

6. MODIFICATION OF MR P. J. ROBBIN'S SHEAR STRENGTH FORMULA BY INCORPORATING SIZE EFFECT PARAMETER

6.1 SIZE EFFECT

Size effect is termed as Nominal shear stress at failure for member without shear reinforcement is decreased with increased in member size.

Normalized shear stress typically calculated by $W_u / \sqrt{f_{ck}} bD$

Where, W_u = Ultimate load

f_{ck} = Characteristic Compressive cube strength

b = Width of specimen

D = Depth of specimen

Nominal shear stress at failure was calculated using above formula for Plain, RCC and Fibrous beam and graph plotted with respect to beam depth.

6.2 COMPARISON OF EXPERIMENTAL TEST RESULTS OF ULTIMATE LOAD WITH VARIOUS FORMULA

Experimental results are presented and compared with theoretical results for RCC beams. Theoretical results are calculated from original formula of various researchers as P. J. ROBINS (1971), TANG AND CHENG (2006) and APPA RAO (2012).

Table 6-1 Comparison of Experimental Test Results of Ultimate Load with Various formula (1P)

Width (b) mm	Depth (D) mm	Effective length (l) mm	Experimental Results (W_u) (Ton)	P J Robbins (1971) (Ton)	Tang and Cheng (2006) (Ton)	Appa Rao (2012) (Ton)
75	150	300	10	10.36	8.15	6.52
75	225	450	13.6	15.6	12.48	10.35
75	300	600	14	19.28	15.47	13.88
75	375	750	15	23.94	19.5	17.22
75	450	900	16.5	28.02	23.13	20.43
75	525	1050	19.4	33.6	28.46	23.48
75	600	1200	25	37.1	31.34	26.35

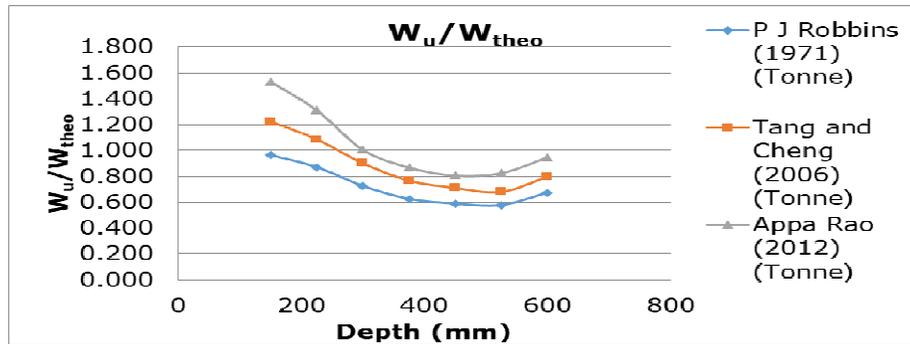
Table 6-2 Ratio of W_{exp} / W_{theo} (1P)

Width (b) mm	Depth (D) mm	Effective length (l) mm	P J Robbins (1971) (Ton)	Tang and Cheng (2006) (Ton)	Appa Rao (2012) (Ton)
75	150	300	0.965	1.227	1.534
75	225	450	0.872	1.090	1.314
75	300	600	0.726	0.905	1.009
75	375	750	0.627	0.769	0.871
75	450	900	0.589	0.713	0.808
75	525	1050	0.577	0.682	0.826
75	600	1200	0.674	0.798	0.949

Ratio of Experimental results to the Theoretical results (W_{exp} / W_{theo})(1P) versus Depth of beam is plotted for various researchers such as P. J. ROBINS (1971), APPA RAO (2012), TANG AND CHENG (2006). Table 6-2 reveals that the Ratio is ranging between 0.57 to 0.96 for P J Robins formula, Range from 0.68 to 1.22 for Tang and Cheng formula and 0.80 to 1.53 for Appa Rao Formula for various beams depth. So it necessary to incorporate the Size Effect parameter in Mr P J Robins formula.

Table 6-3 Percentage Difference of $((W_{exp} - W_{theo})/W_{exp})$ for RCC Series (1P)

Width (b) mm	Depth (D) mm	Effective length (l) mm	P J Robbins (1971) (Ton)	Tang and Cheng (2006) (Ton)	Appa Rao (2012) (Ton)
75	150	300	-3.600	18.500	34.800
75	225	450	-14.706	8.235	23.897
75	300	600	-37.714	-10.500	20.857
75	375	750	-59.600	-30.000	-14.800
75	450	900	-69.818	-40.182	-23.818
75	525	1050	-73.196	-46.701	-21.031
75	600	1200	-48.400	-25.360	-5.400
+ Percentage more than Exp. Results					
- Percentage less than Exp. Results					



