REVIEW QUESTIONS :-

WHY IS THE PARTIAL SAFETY FACTOR FOR CONCRETE GREATER THAN THAT FOR REINFORCING STEEL IN THE CONSIDERATION OF ULTIMATE LIMIT STATE METHOD?
ANSWER :- THE FACTOR OF SAFETY FOR REINFORCING STEEL IS LESS THAN CONCRETE BECAUSE AS STEEL IS CASTED UNDER QUALITY CONTROL IN FACTORY WITH WELL MAINTAINED MOULDS , CASTING PROCESS , TEMPERATURE CONTROL ETC , THE % OF VOIDS IN STEEL IS VERY VERY LESS IN COMPARITION TO CONCRETE. AS THE CONCRETE HAS MORE , VOIDS THERE ARE MORE CHANCES OF DEVELOMENT OF CRACKS , VOIDS ALSO REDUCES THE AREA OF CROSS SECTION OF CONCRETE. FOR THIS REASON THE PARTIAL SAFETY FACTOR FOR CONCRETE IS MORE THAN COMPARE TO STEEL.

WHY IS THE PARTIAL SAFETY FACTOR FOR CONCRETE AND REINFORCING STEEL TAKEN SAME IN SERVICEABILITY LIMIT STATE METHOD?
ANSWER :- FOR SERVICEABILITY LIMIT STATE THE PARTIAL SAFETY FACTOR FOR STEEL = 1.0 AND THAT FOR CONCRETE ALSO IS = 1.0 , BECAUSE THE INTEREST IS IN ESTIMATING THE ACTUAL DEFLECTION AND ACTUAL PROBABLE CRACK WIDTH UNDER SERVICE LOADS AND NOT "SAFE" VALUES.

WHY IS PARTIAL SAFETY FACTOR DIVIDED TO ALL STRESS LEVELS OF CHARACTERISTIC STRESS-STRAIN CURVE FOR CONCRETE AND IN CASE OF REINFORCING STEEL PARTIAL SAFETY FACTOR IS DIVIDED TO STRESS LEVELS OF CHARACTERISTIC STRESS-STRAIN CURVE FOR STRESS VARING FROM 0.8FY TO FY?
ANSWER :-THE MODULUS OF ELASTICITY FOR CONCRETE Ec = $5000\sqrt{FCK}$, WHICH VARIES FOR DIFFERENT GRADE OF CONCRETE AND SO ALL THE ORDINATES ON THE CHARACTERISTIC STRESS-STRAIN CURVE OF CONCRETE ARE DIVIDED BY THE PARTIAL SAFETY FACTOR (1.5) TO OBTAIN THE DESIGN STRESS-STRAIN CURVE FOR CONCRETE.
WKERE AS IN REINFORCING STEEL , THE MODULUS OF ELASTICITY FOR REINFORCING STEEL Es = 200000 N/MMM2 IS THE SAME FOR ALL TYPE OF STEEL. SO THE PARTIAL SAFETY FACTOR FOR REINFORCING STEEL (1.15) IS ONLY APPLIED TO NON-LINEAR PORTION OF THE CHARACTERISTIC STRESS-STRAIN CURVE FOR REINFORCING STEEL i.e STRESS LEVELS VARING FROM 0.8FY TO FY TO GET THE DESIGN STRESS-STRAIN CURVE FOR REINFORCING STEEL.

WHAT IS PROOF STRESS?
ANSWER :- WHEN A YEILD POINT IS NOT EASILY DEFINED BASED ON SHAPE OF STRESS-STRAIN CURVE AN OFFSET YEILD POINT IS ARBITRARILY DEFINED. THIS OFFSET VALUE DECIDED BY IS 456: 2000 FOR COLD DEFORMED BARS IS 0.002 STRAIN , FROM WHICH A STRAIGHT LINE PARALLEL TO ELASTIC CURVE IS DRAWN WHICH FOLLOW'S HOOKS LAW AND CUTS THE STRESS - STRAIN CURVE WHICH PRACTICALLY IS CONSIDERED AS YEILD POINT CALLED AS PROOF STRESS.

WHAT IS THE YEILD STRAIN AT 0.002 PROOF STRESS IN CASE OF COLD WORKED DEFORMED BARS?
ANSWER :- (0.87FY/Es) + 0.002 , WHERE Es = 200000 N/MM2 (MODULUS OF ELASTICITY FOR REINFORCING STEEL)

WHETHER UNDER-REINFORCED OR OVER-REINFORCED WHEN DOES THE FLEXURE MEMBER UNDER GOES FAILURE?
ANSWER :- FAILURE OF FLEXURE MEMBER OCCURS DUE TO CRUSHING OF CONCRETE WHEN THE MOST COMPRESSION FACE REACHES THE ULTIMATE STRAIN WHICH IS EQUAL TO 0.0035.

