International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 4, Issue 10
October 2017

Parametric Analysis of Continuous Beams for Curtailment of Reinforcement Bars

Nikhil B. Shedbale
PG Student
Datta Meghe College of Engineering

Dr. Ganesh Kame
Professor
M.H. Saboo Siddik College of Engineering

ABSTRACT: *Construction industry accounts for more than fifty percent of world's steel production. Steel comprises of various naturally occurring substances like iron, manganese and chromium. There is fear of depletion of these resources. Therefore even the slightest change in our construction industry favoring the economical use of steel is greatly welcome. In the present study the analysis and design of continuous beams would be carried out using the procedure given in IS 456 – 2000 and SP 34 as well using STAAD-Pro v8i software. The quantity of steel will be estimated for conventional method of detailing as well as adopting rules for curtailments. The results for quantity of steel, adopting method of curtailment are compared with that obtained using conventional method. Structural Cad software was used to present the detailing of the reinforcement obtained by calculations.*

KEYWORDS: Reinforced concrete, Curtailment, quantity of steel, continuous beams, STAAD-Pro v8i, Structural Cad.

INTRODUCTION: Construction is one of the most important steel using industries accounting for more than 50% of world steel production. High quality steel is 96.5% iron with about 2% carbon added to it. It also contains 1.5% manganese from which it obtains its tensile strength. For stainless steel chromium is also added. There is a fear of scarcity of these components which are naturally occurring and its rising prices which is challenging the human societies around the globe to come up with solutions. As a civil engineer one of the methods to reduce the usage of steel in the construction industry without comprising on the quality of the structure is curtailment of the steel used in reinforced concrete beams.

Curtailment is a theoretical point where some of the reinforcement is cut off along the span of the beam where the bending moment reduces, given that the remaining reinforcement will be able to support the reduced bending moment. The steel is adjusted with respect to changes in bending moment over a section. Congestion of bars can also be avoided thus enhancing the compaction of concrete. It is basically done to economize the design of a flexural member, by curtailing the tensile bars at the section beyond which it is no longer required to resist flexure. Curtailment can be applied to simply supported beams but it is generally not economical and the real advantages occur with repetitive multi-span beams (continuous beams) and slabs. It can also be used to facilitate construction by curtailing bars to practical lengths which are easier to handle.

METHODOLOGY: In R.C.C beams, change in bending moment and shear force at various points along span is observed and hence the moment of resistance is also accordingly changed which enables the provision of curtailment of beam reinforcements. Figure 1 describes the varying bending moment along the span of the continuous beam.

