B44 Structural Design -I **4:0**

Preamble:

The primary concern of an engineer is design. Structural design consists conceptualization, idealization, analysis, design, construction and maintenance. Conceptualization is required to arrive at the final shape and size of the structure. Idealization involves reducing the conceived structure into primary elements. By analysis internal forces like bending moments, shear, torsion, compression and tension in each and every element is determined. Design assigns every element a particular material and size. Construction involves putting all the elements together to perform like the originally conceived structure. Maintenance is needed to keep the performance of the structure without deterioration.

In this course, designs of structural elements, like beam, walls and columns, made of specific materials like masonry and steel are dealt with. Further the elements are designed for internal forces like tension, compression, bending moment and shear.

Program out comes addressed

a. Graduates will demonstrate knowledge of mathematics, science and engineering.
b. Graduates will demonstrate an ability to identify, formulate and solve engineering problems.
c. Graduate will develop confidence for self education and ability for life long learning.
d. Graduate will be able to participate and succeed in competitive examinations.

Competencies

At the end of the course the students will be able to

1. Determine the dimensions of the walls and columns of brick masonry.
2. Determine the strength of bolted and welded connections.
3. Analysis and Design of steel tension member
4. Determine the Capacity of steel column of rolled steel and built up sections
5. Determine flexural strength of simple and compound steel beams for different conditions.

Assessment pattern

S.No	Bloom's category	Test1	Test2	Test3
1	Remember	10	10	10
2	Understand	10	10	10
3	Apply	80	80	80
4	Analyze	-	-	-
5	Evaluate	-	-	-
6	Create(Design)	-	-	-

Course level learning objectives

Remember

1. What are the factors affecting permissible stresses of brick masonry?
2. What are the different modes of failure of bolted and welded joints?
3. What are the different types of connections where joints and welds are used?
4. What are simple and compound beams?
5. What are the different modes of failure of a column?
6. What are different end connections of the columns?
7. What is laterally unsupported / supported steel column?
8. How many Indian standard beam section are available?

Understand

1. What is the effect of slenderness ratio on masonry piers and columns?
2. How efficient should a bolt or weld joint be?
3. When do local buckling of web occurs in simple and compound beam?
4. Sketch different sections used for compound beams?
5. How does slenderness determines the final design of columns?
6. What is the importance of stress reduction factor?
7. When will you apply shape modification factor?
8. How will you take permissible stresses for piers for different eccentricity ratio?
9. Compare the net area of bolted and welded connection in a tension member?
10. Under which situation the built up beams are preferable?

