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Valuation of Design for RCC Balanced Beam Versus Under Reinforced Beam Using I.S. Code: 456-2000

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ABSTRACT

This technical paper highlights to use balanced section of RCC beam during casting and designing to make economical structure rather than under reinforced. The technical article includes the illustration to make the title lucid to emphasize and promote balanced section to save cost by 2 %.

Key Words: *LSM, Under Reinforced, Balanced, Valuation, Mu, Mulimit, Ast, Qu, Xumax, economical, fy, fck, b, d, wu, wd, wl, d req and d assum etc.*

INTRODUCTION

Valuation of RCC beam includes the cost of concrete of particular grade and steel. While designing the singly reinforced beam under IS-Code-456-2000 known as limit state method, the depth assumed and depth comes through bending moment, the depth assumed is taken into account by which the section remained under reinforced because depth by the bending moment deserved more [1]. The thought behind this concept is that, less reinforcement may cause less cost, as the steel is costlier by 70 times to the concrete, but seeing beam size more, the cost remains more 2].

To overcome this problem the design has been made done assuming balanced section where steel area seems more and concrete area is less [3]. Hence the over-all cost reduced so the section becomes economical. The general concept usually assessed under IS Code 456-2000 where the section usually exists for under reinforced [4]. As far as on site, steel saving concept remains there. It is assumed that lesser the steel may cause failure of structure by not abruptly because the steel is ductile material. Once the structure is failed, the overall structure is casted again, which costs more. To overcome such problem, the author has emphasized to use balance section, while designing the structure and while same is casted with intention of steel saving, the section would already become under reinforced and the objective of existing code will be automatically meet out [5].

But if at initial stage of designing of RCC structure, the section is under reinforced and on site construction, it will become more under reinforced due to actually saving intention of steel on site, hence the structure will be more susceptible to fail abruptly [6]. The loss of life and material cannot be regained. This will be big loss for the society and reputation of civil engineers will be under treated. The author has emphasized to use balanced section in place of under reinforced for economical and safety point of view [7].

PROCEDURE

While designing RCC beam, effective length, and incoming load, grade of concrete as well as steel will be given and size, steel reinforcement and its safety will be checked to stable the structure. Initially beam size will be assessed and effective length will be determined and on the basis of dead load plus incoming load factored load will be determined by multiplying 1.5 and then maximum bending moment (M) to that particular beam. Now on the basis of steel grade and concrete grade moment resistance factor (Qu) will be determined by the calculation. After this effective depth required (dreq.) will find on the basis of incoming Bending moment, Qu and beam width. Most of the cases d(required) will be less than d(assumed). While going to calculate the Ast (area of steel) the code identifies the steel as under reinforced by using formula Mu=0.87 fy.Ast.d (1-fy.Ast/b.d.fck).

Here d has taken as d(assumed). The author has taken d(required) and then taken as balance section by this cause Ast formula is as below. Ast=Mu/0.87 fy(d-0.42xumax). The structure after this is checked in bond, deflection and shear.

ILLUSTRATION

A simply supported beam design for valuation point of view under load 15KN/m as U.D.L. on span of 5.77 m with bearing 230 mm by using M-15 and Fe-415.

Solution
Say b×d=250 mm×450 mm.
Effective length l=5.77+0.45=6.22 m
Or
l=5.77+0.23=6.00 m
Here l=6.00 m taken

Load
Dead load of beam=Wd=1×0.50×0.25×25=3.125 KN/m
Live load on beam=Wl=15KN/m
w=15+3.125=18.125 KN/m
Factored load=wu=1.5×18.125=27.2 KN/m
Maximum bending moment= Mu=wu×l×l/8=27.2×6×6/8=122300000N-mm
Resisting moment factor =Qu=0.36.fck.Xumax (1-0.42Xumax/d)/d =3.45 N/sq.mm.
5-d required =(122300000/3.45×250)whole power 0.5=376 mm

As per Existing provision Considering as under Reinforced	As per Authors Balanced Section
Mu=0.87fy.Ast.d(1-fy.Ast/b.d.fck) *Ast=833 sq mm for d=450 mm*	*Mu=0.87 fy. Ast(d-0.42 Xumax)* *Ast required =1120 sq mm, for depth d=376 mm*
Using 20 mm diameter 3 number bars,	*Using 22 mm diameter 3 bars*
Ast provided=3×314=942 sq mm.	*Ast provided=1140 sq mm.*
%age steel =100×942/250×450=0.84%	*%age steel=100×1140/250×376=1.21%*
Service stress=fs=212 N/sq.mm *Kt=1.29 as modification factor.*	*Service Stress*

Deflection (l/d)maximum =20×1.29=25.80 *(l/d) provided=6000/450=13.33<25.8* *Ok*	*fs=0.58×415×1120÷1140=236 N/sq.mm* *Kt=1.21=modification factor* *(l/d)maximum =20×1.21=24.2* *(l/d)provided=6000/376=15.9=16 say<24.2 OK*
VALUATION	**VALUATION**
Concrete size=b×d=250×450=112500 sq.mm *Rate=1/sq mm* *Concrete cost=112500/-* *Steel =942 sq mm* *Rate=70/-sq.mm* *Cost=942×70=65940/-* *Total cost=112500+65940=178440/-*	*Concrete size=250×376=94000 sq mm* *Rate=1/- sq mm* *Cost=94000/-* *Steel =1140 sq mm* *Rate=70/-sq.mm* *Cost=1140×70=79800/-* *Total =94000+79800=173800/-*

Cost Ratio=under reinforced/balanced section=178440÷173800=1.02: 1
Concrete Cost ratio=112500/94000=1.2: 1
Steel cost ratio=65940/79800=0.82: 1

CONCLUSION

The study reveals that balanced section in designing of RCC beam is economical in concrete but costlier in steel with respect to under reinforced singly reinforced beam. However, cost of balanced section is economical by 2% and safer strength wise, also good looking architectural wise, than under reinforced beam. Hence, it is recommended by author of this technical paper that balanced sections must be preferred to design the singly RCC beam under limit state method of design and promoted its design rather than under reinforced. As if we will try to make balanced section and steel is saved during construction, then the beam casting will automatically under go with under reinforced. If already under reinforced design has been preferred then it will go more under reinforced and may cause abrupt collapse. Hence, through this paper the author is recommending to design balanced section of RCC Beam rather than under reinforced design for strength and economical point of view.

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