Graph 6-1 W_{exp} / W_{theo} . VS. Depth

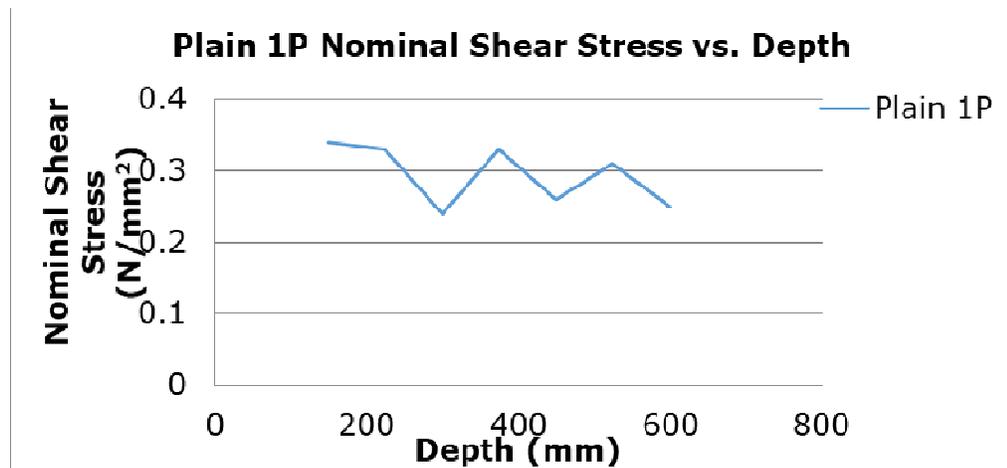
6.3 COMPARISON OF ULTIMATE LOAD BETWEEN RCC AND FIBROUS SERIES

Table 6-4 Comparison of Ultimate load between RCC and Fibrous series(1P)

Width (b) mm	Depth (D) mm	Experimental Results RCC 1P (W_u) (Ton)	Experimental Results RCC+Fibre 1P(W_u) (Ton)	Ratio= (RCC+Fiber)/ RCC	% Strength Increase
75	150	10	12	1.20	20.00
75	225	13.6	14.6	1.07	7.35
75	300	14	16.4	1.17	17.14
75	375	15	19.2	1.28	28.00
75	450	16.5	23	1.39	39.39
75	525	19.4	28.1	1.45	44.85
75	600	25	29	1.16	16.00

Table 6-5 Size Effect for Plain Series and Graphical Representation(1P)

Width (mm)	Depth (mm)	Effective span (mm)	Ultimate Load (Ton) W_u	F_{ck} (N/mm^2)	Nominal Shear Stress = $W_u / (bD\sqrt{f_{ck}})$ (N/mm^2)
75	150	300	2.5	43.11	0.34
75	225	450	3.6	43.11	0.33
75	300	600	3.1	35.85	0.24
75	375	750	6	43.11	0.33
75	450	900	5.2	35.85	0.26
75	525	1050	8	43.11	0.31
75	600	1200	6.5	35.85	0.25

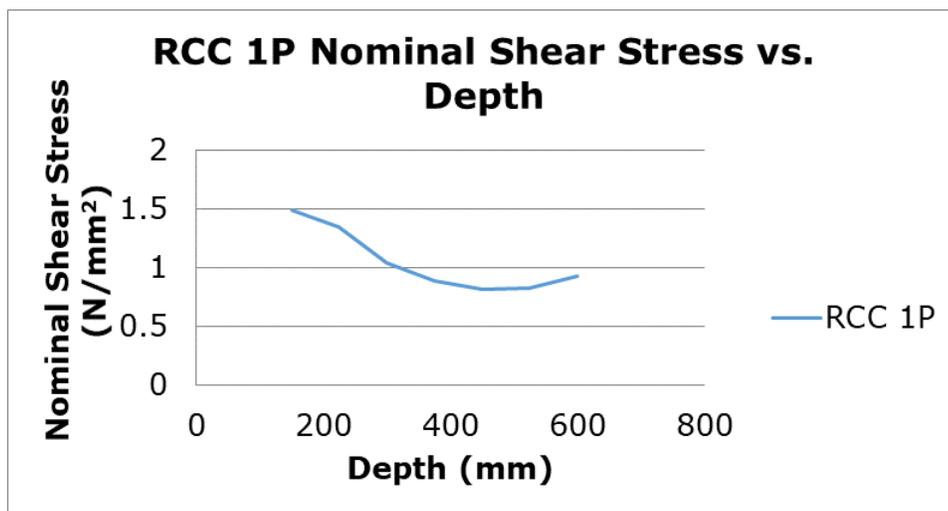


Graph 6-2 Nominal Shear Stress VS. Depth (1P)

6.3.1 RCC Series and Graphical Representation(1P)

Table 6-6 Nominal Shear Stress for RCC Series (1P)

Width (mm)	Depth (mm)	Effective span (mm)	Ultimate Load (Ton) W_u	F_{ck} (N/mm ²)	Nominal Shear Stress = $W_u / (bD\sqrt{f_{ck}})$ (N/mm ²)	Reduction of strength %
75	150	300	10	36	1.49	11.50
75	225	450	13.6	36	1.35	9.40
75	300	600	14	36	1.04	30.20
75	375	750	15	36	0.89	40.27
75	450	900	16.5	36	0.82	44.97
75	525	1050	19.4	36	0.83	44.30
75	600	1200	25	36	0.93	37.58



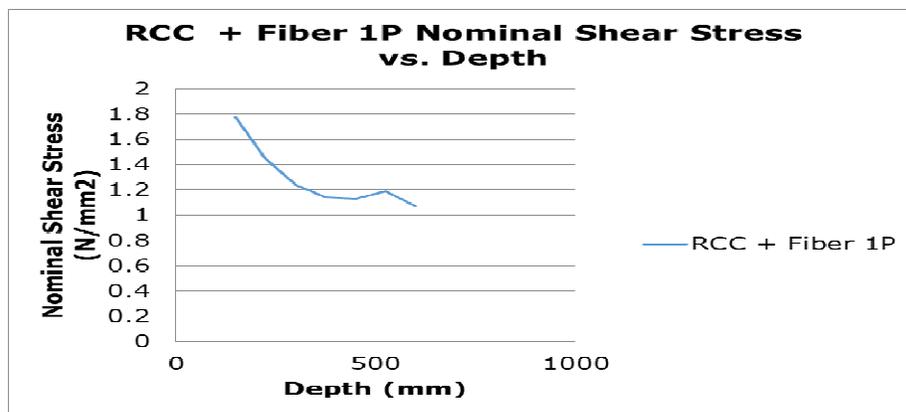
Graph

Graph 6-3 Nominal Shear Stress VS. Depth(1P)