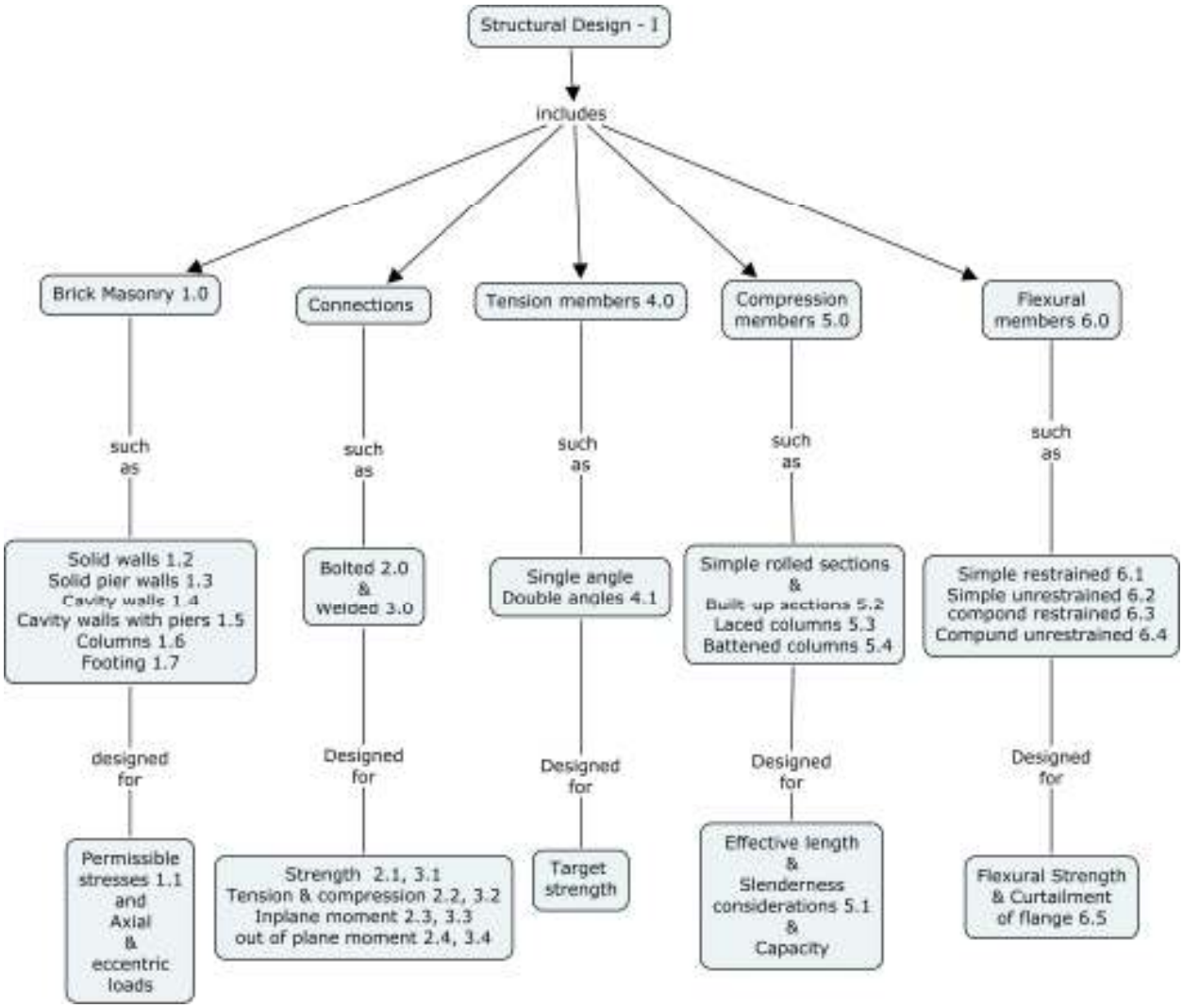
Apply

1. Calculate the load carrying capacity of wall of 200mm thick. Height of wall is 3000mm. the wall is restrained at both ends. Crushing strength of the brick is 6 N/mm^2. Cement mortar 1:5 is used.
2. A pier of size 400mm x 400mm carries an axial load of 60KN at an eccentricity of 72mm about an axis. M1 grade mortar and brick of crushing strength 7.5 N/mm^2 are used. Calculate maximum stress produced and check for safety. Effective height is 3m.
3. A 50x16 mm plate is welded to other plate by two side welds 12mm each and end fillet of 100mm length. Find the safe axial load to which this joint may be subjected if the size of the weld is 7mm?
4. An equal angle 75x75 mm @ 11.0 kg/m is subjected to a load of 180KN, whose line of action passes through the centroid of the section, which is at 22.2 mm from heel. This

angle is to be welded to a gusset plate. If the size of the weld is to be 8 mm, find the length of the side fillet welds.

5. Check the beam section ISWB 600 @ 1.451 kN-m against web crippling and web buckling if reaction at the end of the beam is 179.6 kN. The length of bearing plate at the support is 120 mm. Determine the bearing plate? The bearing plate is set in masonry wall.
6. A laterally unsupported beam having an effective span of 9 m consists of ISWB 500 @ 0.952 kN/m and cover plates of 300x20 mm connected to each flange by 20 mm dia rivets. Determine the safe udl which the beam can carry in addition to its own weight.
7. A built-up column consists of two ISMC 300 @ 35.8kg/m placed back to back at such a distance that would give the column equal resistance to bending about either axis. Determine the maximum allowable load for the column if its effective length is 5m.The channels are braced appropriately.
8. A column of effective length 7m is subjected to an axial load of 300KN and end moments of 40KN-m about the major axis such that the column bends in single curvature. The column section consists of ISHB400 @ 82.2 kg/m, check the adequacy of the section.
9. Design completely a built-up battened column to carry an axial compressive load of 2000kN.The length of the column is 4.5m.It is effectively held in position at both ends but restrained against rotation at one end only.

