ANALYSIS AND DESIGN OF REINFORCED CONCRETE ELEMENTS-SLAB, BEAM AND COLUMNS USING COMPUTER PROGRAMS.

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INTRODUCTION:

Nowadays not only practicing engineers but especially young engineers try to analysis and design of R.C.C members using computer programs. There is no harm in using the available marketed software to design the members but caution should be taken not to approach the software blindly without verifying the validity of the results. Before using the software program, it is good practice to understand the basic fundamental principles that were taught at our bachelor degree course. Because without the basic, using the result may lead either failure or cracking of the members.

Choosing a correct software for the analysis and design member is also a good approach. Computer programs are utilized in most of the consulting offices to analysis and design RCC elements. There are many software -STAAD, ETABS, SAP2000, NISA DESIGN STUDIO, TEKLA TEDDS, TEKLA STRUCTURAL DESIGNER, TEKLA STURCTURE AND RAM ELEMENTS, ROBOT ATRUCTURAL ANALYSIS and many more available in the market. Choosing a right software program is an important as it should help the user to verify the fundamental engineering principle say the Newton's Law of statics should be satisfied. i.e $\sum V=0$, $\sum H=0$ and $\sum M=0$. Also the software shall follow our IS CODES-IS 456: 2000, IS 1893.IS13920 etc. That means the user should not only know the basic fundamental principle of civil engineering but also a thorough knowledge of IS CODES so that the design is an acceptable ,safe and economical one.

The software should help not only in analyzing and designing but also aid to get the detailing of the element following the codal provisions. The software listed above yield details but many of them are not upto the best of our requirement. Staad is a general software but gives details but not to our best satisfaction. I suggest one good approach is use the STAAD for analysis and get the results and use small programs like EXCEL and detail them manually using CAD PROGRAMS. Or use STAADRCDC program which is a secondary supporting software from BENTLY for DESIGNING AND DETAILING. After getting the details in DXF format one need to check it's clarity and other engineering priciples. The Program Etabs that is a building design software from CSI, USA is now updated and it is giving much better design and detailing.

Tekla TEDDS is a program like EXCELL but is a powerful one for basic members which is having many subdivisions for the RCC and STEEL member. It gives the

member details. Tekla structural designer and NISA DESIGN STUDIO are better one than STAAD as the output are with good detailing.

The designer should choose the right software for the right elements. Because shell elements cannot be correctly analyzed and designed the general software like STAAD to a best level.

SLAB:

In RCC structures the slab occupies about 65% of area and it is very important to pay more attention in analyzing and designing. Over reinforcement is not always advisable but the client even a good experienced engineers are afraid of using lesser dia say 8mm bars as main bars and use minimum 10 mm at 6" spacing which means over reinforcing them above the balanced section. Common and engineering approach is use a smaller diameter of bar at closer spacing will help in reducing cracks and also to get better ductility which is required for seismic forces. Even though the code IS456: 2000 clause 26.3.3 allow for the main bars a spacing of 3d or 300mm and secondary(distributors) at a spacing of 5d or 450 whichever is minimum, best practice is not to allow the main bar whatever be the diameter a spacing of 200mm and distributors at 250mm in order to get lesser cracks. Refer for the above spcing Khann's HB and German code.

It is good not to increase the thickness above the deflection criteria because the increased depth will be a dead load which is going to act continuously till the death of the member and increasing the dead weight is not a good approach for the earthquake point of view. Refer clause 24.1 of the code for basic depth that will alleviate the deflection calculations.

BEAMS:

Beams are the one which need more attention while designing. The bars that are designed should not cause congestion at the junction of beam-column as it will create practical problem of filling concrete and using needle vibrator for compaction. This need best detailing after analysis and designing. Adding little more depth will get lesser steel area but take care of the architectural point on a deeper beams. Usually the depth can be initially taken as span/15 to span/20. In beams the bars are arranged so that there is sufficient gap for concreting and compacting. Need good attention in designing for shear forces and better to use the IS 13920 code approach in detailing. i.e use 100 mm spacing for a length of 2d from the face of the support and use d/2 or 8" max at the center which is good for seismic forces to form hinges. Designing Tee beam and L beams are not available in STAAD and also doubly reinforced and deep beams design are not possible with STAAD. Use the analysis results-B.M AND S.F and design using EXCEL or small programs available in the market. In NISA DESIGN STUDIO there is a independent design is available where you can design slab, beam and columns. To mention available small programs-ARCHON, BETON EXPRESS, MIDAS

DESIGN + etc. Follow the codes to detail the beams as detailing is not taught at colleges when I was graduated. Detailing is very important since many failures took place by not issuing proper details.

COLUMNS:

This is the item require at an earlier stage while execution. After marking centre line and excavation the immediate details required are the footing details and column bars. In order to get a good idea refer the Reynold Reinforced Concrete Designers Handbook where the following simplification is given.

Equvalent direct load=coefficientX static axial load

For rigid connection

	Top	Storey to top	Lower
Internal column	1.0	1.0	1.0
Edge(side) column	4.5	2.0	1.4
Corner column	6.0	2.3	1.8

Always design columns with minim eccentricity as per code since there will be slight irregularity in alignment of columns. Remember the minimum 0.8% amd maximum 8% of sectional area for the column reinforcement. Practically 4% max. is advisable as per code for not to congest the section.

CONCLUSION:

As already mentioned it is better to get the output of the computer program checked manually with basic engineering practice and principles. It is good practice to prepare a good detailing which will facilitate the field staff to follow without ambiguity and the concrete members will serve with its full strength. Designers aim should be first SAFTY then ECONOMY and the last the beauty (Architectural).

REF:

1. **Good R.C.C. text book- Krishna raju, Menon & Pillai, Karve etc,**
2. **RCDH_by Reynold.**
3. **IS CODES.**