6.3.2 Size Effect for Fibrous Series and Graphical Representation (1P)

Table 6-7 Nominal Shear Stress for Fibrous Series (1P)

Width (mm)	Depth (mm)	Effective span (mm)	Ultimate Load (Ton) W_u	F_{ck} (N/mm ²)	Nominal Shear Stress = $W_u / (bD\sqrt{f_{ck}})$ (N/mm ²)	Reduction of strength %
75	150	300	12	36	1.78	
75	225	450	14.6	36	1.45	18.54
75	300	600	16.8	36.74	1.24	30.34
75	375	750	19.2	36	1.14	35.96
75	450	900	23	36.74	1.13	36.52
75	525	1050	28.1	36	1.19	33.15
75	600	1200	29	36.74	1.07	39.89



Graph 6-4 Nominal Shear Stress VS. Depth(1P)

Table 6-8 Comparison of Experimental Test Results of Ultimate Load with Various formula (2P)

Width (b) mm	Depth (D) mm	Effective length (l) mm	Experimental Results (W_u) (Ton)	P J Robins (1971) (Ton)	Tang and Cheng (2006) (Ton)	Appa Rao (2012) (Ton)
75	150	300	9	12.64	10.08	7.53
75	225	450	18	19.12	15.43	11.90
75	300	600	21.9	23.46	18.68	15.90
75	375	750	21.3	29.5	23.58	19.71
75	450	900	24.1	34.6	27.79	23.27
75	525	1050	22	41.58	34.55	26.78
75	600	1200	26	45.92	37.7	29.97

Table 6-9 Ratio of W_{exp} / W_{theo} (2P)

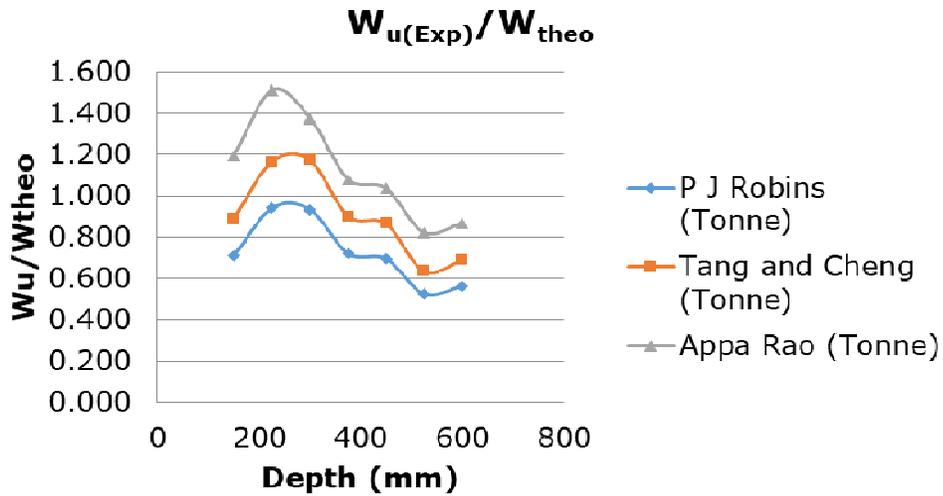
Width (b) mm	Depth (D) mm	Effective length (l) mm	P J Robins (1971) (Ton)	Tang and Cheng (2006) (Ton)	Appa Rao (2012) (Ton)
75	150	300	0.712	0.893	1.195
75	225	450	0.941	1.167	1.513
75	300	600	0.934	1.172	1.377
75	375	750	0.722	0.903	1.081
75	450	900	0.697	0.867	1.036
75	525	1050	0.529	0.637	0.822
75	600	1200	0.566	0.690	0.868

It is observed that the ratio of experimental results to the theoretical results (W_{exp} / W_{theo})(2P) verses Depth of beam is plotted for various researchers such as P. J. ROBINS (1971), APPA RAO(2012), TANG AND CHENG (2006). Table 6-9 result shows that the ratio is ranging between 0.53 to 0.94 for P J Robins formula, Range of 0.64 to 1.17 for Tang and Cheng formula and 0.82 to 1.51 for Appa Rao Formula for various beams depth.

Table 6-10 % Difference of $((W_{exp} - W_{theo})/W_{exp}) \times 100$ for RCC Series

Width (b) mm	Depth (D) mm	Effective length (l) mm	P J Robins (1971) (Ton)	Tang and Cheng (2006) (Ton)	Appa Rao (2012) (Ton)
75	150	300	-40.444	-12.000	16.333
75	225	450	-6.222	14.278	33.889
75	300	600	-7.123	14.703	27.397
75	375	750	-38.498	-10.704	7.465
75	450	900	-43.568	-15.311	3.444
75	525	1050	-89.000	-57.045	-21.727
75	600	1200	-76.615	-45.000	-15.269

+ Percentage more than Exp. Results
- Percentage less than Exp. Results



Graph 6-5 $W_{u(Exp)} / W_{theo}$. VS. Depth (2P)

It is observed that the Experimental results of the present work are compared with theoretical results for RCC beams. Theoretical results are calculated using P. J. ROBINS formula (1971) (Before the incorporation of size effect factor). Table 6-10 results calculated using Original Mr. P J ROBINS formula, the 71 % of experimental results are showing ± 59 % of variation compare to actual experimental results. This result shows that Mr P J Robins Shear strength formula modify by incorporating the size effect parameter.