Concept Map



Course contents and lecture schedule

Lecture schedule		
No	**Topic**	**No of Lectures**
1	**Brick masonry**	
1.1	Permissible stresses	1
1.2	Design of solid walls - axial and eccentric loads	2
1.3	Design of solid pier walls – axial and eccentric loads	2
1.4	Design of cavity walls - axial and eccentric loads	2
1.5	Design of cavity walls with piers - axial and eccentric loads	2

1.6	Design of masonry columns - axial and eccentric loads	2
1.7	Design of masonry footings	2
2	**Bolted connection in steel Structures**	
2.1	Type of connections, Force transfer mechanism, failure mechanism	1
2.2	Design of connection – direct tension and compression	2
2.3	Design of connection - Moment in plane of the bolt	2
2.4	Design of connection - Moment perpendicular to the bolt	2
3	**Welded connection in steel structures:**	
3.1	Type of welds, accepted criteria for welded joints, strength of weld	2
3.2	Design of connection – direct tension and compression	2
3.3	Design of connection - moment in plane of the weld	2
3.4	Design of connection - moment perpendicular to the weld	2
4	**Steel tension members:**	
4.1	Behaviour of tension member, Design strength of tension member –single angle, double angle	3
5	**Steel compression members:**	
5.1	Type of Column sections, Effective length, maximum slenderness ratio	1
5.2	Design of compression member – rolled steel section – simple and built up section.	3
5.3	Design of compression member - laced columns	2
5.4	Design of compression member – battened columns	3
6	**Steel flexure members**:	
6.1	Behaviour of steel beams, Limit state of serviceability, Design of simple beams fully restrained along compression flange	2
6.2	Design of compound beams fully restrained along compression flange	2
6.3	Lateral torsional buckling of beams, Factors affecting lateral stability Design of simple beams unrestrained along compression flange	3
6.4	Design of compound beams unrestrained along compression flange	2
6.5	Curtailment of flange plates	1

Syllabus

Brick masonry: Permissible stresses, Design of solid masonry walls, solid pier walls, cavity walls with piers and columns for axial and eccentric loads. Design of masonry footings **Bolted connection in steel structures:** Type of connections, Force transfer mechanism, failure mechanism. Design of connection in direct tension, compression, moment in plane of the bolt, moment perpendicular to the bolt. **Welded connection in steel structures:** Type of welds, accepted criteria for welded joints, strength of welds. Design of connection in direct tension, compression, moment in plane of the weld, moment perpendicular to the weld. **Steel tension members:** Behaviour of tension member, Design strength of tension members with single angle, double angle. **Steel compression members:** Type of Column sections, Effective length, maximum slenderness ratio, Design of compression member with rolled steel section, simple and built up section - laced and battened columns. **Steel flexure members**: Behaviour of steel beams, Limit state of serviceability, Design of simple and compound beams with fully restrained, Lateral torsional buckling of beams, Factors affecting lateral stability, Design of simple and compound beams unrestrained along compression flange, Curtailment of flange plates.

Text Books

1. Dayaratnam. P., (1987) "Brick and Reinforced Brick Structures", Oxford IBH publishing Co .Pvt Ltd,New Delhi.
2. Teaching Resource for Structural Steel Design, Vol. 1,2,3 (2000), INSDAG- Institute for Steel Development and Growth, Kolkatta.
3. Subramanian, N., (2008), Design of Steel Structures, oxford university press, USA,.

Indian Standard Codes

4. IS: 800 – 2007, Code of Practice for general construction in steel, BIS, New Delhi
5. IS: 800 – 1984, Code of Practice for general construction in steel, BIS, New Delhi
6. SP 6 (1) – Structural steel sections
7. IS: 1905 – 1987, Code of practice for structural use of unreinforced masonry
8. IS: 816 - 1969, Code of practice for use of metal arc welding for general construction in mild steel

Course Designers

1. S. Joseph Sugunaseelan **sjsciv@tce.edu**
2. V. Muruganandam **vmciv@tce.edu**
3. S. Arulmary **samciv@tce.edu**