P118-112 (ESE)

DEC. 2018 / ENDSEM (ESE) **F. Y. M. TECH. (CIVIL-Structures) (SEMESTER - I)**

COURSE NAME: Critical Review of Design of Concrete Structures **COURSE CODE:** CVPB11182

Time : [3 Hour] **(PATTERN 2018)** [Max. Marks : 50]

Unit-C.O.-Question Mapping

Q. No	UNIT	Total Marks	Degree of Difficulty	CO- Que. Mapping	Cognitive Level
1a	1	3	Medium	1	Adv. Knowledge, Recall, Analysis, Critical Thinking, Describe, Conclude, Recommend, Reporting.
1b	1	3	Difficult	1, 3 & 4	Adv. Knowledge, Rationalize, Critical Thinking, Present, Understanding, Describe
2a	2	3	Medium	1 & 2	Adv. Knowledge, Recall, Analysis, Critical Thinking, Describe, Conclude, Recommend, Reporting.
2b	2	3	Medium	2	Core Knowledge, Recall, Rationalize, Understanding, Justify, Compose, Describe
3a	3	2	Medium	1 & 3	Adv. Knowledge, Recall, Rationalize, Understanding, Justify, Compose, Describe
3b	3	2	Medium	3	Adv. Knowledge, Recall, Rationalize, Understanding, Justify, Compose, Describe
4	4	14	Medium	1, 3 & 4	Adv. Knowledge, Rationalize, Critical Thinking, Recollect, Sketch, Understanding, Describe, Apply, Analyze, Compose, Conclude
5	4	14	Medium	1 & 4	Observe, Identify, Critical Thinking, Describe, Review, Adv. Knowledge, Comprehend, Apply, Rationalize, Interpretation, Decide, Conclude, Reporting, Deduce, Judgment, Visualize.
6	5	14	Medium	1 & 5	Adv. Knowledge, Rationalize, Critical Thinking, Recollect, Sketch, Understanding, Appraise, Describe, Apply, Analyze, Compose, Illustrate, Conclude
7	5	14	Difficult	1 & 5	Observe, Identify, Critical Thinking, Describe, Review, Adv. Knowledge, Comprehend, Apply, Rationalize, Interpretation, Decide, Conclude, Reporting, Deduce, Judgment, Visualize.
8	6	14	Difficult	1 & 6	Observe, Identify, Critical Thinking, Describe, Review, Adv. Knowledge, Comprehend, Apply, Rationalize, Interpretation, Discuss, Conclude, Reporting, Deduce, Illustrate, Visualize.
9	6	14	Difficult	1, 3 & 6	Adv. Knowledge, Explain, Rationalize, Critical Thinking, Recollect, Sketch, Understanding, Appraise, Describe, Analyze, Compose, Conclude

C.O.s: Students will be able to … …

1) Demonstrate the performance requirements for the design of the RC elements considered by IS code
2) Appraise the flexure design using working stress method
3) Establish and demonstrate the various performance states on M-phi curve (serviceability, cracking, yielding, ultimate)
4) Demonstrate the limit state of serviceability design for flexure member
5) Demonstrate the limit state method of shear design for flexure member
6) Establish the P-M curve for the column under uniaxial load case

Course Objectives:

- To appraise the basics of reinforced concrete design
- To comprehend and apply the knowledge of composite behavior
- To solve design problem

Unit I : Preliminary considerations
Stress strain curve (characteristics and design) for concrete, steel and composite (RCC elements). Performance requirements – compressive strength, tensile strength, flexural strength, modulus of rupture, modulus of elasticity (initial, secant and tangent), Ductility and durability aspects. Various failure modes (axial, flexure, shear, torsion and combinations), Loads, load combinations for various limit states.
Hands On Demonstrations, Drawing Sketches, Interactions with Experts on specific course content

Unit II : Working Stress Method
Introduction and assumptions, Transformed section philosophy, Plot the working stresses in steel and concrete and marked WSM limits specified by IS 456, Design procedure for flexure (singly and doubly)
Hands On Discussion based on technical video/documentaries for understanding the concept of modular ratio, illustrative examples

Unit III : Limit State Method - Flexure
Introduction –assumptions and Philosophy, Performance limit states, Flexure section analysis, M-phi curve
Demark the various performance states on M-phi curve (serviceability, cracking, yielding, ultimate)

Unit IV : Limit State Method – Serviceability
Crack width and depth analysis for flexure (singly reinforced section), Short term and long term deflection calculations | Hands On Illustrative examples using IS 456.