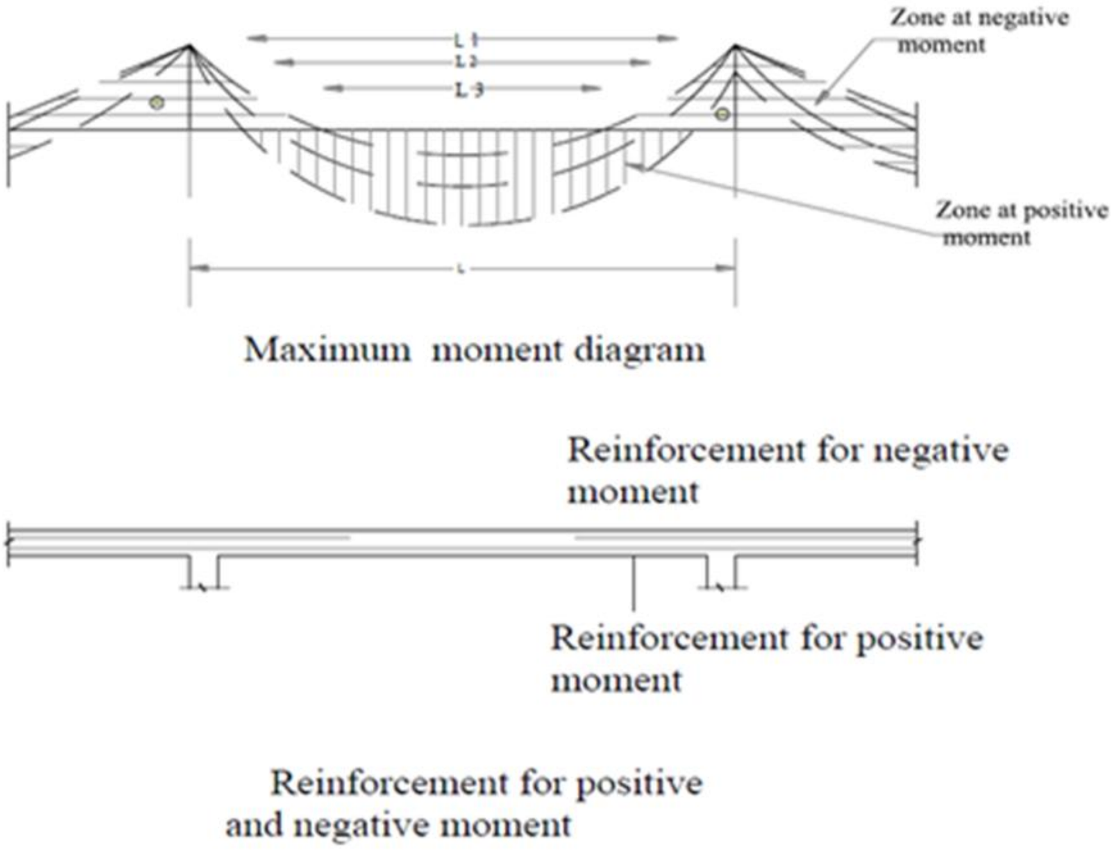

Figure 1: Typical diagram of varying bending moment along the span of the continuous beams and its respective reinforcement requirement.

Four continuous types of beams of various spans as well as cross sections are considered for analysis and design. The analysis and design are carried out manually and also using STAAD-Pro v8i software. The quantity of steel is estimated for conventional method of detailing as well as for the same beams designed adopting rules of curtailment. The results for quantity of steel adopting method of curtailment are compared with that obtained using conventional method.

For the parametric study the following data is used:

- Type of beam: Continuous Beam
- Category of beam: The four beams designed are as listed below

1. BM1- (Span: 4 meters)
2. BM2- (Span: 5 meters)
3. BM3- (Span: 6 meters)
4. BM4- (Span: 7 meters)

- Grade of steel: Fe415
- Grade of concrete: M25
- Span/depth ratio: 1/10
- Width of support: 230 mm

RESULTS:

A. Conventional Method of Designing and Detailing

Table 1: Design Values for BM 1 (span 4m)

	Near Middle Of End Span AB & CD	**At Support B & C Next To End Support**	**At Middle Of Interior Span BC**
Bending Moment (KNm)	82.97	–98.62	63.12
A_{st} (required)	746.20 mm^2	925.82 mm^2	541.75 mm^2
No. of Bars	4-16ϕ	5-16ϕ	3-16ϕ
A_{st}(provided)	804.24 mm^2	1005.30 mm^2	603.18 mm^2
P_t(%)	0.96	1.20	0.72
Strength of Shear reinforcement V_{us}	60.08 KN	-	52.46 KN
Using 2legged – 8mmϕ stirrups			
Spacing	210 mm c/c	-	250 mm c/c

Table 2: Quantity of Steel for BM 1 (curtailment method)

Span	**Diameter of Bar (mm)**	**Total Length (m)**	**Weight per running meter (kg/m)**	**Total Weight (kg)**
Main Reinforcement				
AB	16	32.46	1.58	51.29
BC	16	28.76	1.58	45.44
CD	16	32.46	1.58	51.29
Total				148.02
Shear Reinforcement				
AB	8	26.32	0.395	10.39
BC	8	22.37	0.395	8.83
CD	8	26.32	0.395	10.39
Total				29.08
Total reinforcement				177.1