It is observed that the Experimental results of the present work are compared with the existing formula of size effect proposed by various researchers as APPA RAO (2012) and TANG AND CHENG (2006). In Table 6-10 shows that the 85% of experimental results showing ± 32 % of variation in case of APPA RAO (2012) formula, and 71% of experimental results of tested specimen showing ± 30 % of variation in case of TANG AND CHENG (2006) formula.

6.4 COMPARISON OF ULTIMATE LOAD BETWEEN RCC AND FIBROUS SERIES (2P)

Table 6-11 comparison of Ultimate load between RCC and Fibrous series

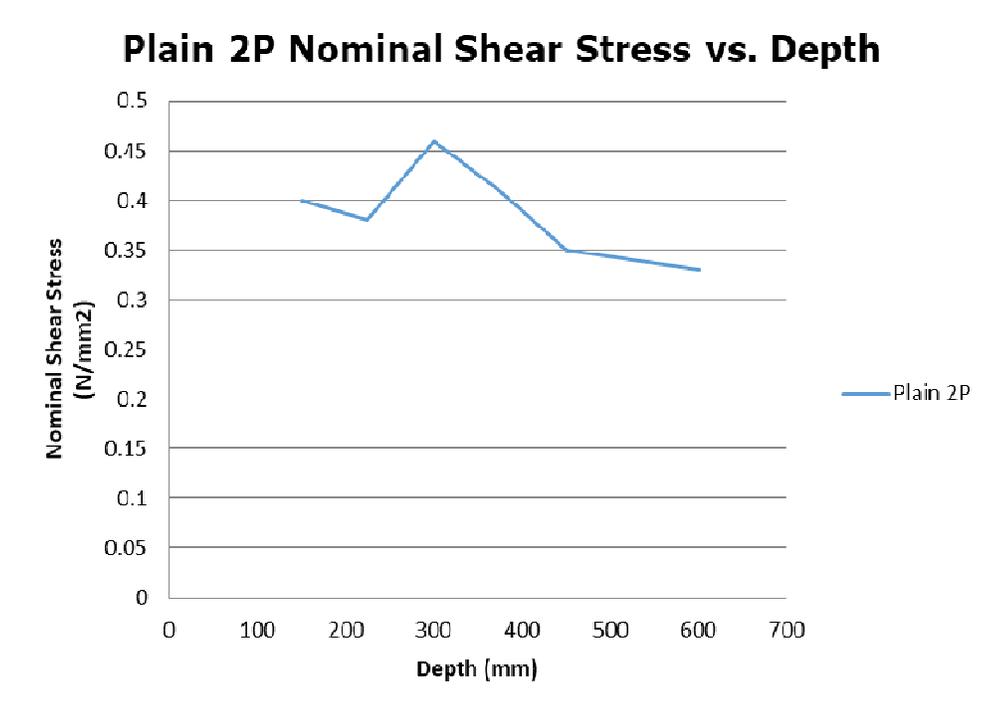
Width (b) mm	Depth (D) mm	Experimental Results RCC 2P (W_u) (Ton)	Experimental Results RCC+Fiber 2P(W_u) (Ton)	Ratio= (RCC+Fiber)/ RCC	% Strength Increase
75	150	9	15	1.67	66.67
75	225	18	20.6	1.14	14.44
75	300	21.9	22	1.00	0.46
75	375	21.3	25.7	1.21	20.66
75	450	24.1	28.6	1.19	18.67
75	525	22	29	1.32	31.82
75	600	26	31	1.19	19.23

It reveals from the Table 6-11 that The Ultimate load carrying capacity of Fibrous beam is increased by 17.54 % compared to RCC Beams. The First Reading is discarded due to slipping of load at supports it shows the higher percentage

6.4.1 Size Effect for Plain Series and Graphical Representation(2P)

Table 6-12 Nominal Shear Stress for Plain Series

Width (mm)	Depth (mm)	Effective span (mm)	Ultimate Load (Ton) W_u	F_{ck} (N/mm ²)	Nominal Shear Stress = $W_u / (bD\sqrt{f_{ck}})$ (N/mm ²)
75	150	300	2.7	36.00	0.40
75	225	450	3.8	36.00	0.38
75	300	600	5.9	33.77	0.46
75	375	750	6.9	36.00	0.41
75	450	900	6.8	33.77	0.35
75	525	1050	8.0	36.00	0.34
75	600	1200	8.5	33.77	0.33

