, the height of the pier between the footing and the top slab is 5.1m.the strength of units may be assumed as 10Mpa.if the load was applied at an eccentricity of 100mm above the major axis of bending. (AUC Nov/Dec 2013)

Data:

Size of column=30x60cm
Ratio of mortar=1:6
Grade of mortar=M_2
Size of the brick=200x100x200mm
Height of the pier=5.1m
Compressive strength of the brick=10Mpa

Step-1

Compressive stress

F=fcxkaxksxkpxkL

To find fc

For mortar M_2 and compressive stress 10Mpa

Fc=0.81Mpa

Step-2

Area reduction factor

Area of the column=0.3x0.6=0.18m^2

Slenderness ratio=hx/t=5100/300=17

=hy/t=10200/600=17

Take 17 as slenderness ratio

e=100mm

e/t=100/600=0.1667

refer table no 9 page no 16

for slenderness ratio=17 and e/t=0.1667

k_s=0.4645

Step-3

load factor k_L=1.25

k_a=0.7+(1.5A)=0.7+1.5X0.18=0.97

Step-4 Shape factor

Height to width ratio of brick=100/100=1

Strength=10Mpa

Refer table 10

K_p=1.1

Step-5 Stress reduction factor

Slenderness ratio=effective height/thickness

The column is laterally restrained in xx direction

Effective height hx=1Xh=1x5100=5100

Hy=1xh=2x5100=10200mm

Step-6

F=fcxk_axk_sx$k_{p.}k_L$

=0.81x0.97x0.4645x1.1x1.25

=0.501N/mm^2.

Result:

Allowable compressive stress=0.501N/mm^2.

9. Explain the following terms: (AUC Nov/Dec 2011)

i) Effective length of brick masonry wall.

The length of the wall to be considered for calculating slenderness ratio. The effective length of wall shall be given in table **no 5 (IS: 1907-1987)**

TABLE 5 EFFECTIVE LENGTH OF WALLS

SL No.	CONDITIONS OF SUPPORT (see FIG. 13)	EFFECTIVE LENGTH
(1)	(2)	(3)
1.	Where a wall is continuous and is supported by cross wall, and there is no opening within a distance of H/8 from the face of cross wall or Where a wall is continuous and is supported by piers/buttresses conforming to 4.2.1.2 (b)	0·8 L
2.	Where a wall is supported by a cross wall at one end and continuous with cross wall at other end or Where a wall is supported by a pier/buttress at one end and continuous with pier/buttress at other end conforming to 4.2.1.2 (b)	0·9 L
3.	Where a wall is supported at each end by cross wall or Where a wall is supported at each end by a pier/buttress conforming to 4.2.1.2 (b)	1·0 L

ii) Effective height of brick masonry wall

The height of the wall or column to be considered for calculating slenderness ratio.the effective height of the wall shall be given in **table no 4 (IS: 1907-1987)**

TABLE 4 EFFECTIVE HEIGHT OF WALLS

(Clause 4.3.1)

SL No.	CONDITION OF SUPPORT	EFFECTIVE HEIGHT
(1)	(2)	(3)
1.	Lateral as well as rotational restraint (that is, full restraint) at top and bottom. For example, when the floor/roof spans on the walls so that reaction to load of floor/roof is provided by the walls, or when an RCC floor/roof has bearing on the wall (minimum 9 cm), irrespective of the direction of the span (foundation footings of a wall give lateral as well as rotational restraint)	0·75 H
2.	Lateral as well as rotational restraint (that is, full restraint) at one end and only lateral restraint (that is, partial restraint) at the other. For example, RCC floor/roof at one end spanning or adequately bearing on the wall and timber floor/roof not spanning on wall, but adequately anchored to it, on the other end	0·85 H
3.	Lateral restraint, without rotational restraint (that is, partial restraint) on both ends. For example, timber floor/roof, not spanning on the wall but adequately anchored to it on both ends of the wall, that is, top and bottom	1·00 H
4.	Lateral restraint as well as rotational restraint (that is, full restraint) at bottom but have no restraint at the top. For example, parapet walls with RCC roof having adequate bearing on the lower wall, or a compound wall with proper foundation on the soil	1·50 H

iii) Permissible stresses for brick masonry

Permissible compressive stress in masonry shall be based on the value of basic compressive stress as given in table 8 and multiplying this value by factor known as

- Stress reduction factor
- Area reduction factor
- Shape modification factor

Stress reduction factor

This factor as given in table 9, take into consideration the slenderness ratio of the element and also the eccentricity of loading.

Area reduction factor

This factor takes into consideration smallness of the sectional area of the element is less than $0.2m^2$.

The factor k_a=0.7+1.5A

A=area of the section in m^2

Shape modification factor

This factor takes into consideration the shape of the unit that is height to width ratio and as given in table 10.this factor is applicable for units of crushing strength up to $15N/mm^2$.

iv) Lateral support to the wall

Trussed roofing may not provide lateral support unless special measures are adopted to brace and anchor the roofing.

However in case of residential and similar buildings of conventional design with trussed roofing having cross walls, it may be assumed that stability requirements are met with by the cross walls and structural analysis for stability may be dispensed with.