Unit V : Limit State Method - Shear
Shear stresses in beams, modes of cracking in shear, Shear transfer mechanisms in RC beams,
Shear failure modes: effect of a/d ratio, Critical sections for shear, Review of examples
Hands On Illustrative examples using IS 456

Unit VI : Limit State Method – Column
Introduction and assumptions, Section analysis- under compression and uni-axial bending, Distribution of strains at ultimate limit states, Design strength – axial load and moment interaction (P-M curve)
Hands On Illustrative examples using IS 456.

Bloom's → LOTS/HOTS Taxonomy Considered:
Knowledge, Adv. Knowledge, Analysis, Synthesis, Comprehension, Applying, Critical Thinking, Observation, Interpretation, Appraise, Understanding, Describe, Judge, Evaluate, Examine, Core knowledge, Compare, Recalling, Critique, Rationalize, Relate, Decide, Review, Summarize, Illustrate, Sketch, Solve, Deduce, Interpret, Recommend, Measure, Assess, Rate, Compose, Inspect, Visualize, Imagine, Present

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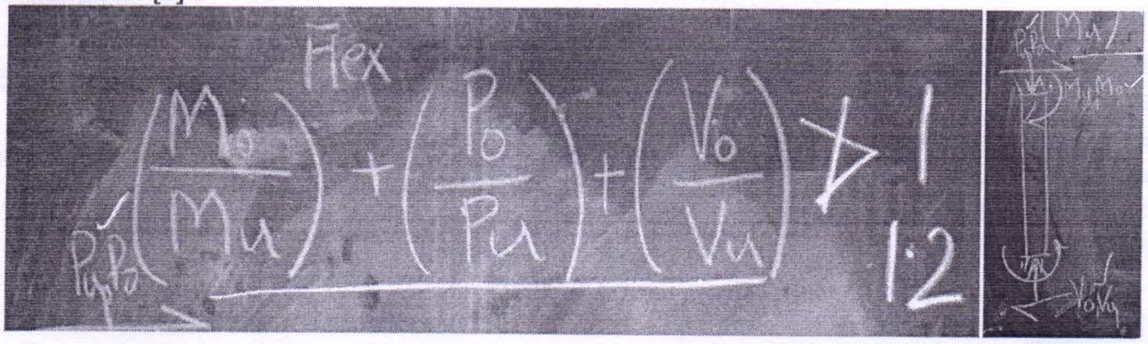
DEC. 2018 / ENDSEM (ESE) **F. Y. M. TECH. (CIVIL-Structures) (SEMESTER - I)**
COURSE NAME: Critical Review of Design of Concrete Structures **COURSE CODE:** CVPB11182
Time : [3 Hour] **(PATTERN 2018)** [Max. Marks : 50]

MARKING GUIDANCE & SOLUTIONS

Ans.1a) [3 marks]
Explain how combinations of different failure modes are considered in design of RC elements – Various modes of failures [1], Combination [2]



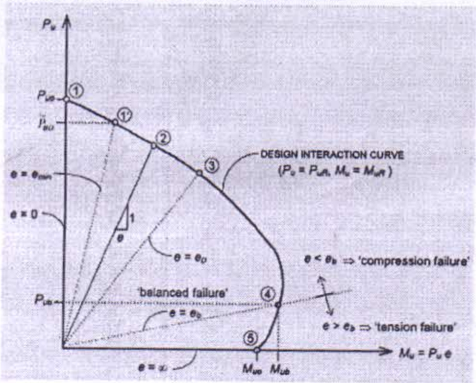
Ans. 1b) [3 marks]
Discuss the performance requirements in RC members related to – i) Ductility, & ii) Durability
Definition and performance requirements, importance of each [1.5]

Ans. 2a) [3 marks]
Explain in brief – i) Singly, & ii) Doubly – RC beam – Description and Sketch of each [1.5 ea.]