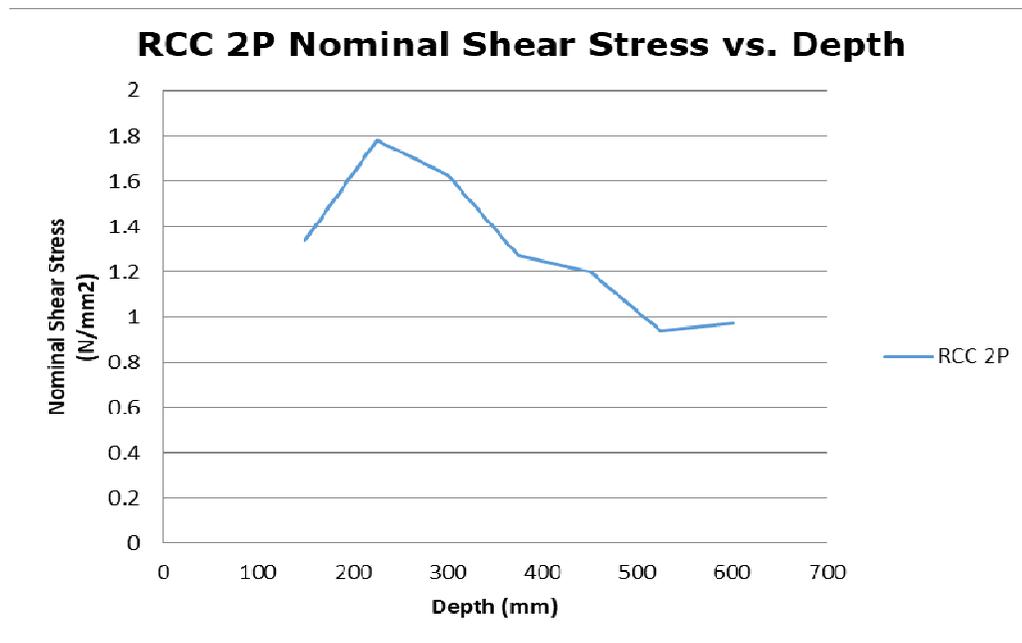


Graph 6-6 Nominal Shear Stress VS. Depth

6.4.2 Size Effect for RCC Series and Graphical Representation

Table 6-13 Nominal Shear Stress for RCC Series

Width (mm)	Depth (mm)	Ultimate Load (Ton) W_u	F_{ck} (N/mm ²)	Nominal Shear Stress = $W_u / (bD\sqrt{f_{ck}})$ (N/mm ²)	Reduction of strength %
75	150	9.0	36	1.34	
75	225	18.0	36	1.78	-32.84
75	300	21.9	36	1.63	-21.64
75	375	21.3	36	1.27	5.22
75	450	24.1	36	1.20	10.45
75	525	22.0	36	0.94	29.85
75	600	26.0	36	0.97	27.61



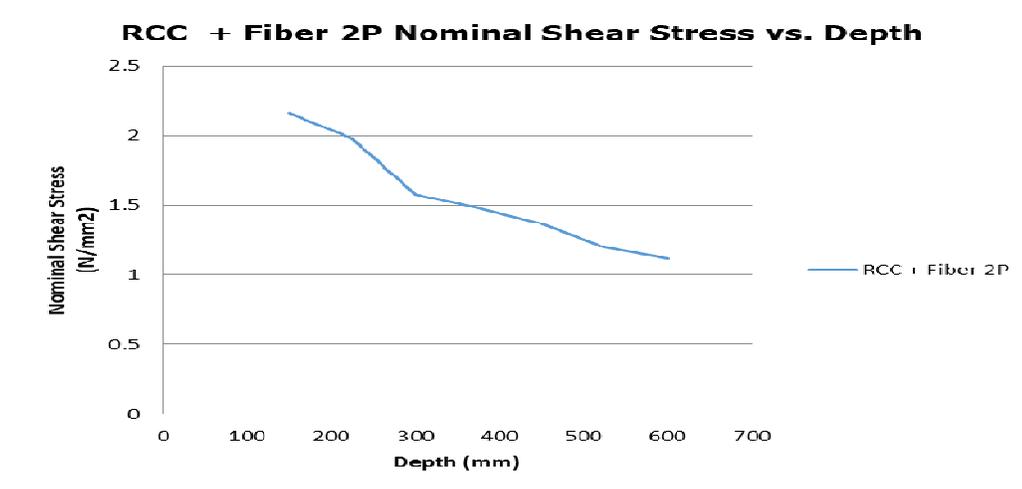
Graph 6-7 Nominal Shear Stress VS. Depth

6.4.3 Size Effect for Fibrous Series and Graphical Representation

Table 6-14 Nominal Shear Stress for Fibrous Series

Width (mm)	Depth (mm)	Ultimate Load (Ton) W_u	F_{ck} (N/mm ²)	Nominal Shear Stress = $W_u / (bD\sqrt{f_{ck}})$ (N/mm ²)	Reduction of strength %
75	150	15.0	38.27	2.16	
75	225	20.6	38.27	1.98	8.33
75	300	22.0	38.37	1.58	26.85
75	375	25.7	38.27	1.48	31.48
75	450	28.6	38.37	1.37	36.57
75	525	29.0	38.27	1.20	44.44
75	600	31.0	38.37	1.12	48.15

It reveals from the table 6-13 and 6-14 that The Nominal shear strength reduces approximately 29.85 % in RCC Moderate deep Beams and 48.15 % in Fibrous Moderate Deep Beams when Size of beam increases from 150 mm to 600 mm.



Graph 6-8 Nominal Shear Stress VS. Depth

6.5 INCORPORATION OF SIZE EFFECT PARAMETER IN ORIGINAL MR P J ROBBIN'S FORMULA FOR SHEAR STRENGTH OF BEAM

P. J. ROBINS and F. K. KONG have considered various assumptions in the derivation of ultimate shear strength formula which are as,

- ❖ The approximate direction of the diagonal crack is the line joining the inside face of the load-bearing block at the support to outside face of the load bearing block at the loading point.
- ❖ The web bar is perpendicular to the diagonal crack. It is more effective in controlling crack growth.
- ❖ The effectiveness of a web bar increases with the depth at which it intersects the line of diagonal crack.
- ❖ For the purpose of the Ultimate shear strength calculations, main longitudinal bars should be considered as web bars.
- ❖ Within practical limits, Ultimate shear strength is independent of the yield stress of the web reinforcement.
- ❖ The shear strength of a deep beam is more dependent upon the splitting strength of the concrete than its compressive strength.