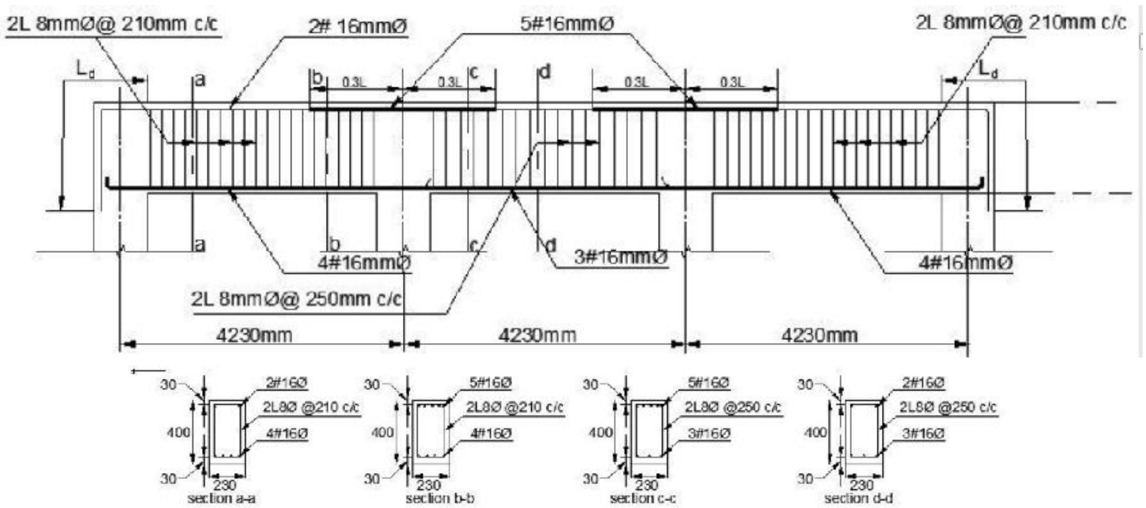

Figure 2: Reinforcement Detailing for BM 1 (Conventional Method)

International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 4, Issue 10
October 2017

B. Curtailment Method of Detailing

Table 3: Design Values for BM 1 (Curtailment method of Detailing)

Top Reinforcement				
Span AB & CD				
	At support A & D	Middle of span AB & CD	At support B & C	Along segment 0.15*l* to 0.30*l* from center of support
A_{st} required	373.10 mm^2	157.07 mm^2	925.82 mm^2	462.91 mm^2
No. of bars	5-10 mm ϕ	2-10 mm ϕ	2-10 mm ϕ 4-16 mm ϕ	2-16 mm ϕ 2-10 mm ϕ
A_{st} provided	392.69 mm^2	157.07 mm^2	961.32 mm^2	559.20 mm^2
Span BC				
	At support B	Middle of span BC	At support C	Along segment 0.15*l* to 0.30*l* from center of support
A_{st} required	925.82 mm^2	157.07 mm^2	925.82 mm^2	462.91 mm^2
No. of bars	2-10 mm ϕ 4-16 mm ϕ	2-10 mm ϕ	2-10 mm ϕ 4-16 mm ϕ	2-16 mm ϕ 2-10 mm ϕ
A_{st} provided	961.32 mm^2	157.07 mm^2	961.32 mm^2	559.20 mm^2

Bottom Reinforcement			
Span AB & CD			
	At support A & D	At middle of span	At support B & C
A_{st} required	373.10 mm^2	746.20 mm^2	248.73 mm^2
No. of bars	2-16 mm ϕ	4-16 mm ϕ	1-16 mm ϕ 1-10 mm ϕ
A_{st} provided	402.12 mm^2	804.24 mm^2	279.60 mm^2
Span BC			
	At support B	Middle of span	At support C
A_{st} required	180.58 mm^2	541.75 mm^2	180.58 mm^2
No. of bars	2-16 mm ϕ	3-16 mm ϕ	2-16 mm ϕ
A_{st} provided	402.12 mm^2	603.18 mm^2	402.12 mm^2

Table 4: Quantity of Steel for BM 1 (Curtailment method)