Ans. 2b) [3 marks]
Inspect the paragraph below and report your thoughts in bulleted description on the following points; Key-words & Key Observations [1], Thoughts & Discussions [1], and Conclusions [1].

Ans. 3a) [2 marks]
State the three principles governing RC structural design – Equilibrium, Compatibility & Material laws [3]

Ans. 3b) [2 marks]
List out the various performance states in M-Phi curve for a RC beam -



Ans. 4) [14 marks]
Explain *M-Phi Curve* in detail, & with figures. State the importance and use of M-Phi Curve.

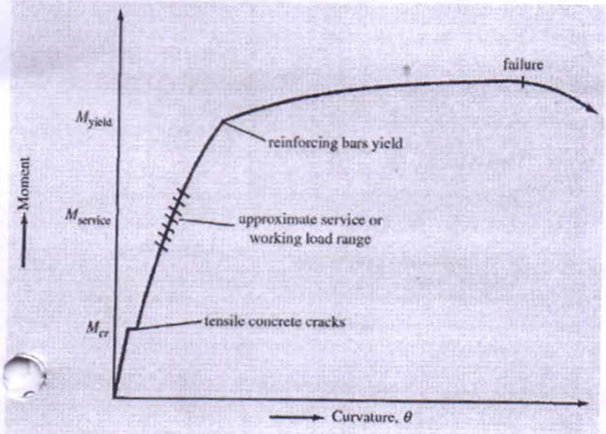


FIGURE 2.4 Moment–curvature diagram for reinforced concrete beam with tensile reinforcing only.

→ ∴ M–φ curve represents fundamental characteristic of a flexural member, from which deformations, i.e., deflections and rotations of member are calculated

M–φ relationship

→ basic tool in non-linear analysis of structure
→ predict behavior of r/f concrete member under flexure
→ Nature of variation of ultimate moment of resistance of x^n with increasing curvature
→ cross-sectional behavior of member can be predi
→ strength, stiffness & ductility of c/s can be determined

Applications

→ M–φ can be used to compute.
* Deflection.
* Strain
* Rotation
* crack-width
* Stiffness
* Ductility
* Yield point
* Failure point.

Theoretical M-φ deln.

Assumptions
→ plane x^ns remain plane before & after bending → Bernoulli's hypothesis.
→ σ-ε curves for concrete & steel are known.
→ strains along depth of c/s will be distributed linearly.
Curvatures can be determined by
* These assumptions
* strain compatibility
* eqm. of forces.

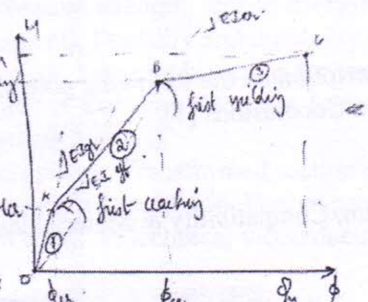
Idealised Moment curvature Relationship

{ C – for ultimate
{ B – for yelding
both points are calculated from cracked x^{n}

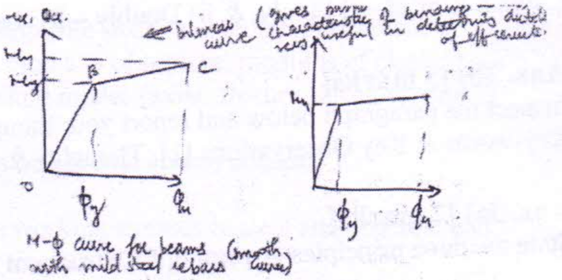
Before cracking, the member is much stiffer, & shd be calculated acc to uncracked x^{n}.

This uncracked M–Φ relationship @ low loads is extended upto A representing cracking of concrete.

→ corresponding rect. sec.



→ corresponding rect. sec.