On the basis of above assumptions, the Original Mr P J Robbins Formula of Ultimate shear strength equation for deep beam is,

$$V = C_1 \left(1 - 0.35 \frac{x}{D}\right) f_t b D + C_2 \sum^n \left\{ A \left(\frac{y_i}{D}\right) \sin^2 \alpha_i \right\}$$

Where,

V = Ultimate shear strength of the beam (N)

C_1 = Empirical coefficient equal to 1.4 and 1.0 for normal weight and light weight concrete respectively

C_2 = Empirical coefficient equal to 130 N/mm² for plain round bars and 300 N/mm² for deformed bars

f_t = Split cylinder tensile strength (N/mm²)

b = Width of the beam (mm)

D = Overall depth the beam (mm)

A = Area of individual web reinforcement bar (mm²)

y_i = The depth at which an individual web bar intersects the potential diagonal crack

Size Effect Factor

Based on the dimensional analysis of the strain energy release rate, BAZANT derived that the failure stress varies as,

$$\left((1+\beta)^{-0.5}\right) \quad \text{Where, } \beta = (d/\lambda_0 d_a)$$

In which,

d = Beam depth

d_a = Maximum size of coarse aggregate

λ_0 = Constant

This indicates that the Nominal stress decreases with increasing beam size Looking to the comparison of experimental test results with P. J. ROBINS formula. The % difference is very high compared to APPA RAO and TANG AND CHENG formula because these two formulas give shear strength of deep beam with incorporating SIZE EFFECT. So, it is necessary to incorporate size effect factor in P. J. ROBINS formula.

So **Modified P. J. ROBIN'S formula as,**

$$V = \text{P. J. ROBINS formula} \times \text{BAZANT's size effect factor}$$

$$V = [C_1 \left(1 - 0.35 \frac{x}{D}\right) f_t b D + C_2 \sum^n \left\{ A \left(\frac{y_i}{D}\right) \sin^2 \alpha_i \right\}]$$

$$\times ((1+d/\lambda_0 d_a)^{-0.5})$$

We need to maintain the generic form of the size effect factor so there is only one way to modify the P. J. ROBBIN'S formula by finding out λ_0 constant. So λ_0 constant is found out using linear Regression Analysis which satisfies the experimental test results.

6.6 LINEAR REGRESSION ANALYSIS

In statistics, Regression Analysis is a statistical process for estimating the relationships among variables. It includes many techniques for modeling and analyzing several variables, when the focus is on the relationship between a dependent variable and one or more independent variables (or 'predictors'). More specifically, Regression Analysis helps to understand how the typical value of the dependent variable (or 'criterion variable') changes when any one of the independent variables is varied, while the other independent variables are held fixed. Regression analysis is also used to understand which among the independent variables are related to the dependent variable, and to explore the forms of these relationships.

Many techniques for carrying out Regression Analysis have been developed. Familiar methods such as linear regression and ordinary least squares regression are parametric, in that the Regression function is defined in terms of a finite number of unknown parameters that are estimated from the data. Nonparametric regression refers to techniques that allow the regression function to tie in a specified set of functions, which may be infinite-dimensional.

6.6.1 Result of Linear Regression Analysis for Constant λ_0

SUMMARY OUTPUT

Regression Statistics

Multiple R	0.929707981
R Square	0.86435693
Adjusted R Square	0.787433853
Standard Error	154.3659141
Observations	14

ANOVA

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	1	1973975.14	1973975.14	82.83976554	9.80469E-07
Residual	13	309774.8605	23828.83542		
Total	14	2283750			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
X Variable 1	13.68367087	1.503429921	9.101635323	5.30173E-07	10.435708	16.93163374	10.435708	16.93163374

Table 6-15 Result of Linear Regression Analysis

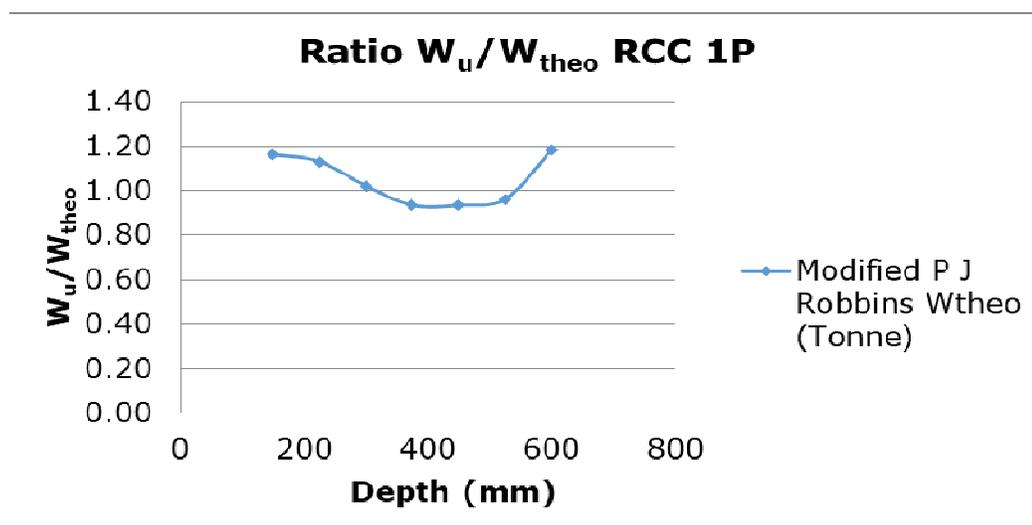
Modified P. J. ROBINS Formula after regression,

$$V = [C_1 \left(1 - 0.35 \frac{x}{D}\right) f_t b D + C_2 \sum^n \left\{ A \left(\frac{y_i}{D}\right) \sin^2 \alpha_i \right\}] \times \left(\frac{1+d}{13.68 \times d_a} \right)^{-0.5}$$

Size effect factor given by $\left(\frac{1+d}{\lambda_o d_a}\right)^{-0.5}$ P.J. ROBINS (1971) formula modified by incorporating size effect factor . $\lambda_o=13.68$ constant was found out by using Linear Regression analysis. (Appendix-II)