WHY IS THE STRAIN DIAGRAM IN CASE OF LIMIT STATES OF DESIGN CONSIDERED TO VARY LINEARLY?
ANSWER :- BECAUSE OF THE ASSUMPTION MADE THAT "PLANE SECTIONS NORMAL TO THE BEAM AXIS REMAINS PLANE AFTER BENDING" i.e IN AN INITIALLY STRAIGHT BEAM , STRAIN VARIES LINEARLY OVER THE DEPTH OF SECTION.

WHAT ARE SHEAR STRESS?
ANSWER :- SHEAR STRESS , FORCE TENDING TO CAUSE DEFORMATION OF MATERIAL BY SLIPPAGE ALONG A PLANE OR PLANES PARALLEL TO IMPOSED STRESSES.

NOMINAL SHEAR STRESS FOR MEMBERS WITH UNIFORM DEPTH?
ANSWER :- Tv = (SHEAR FORCE)/(B * d) , WHERE B IS THE WIDTH OF WEB AND d IS THE EFFECTIVE DEPTH OF MEMBER

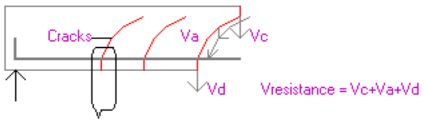
NOMINAL SHEAR STRESS FOR MEMBERS WITH VARING DEPTH?
ANSWER :-

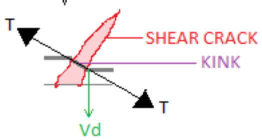
$$\text{SHEAR FORCE} = V \pm \frac{M}{d}\,\text{Tan(beta)}$$

Tv = (SHEAR FORCE)/(B * d) , WKERE B IS THE WIDTH OF WEB AND d IS THE EFFECTIVE DEPTH OF MEMBER

GENERALLY THE CRITICAL SECTION FOR SHEAR IN A REINFORCED CONCRETE BEAM IS LOCATED AT A DISTANCE "d" (effective depth of beam) AWAY FROM THE FACE OF THE SUPPORT WHY?
ANSWER :- WHEN A SUPPORT REACTION INTRODUCES TRANSVERSE COMPRESSION IN THE END REGION OF THE MEMBER , THE SHEAR STRENGTH OF THIS REGION IS ENHANCED , AND INCLINED CRACKS DO NOT DEVELOP NEAR THE FACE OF SUPPORT. IN SUCH CASES THE CODE ALLOWS TO CONSIDER SHEAR FORCE AT A SECTION LOCATED AT DISTANCE "d" FROM THE FACE OF SUPPORT TO BE CRITICAL.

HOW DOES THE DOWEL FORCE Vd COMES IN ACTION?
ANSWER :- WHEN A DIAGONAL SHEAR CRACK IS DEVELOPED THAN THE LONGITUDINAL REINFORCEMENT AT THE LEVEL OF CRACK KINKS GIVING A VERTICAL RESISTING DOWEL FORCE Vd DUE TO TENSION REINFORCEMENT.





Va is vertical component of inclined aggregate interlock force
Vc is shear force across the compression zone above crack
Vd is dowel force transmitted across the crack by tensile reinforcement

IN CASE OF BENT UP BARS USED FOR TAKING SHEAR AS PER CODE CLAUSE 40.4 :-
WHERE BENT UP BARS ARE PROVIDED , THEIR CONTRIBUTION TOWARDS SHEAR RESISTANCE SHALL NOT BE MORE THAN HALF THAT OF THE TOTAL SHEAR REINFORCEMENT.

UNDER WHAT CONDITION IS THE TRADITIONAL METHOD OF SHEAR DESIGN INAPPROPRIATE?
SHEAR STRESS IN HOMOGENEOUS RECTANGULAR BEAM = (V * Q) / (I * B) , WHERE V IS THE SHEAR FORCE , Q IS THE FIRST MOMENT OF AREA @ NEUTRAL AXIS , I IS THE SECOND MOMENT OF AREA @ NEUTRAL AXIS
IT SHOULD BE NOTED , HOWEVER , THAT ONCE A CRACK DEVELOPS IN CONCRETE , THE STRESS PATTERN CHANGES AND ABOVE FORMULA ARE NO LONGER VALID.

WHAT IS PRIMARY TORSION?
ANSWER :- THE PRIMARY TORSION IS REQUIRED FOR BASIC STATIC EQUILIBRIUM OF MOST OF THE STATICALLY DETERMINATE STRUCTURE. ACCORDINGLY , THIS TORSIONAL MOMENT MUST BE CONSIDERED IN THE DESIGN AS IT IS A MAJOR COMPONENT. (e.g WHETHER SHADE , CANTILEVER CYCLE STAND)
WHAT IS SECONDARY TORSION?
TORSION THAT CAN BE NEGLECTED IN DESIGN , PROVIDED TORSIONAL STIFFNESS IS NEGLECTED IN THE CALCULATION OF INTERNAL FORCES.

REVIEW QUESTIONS :- 2

HOW IS THE ASSUMPTION THAT PLANE SECTION REMAINS PLANE EVEN AFTER BENDING RELATED TO BOND IN REINFORCED CONCRETE?