Span	Diameter of Bar (mm)	Total Length (m)	Weight per running meter (kg/m)	Quantity (kg)
Main Reinforcement				
AB	16	16.505	1.58	26.078
	10	12.30	0.617	7.589
BC	16	23.735	1.58	37.502
	10	8.46	0.617	5.219
CD	16	16.505	1.58	26.078
	10	12.30	0.617	7.589
Total				110.055
Shear Reinforcement				
AB	8	34.216	0.395	13.315
BC	8	27.636	0.395	10.916
CD	8	34.216	0.395	13.315
Total				37.946
Total Reinforcement		`		148.001

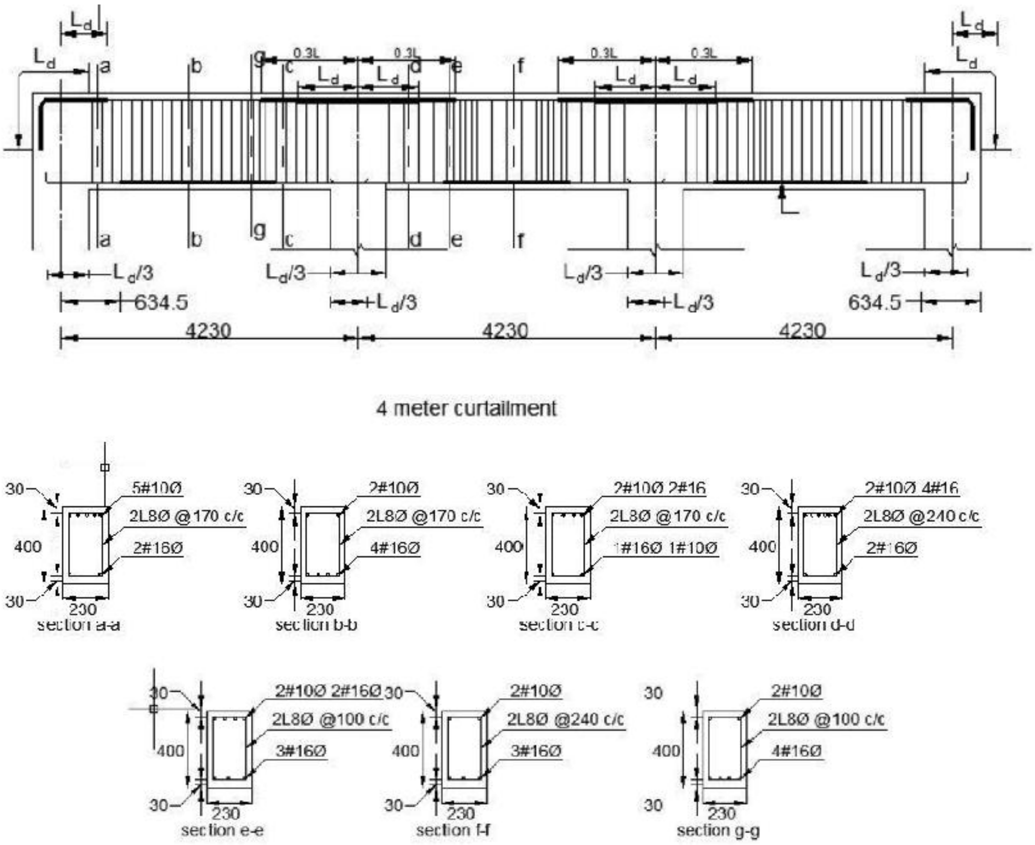

Figure 3: Reinforcement Detailing for BM 1 (Curtailment Method)

Similarly quantity of steel was obtained for BM 2, BM 3 and BM 4 for conventional as well as curtailment method and compared.

Table 5: Quantity of Steel

	Conventional Method of Designing	Curtailment Method of Detailing	Percentage Reduction of Steel (%)
BM1	177.10 kg	148.00 kg	16.43
BM2	258.26 kg	198.32 kg	23.20
BM3	349.32 kg	268.51 kg	23.13
BM4	463.83 kg	365.45 kg	21.21