Table 6-16 Comparison of RCC Ultimate load Results with Modified P. J. ROBBINS Formula (1P)

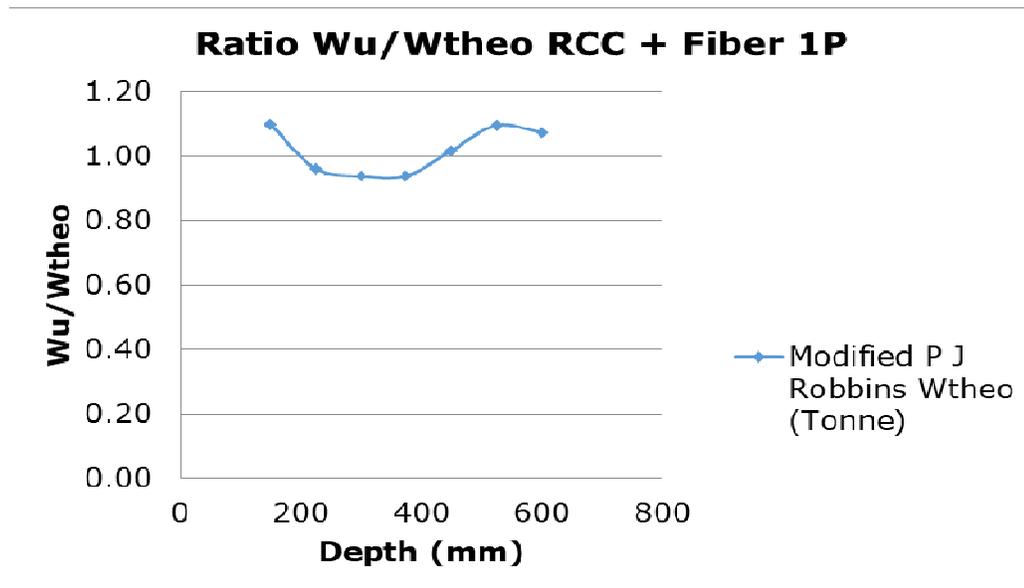
Width (b) mm	Depth (D) mm	Effective length (l) mm	Experimental Results (W _u) (Ton)	Modified P J Robbins W _{theo} (Ton)	Ratio W _u /W _{theo}	% Difference
75	150	300	10	8.6	1.16	14.00
75	225	450	13.6	12.02	1.13	11.62
75	300	600	14	13.7	1.02	2.14
75	375	750	15	16.04	0.94	-6.93
75	450	900	16.5	17.66	0.93	-7.03
75	525	1050	19.4	20.16	0.96	-3.92
75	600	1200	25	21.14	1.18	15.44



Graph 6-9 Ratio Wu/Wtheo VS. Depth(1P)

Table 6-17 Comparison of Fibrous ultimate load Results with Modified P. J. ROBBINS Formula(1P)

Width (b) mm	Depth (D) mm	Effective length (l) mm	Experimental Results (W_u) (Ton)	Modified P J Robbins W_{theo} (Ton)	Ratio W_u/W_{theo}	% Difference
75	150	300	12	10.92	1.10	9.00
75	225	450	14.6	15.2	0.96	-4.11
75	300	600	16.4	17.5	0.94	-6.71
75	375	750	19.2	20.48	0.94	-6.67
75	450	900	23	22.6	1.02	1.74
75	525	1050	28.1	25.64	1.10	8.75
75	600	1200	29	27.02	1.07	6.83

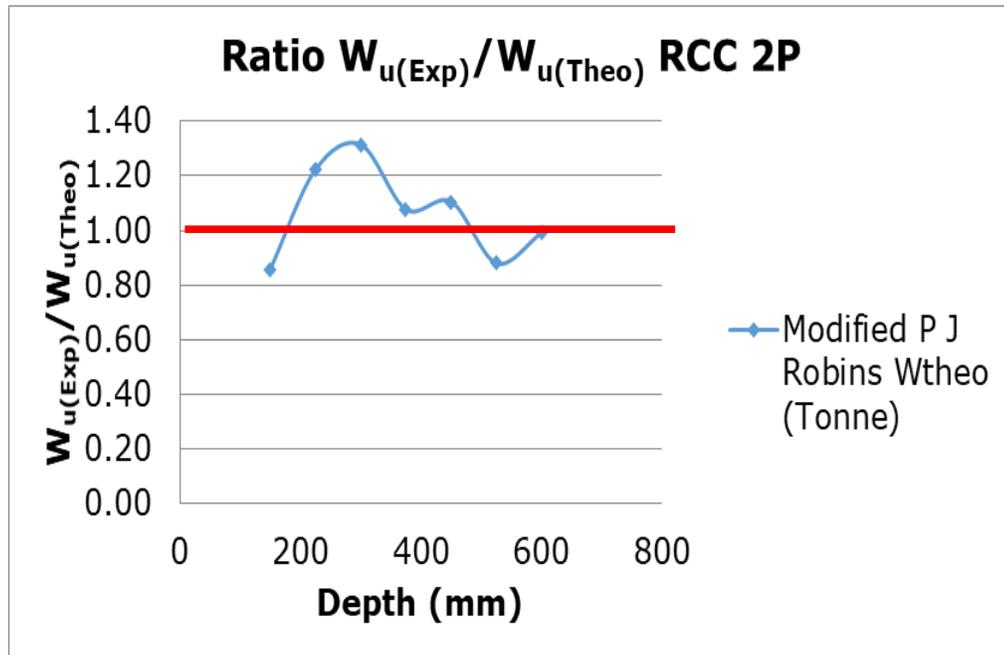


Graph 6-10 Ratio W_u/W_{theo} VS. Depth(1P)