ANSWER :- BOND IN REINFORCED CONCRETE REFERS TO THE ADHESION BETWEEN THE REINFORCEMENT AND THE SURROUNDING CONCRETE. IT IS DUE TO THIS BOND ONLY THE AXIAL FORCE IN REINFORCEMENT IS TRANSFERED TO THE SURROUNDING CONCRETE. IF THE BOND IS INADEQUATE THAN SLIPPING OF REINFORCEMENT WILL OCCUR. HENCE , THE FUNDAMENTAL ASSUMPTION OF THE THEORY OF FIEXURE , PLANE SECTION REMAINS PLANE EVEN AFTER BENDING BECOMES VALID IN REINFORCED CONCRETE ONLY IF BOND'S ARE FULLY EFFECTIVE.

WHICH ARE THE TWO TYPES OF BOND?

ANSWER :- 1) FLEXURAL BOND - IS THAT WHICH ARISES IN FLEXURAL MEMBERS ON ACCCOUNT OF VARIATION IN BENDING ALONG THE SPAN WHICH CAUSES A VARIATION IN AXIAL TENSION ALONG THE LENGTH OF A REINFORCING BAR. TO OBTAIN ADEQUATE FLEXURAL BOND PROPER PERIMETER OF BARS (CONTACT SURFACE AREA) HAS TO BE PROVIDED. IN CASE MILD STEEL CHECK FOR FLEXURAL BOND STRESS IS MUST.

2) ANCHORAGE BOND - IS THAT WHICH ARISES OVER THE LENGTH OF ANCHORAGE PROVIDED FOR A BAR OR NEAR THE END OR CUT-OFF POINT OF A REINFORCING BAR , THIS BOND RESISTS THE PULLING OUT OF BAR IN TENSION OR PUSHING IN OF THE BAR IF IN COMPRESSION. THIS BONDS ARE ALSO CALLED AS DEVELOPMENT BONDS.

WHAT IS DEVELOPMENT LENGTH?

ANSWER :- DEVELOPMENT LENGTH IS THE LENGTH OF BAR REQUIRED TO TRANSFER THE STRESS FROM BAR TO THE SURROUNDING CONCRETE. ACCORDING TO CODE "THE CALCULATED TENSION OR COMPRESSION IN ANY BAR AT ANY SECTION SHALL BE DEVELOPED ON EACH SIDE OF THE SECTION BY AN APPROPRIATE DEVELOPMENT LENGTH OR END ANCHORAGE OR BY COMBINATION THEREOF"

WHAT IS THE MOST EFFECTIVE WAY OF REDUCING THE DEVELOPMENT LENGTH REQUIREMENT OF BARS IN TENSION?

ANSWER :- USE OF SMALL DIAMETER BARS CAN REDUCE THE DEVELOPMENT LENGTH.

WHAT ARE THE TYPE OF DEFLECTIONS?

ANSWER :- 1) SHORT TERM DEFLECTION - ARE DUE TO APPLIED SERVICE LOADS , ARE GENERALLY BASED ON THE ASSUMPTION OF LINEAR ELASTIC BEHAVIOUR , AND FOR THIS PURPOSE , REINFORCED CONCRETE IS TREATED AS A HOMOGENEOUS MATERIAL.

2) LONG TERM DEFLECTION - ARE THE DEFLECTION OF A REINFORCED CONCRETE FLEXURAL MEMBER WHICH INCREASES WITH TIME MAINLY DUE TO :-

A) DIFFERENTIAL SHRINKAGE OR TEMPERATURE VARIATION

B) CREEP UNDER SUSTAINED LOADING

WHAT ARE THE MAJOR FACTORS WHICH INFLUENCE CRACK-WIDTHS IN FLEXURAL MEMBER?

ANSWER :- THE FOLLOWING ARE THE FACTORS INFLUENCING CRACK WIDTHS OF FLEXURAL MEMBERS

1) THE MEAN TENSILE STRAIN IN NEIGHBOURING REINFORCEMENT

2) THE DISTANCE FROM CRACK TO THE NEAREST LONGITUDINAL BAR WHICH RUNS PERPENDICULAR TO CRACK

3) DISTANCE OF NEUTRAL AXIS

CODE DOES NOT CALL FOR EXPLICIT CHECKS ON THE SERVICEABILITY LIMIT STATES OF DEFLECTION PROVIDED CERTAIN REQUIREMENTS ARE COMPILED WITH IN THE DESIGN. WHAT ARE THE REQUIREMENTS?

ANSWER :- IF THE ASPECT RATIO FOR (SPAN/EFFECTIVE DEPTH) IS SATISFIED IN DESIGN THEN CODE DOES NOT CALL FOR EXPLICIT CHECKS ON SERVICEABILITY LIMIT STATES OF DEFLECTION.

$(L/d)_{maximum} = (L/d)_{basic} + K_t + K_c$

$(L/d)_{basic}$ FOR A) 7 FOR CANTILEVER B) 20 FOR SIMPLY SUPPORTED BEAMS C) 26 FOR CONTINUOUS BEAMS

FORMAT TO GIVE INPUT DATA FOR 2D FRAME AND TRUSS