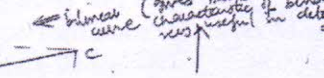
M–φ curve for beams (smooth curve) with mild steel rebars

→ Trilinear relationship

1st stage → cracking

2nd → yield of tension steel

3rd → limit of useful strain in concrete.



M – Phi

→ why is it necessary to load-defn characteristics ?

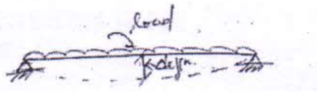
① * To avoid brittle failure
* Structure shd be capable of undergoing large defn @ max. load-carrying capacity.
* Thus giving warning of failure & preventing Total collapse.

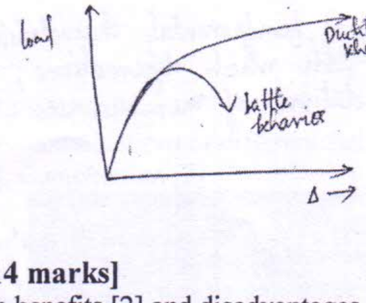
② * dls of BM, SF, AL depends on ductility of members @ critical x^{ns}.

→ As ultimate load is approached, some x^{ns} may reach their ultimate resisting moments before others, but if plastic Rotation can occur there, additional load can be carried.
↳ so ultimate load is reached when sufficient plastic hinges, a collapse mechanism is developed.

③ → In areas sub. to earthquakes, a very imp. design consn is ductility of structures when sub. to seismic-type loading.

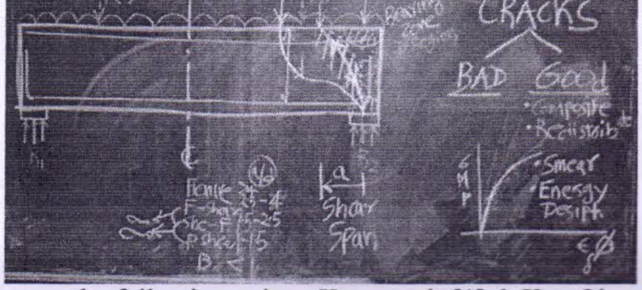
→ structures incapable of behaving in a ductile fashion must be designed for much higher seismic forces if collapse is to be avoided





→ so load-deformation characteristics of flexural members are mainly dependent on Moment – φ characteristics of x^{ns}, ∵ most of deformations of members arise from strains associated with flexure.

Ans. 5) [14 marks]
Discuss the benefits [2] and disadvantages [2] of cracks in RC members. Inspect the figure below and report your



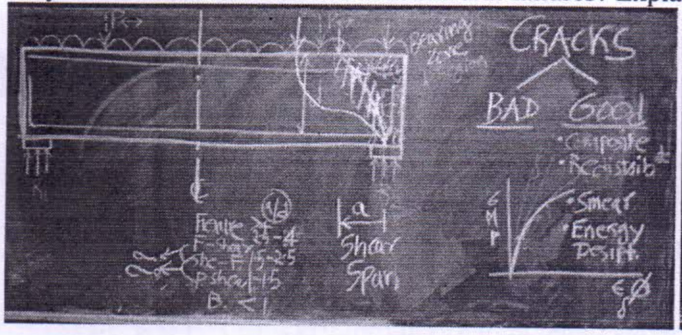
observations in bulleted description on the following points; Key-words [1] & Key Observations [3], Discussions [4], and Conclusions [2]

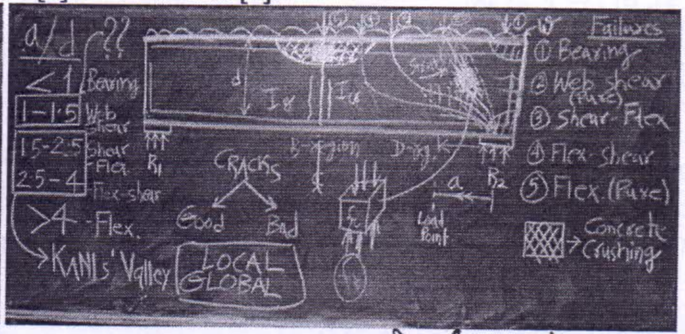
Ans. 6) [14 marks]