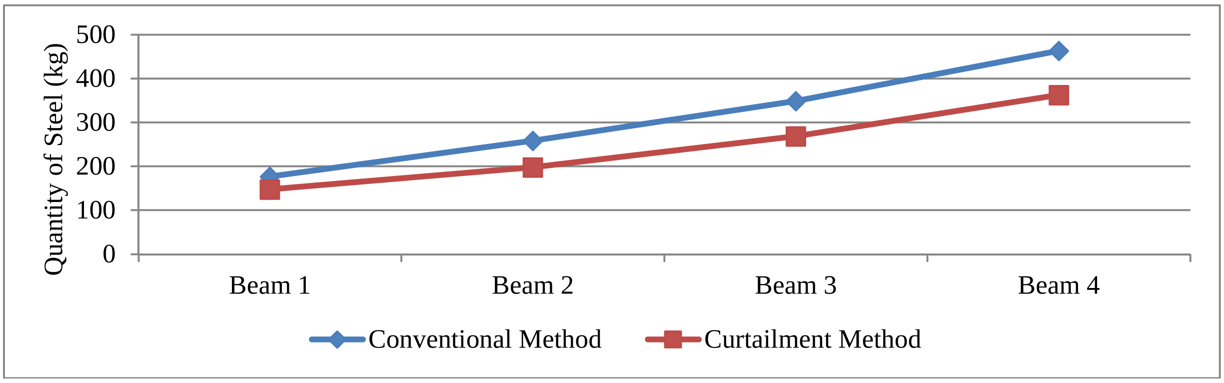

Figure 4: Comparison of quantity of steel in beams

CONCLUSION:

- In Figure 4 and Table 5, the comparison of quantity of steel is shown. As much as 15 to 25% of reduction in steel can be achieved with curtailment of reinforcement.
- For lower value of span the difference in amount of steel is less but the difference in quantity of steel is higher for higher value of span.
- It is clear from the comparison of quantity of steel that saving in quantity of steel by adopting curtailment increases with increase in span. Therefore for more economical construction the advantage of method of curtailment can be taken.
- But the saving in steel is off-set by increased design calculations, detailing and site supervision. However to get the idea of designing of curtailments in a beam it is important to understand the procedure for analysis and designing of beams.
- The study can further be carried to simply supported beams and slabs.

REFERENCES:

1. Sinha, N.C. and Roy, S.K. (2007):“Fundamentals of Reinforcement Concrete”, S. Chand & Company Ltd. Fifth Revised Edition. pp. 287-289.
2. Shah, V. L. and Karve, S.R. (Feb.2010):“Illustrated Design of Reinforced Concrete Building”, Structures Publications, pp. 105-109.
3. Punmia, B. C. and Jain, Arun Kumar and Jain, Ashok Kumar:“Limit State Design for Reinforced Concrete Design”.
4. IS 456 (2000):, “Plain and Reinforced Concrete – Code of practice”, Bureau of Indian Standards.
5. SP 34 (1987):, “Handbook on Concrete Reinforcement and Detailing”, Bureau of Indian Standards, pp. 47-51.
6. BS 8110 2 (1985):, British Standard.
7. Jain, A. K.:“Reinforced Concrete Limit State Design”, 6th Edition,
8. Sayal, I.C. and Goel, A.K.(2001):“Reinforced concrete structures”, A.H.Wheeler & Co. Ltd.,Allahabad, p.p. 27-31.
9. Nikhil B Shedbale, Prof P.V. Muley, Prof P.Barbude, "Performance Based Placement Of Visco-Elastic Dampers In An R.C.C Building", International Journal of Engineering Development and Research (IJEDR), ISSN:2321-9939, Volume.5, Issue 3, pp.450-456, July 2017
10. Nilson,H. and Darwin, David and Charles, W.:“Design of Concrete Structures”.
11. Reynolds, C.E. and Steedman, J.C.:“Reinforced Concrete Designer’s Handbook”.
12. Roberts, John. M. (Sept2004): “Reinforced Concrete Structures”.
13. Rafeeqi, S.F.A. and Lodi,S.H. and Wadawala, W.R.:“Behavior of Reinforced Concrete Beams strengthened in shear”.
14. British Standarts (BS EN 1992-1-2:2004):“Design of Concrete Structures”.
15. Lawrence Martin and John Parkiss(EN: 1992): “Concrete Design”