What is shear stress? Define and explain [3] Sketches [2]

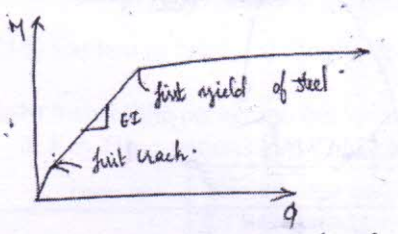
How one can enhance the shear capacity of RC element? - Size of member | Strength of materials | Transverse steel size & spacing – Explain with rational discussions [5]

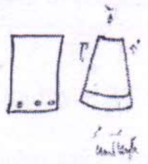
Why shear failures are critical than flexural failures? Explain [3] with sketches [1].



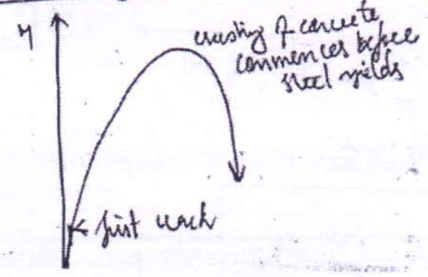


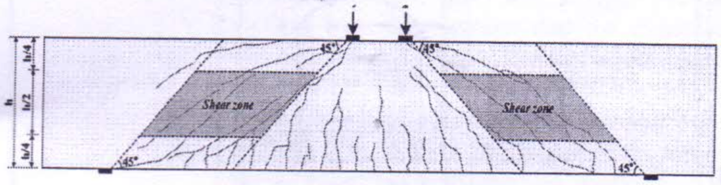
Ductile failure (Failing in Tension) under 1/6.



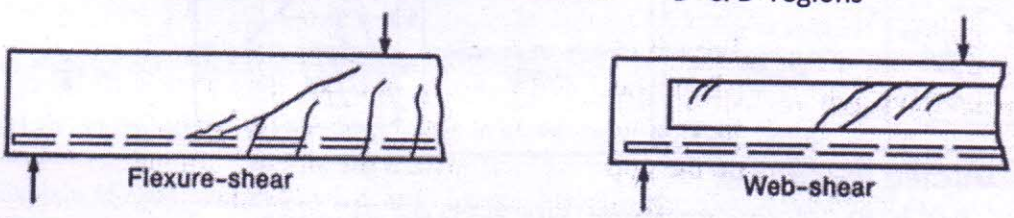


Brittle failure (failing in comp^n) (over 1/6)

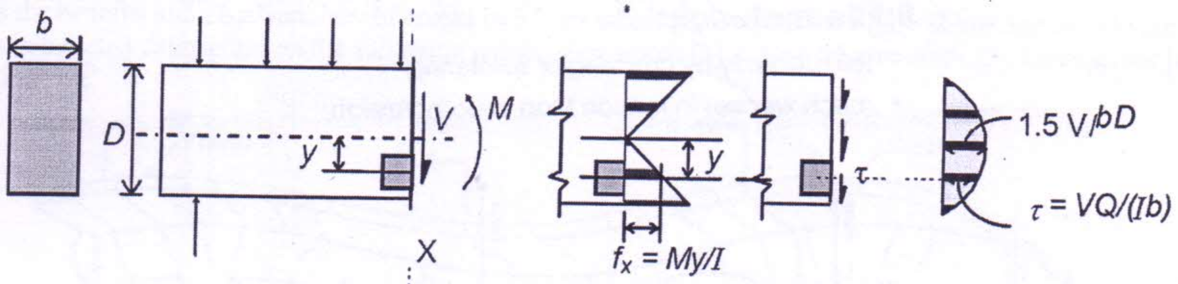


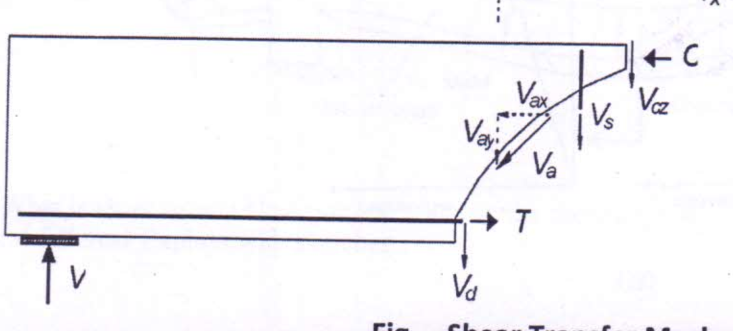


D- & B- regions



c) Shear.





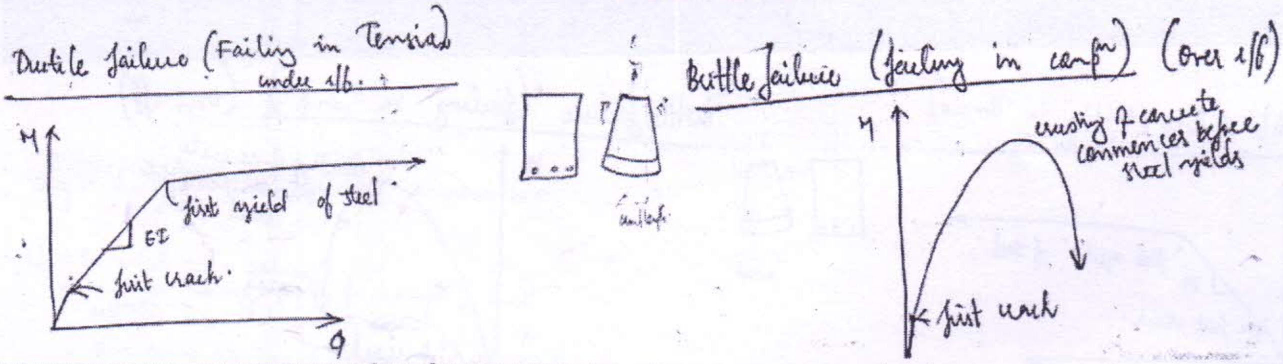
$$V = V_{cz} + V_{ay} + V_d + V_s$$

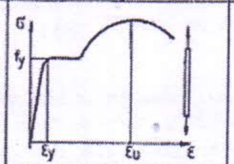
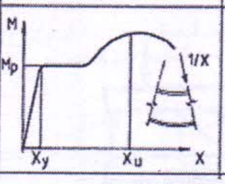
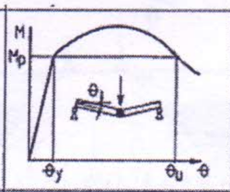
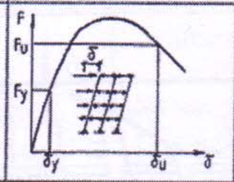
Fig. – Shear Transfer Mechanism in RC Beam

Ans. 7) [14 marks]
Inspect the figure below and report your observations in bulleted description on the following points;
Key-words [1] & Key Observations [4], Discussions [7], and Conclusions [2].

Ans. 8) [14 marks]
Observe the figures below and report your observations in bulleted description on the following points;
Key-words [1] & Key Observations [4], Discussions [7], and Conclusions [2].

Ans. 9) [14 marks]
Explain with sketches the various types of "Ductility" in RC elements such as beams and columns. Present your answer in bulleted description including, but not limited to the following points; Definition [2], Types [3], Importance [1], Discussions [4], Sketches [2], and Conclusions [2].



Ductility types	Schematic representation	Definition
Material (axial) ductility		$\mu_\varepsilon = \frac{\varepsilon_u}{\varepsilon_y}$
Cross-section (curvature) ductility		$\mu_\chi = \frac{\chi_u}{\chi_y}$
Member (rotation) ductility		$\mu_\theta = \frac{\theta_u}{\theta_y}$
Structure (displacement) ductility		$\mu_\delta = \frac{\delta_u}{\delta_y}$

- **Ductile materials:**
  - able to deform significantly into the inelastic range
- **Brittle materials:**
  - fail suddenly by cracking or splintering
  - much weaker in tension than in compression