6.7 COMPARISON OF EXPERIMENTAL RESULTS WITH MODIFIED P. J. ROBIN'S FORMULA AND GRAPHICAL REPRESENTATION

Table 6-18 Comparison of RCC Ultimate load Results With Modified P.J.ROBINS Formula

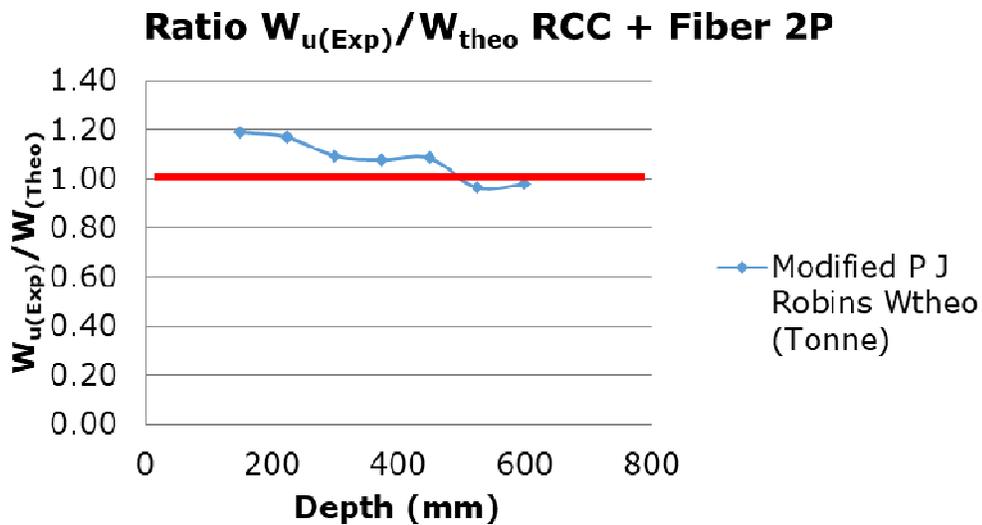
Width (b) mm	Depth (D) mm	Effective length (l) mm	Experimental Results (W_u) (Ton)	Modified P J Robins W_{theo} (Ton)	Ratio = W_u/W_{theo}	% Difference
75	150	300	9	10.5	0.86	-16.67
75	225	450	18	14.72	1.22	18.22
75	300	600	21.9	16.66	1.31	23.93
75	375	750	21.3	19.76	1.08	7.23
75	450	900	24.1	21.8	1.11	9.54
75	525	1050	22	24.96	0.88	-13.45
75	600	1200	26	26.18	0.99	-0.69



Graph 6-11 Ratio $W_{u(Exp)}/W_{theo}$ VS. Depth

Table 6-19 Comparison of Fibrous Ultimate load Results With Modified P. J. ROBINS Formula

Width (b) mm	Depth (D) mm	Effective length (l) mm	Experimental Results (W_u) (Ton)	Modified P J Robins W_{theo} (Ton)	Ratio W_u/W_{theo}	% Difference
75	150	300	15	12.6	1.19	16.00
75	225	450	20.6	17.6	1.17	14.56
75	300	600	22	20.08	1.10	8.73
75	375	750	25.7	23.8	1.08	7.39
75	450	900	28.6	26.3	1.09	8.04
75	525	1050	29	29.96	0.97	-3.31
75	600	1200	31	31.54	0.98	-1.74



Graph 6-12 Ratio $W_{u(Exp.)}/W_{u(Theo)}$ VS. Depth

From the Modified Mr. P J ROBINS formula Ratio of Experimental result to the Theoretical results were calculated. The graph was plotted (W_{exp} / W_{theo}) v/s Beam Depth. The result shows that ratio is ranging from 0.93 to 1.18 (RCC 1P Table 6-16) , 0.94 to 1.10 (RCC+ Fiber 1P Table 6-17) , 0.86 to 1.31 (RCC 2P Table 6-18) and 0.97 to 1.17 (RCC+ Fiber 2P Table 6-19) in good range.

Table 6-20 Comparison of Experimental Nominal Shear Stress with APPA RAO Formula and MODIFIED P. J. ROBBINS Formula(1P)

Width (mm)	Depth (mm)	Effective span (mm)	Ultimate Load (Ton) W_u	F_{ck} (N/mm ²)	Experiment Nominal Shear Stress = $W_u / (bD\sqrt{f_{ck}})$ (N/mm ²)	Appa Rao Ultimate Load (Ton)	Appa rao Nominal Shear Stress = $W_u / (bD\sqrt{f_{ck}})$ (N/mm ²)	Ultimate Shear Strength by Modified P J Robbins formula (Ton)	Modified P J Robbins Nominal Shear Stress = $W_u / (bD\sqrt{f_{ck}})$ (N/mm ²)
75	150	300	10	36	1.49	6.52	0.97	8.6	1.27
75	225	450	13.6	36	1.35	10.35	1.02	12.02	1.19
75	300	600	14	36	1.04	13.88	1.03	13.7	1.01
75	375	750	15	36	0.89	17.22	1.02	16.04	0.95
75	450	900	16.5	36	0.82	20.43	1.01	17.66	0.87
75	525	1050	19.4	36	0.83	23.48	0.99	20.16	0.85
75	600	1200	25	36	0.93	26.35	0.98	21.14	0.78

Table 6-21 Comparison of Experimental Nominal Shear Stress with MODIFIED P. J. ROBBINS Formula (1P)

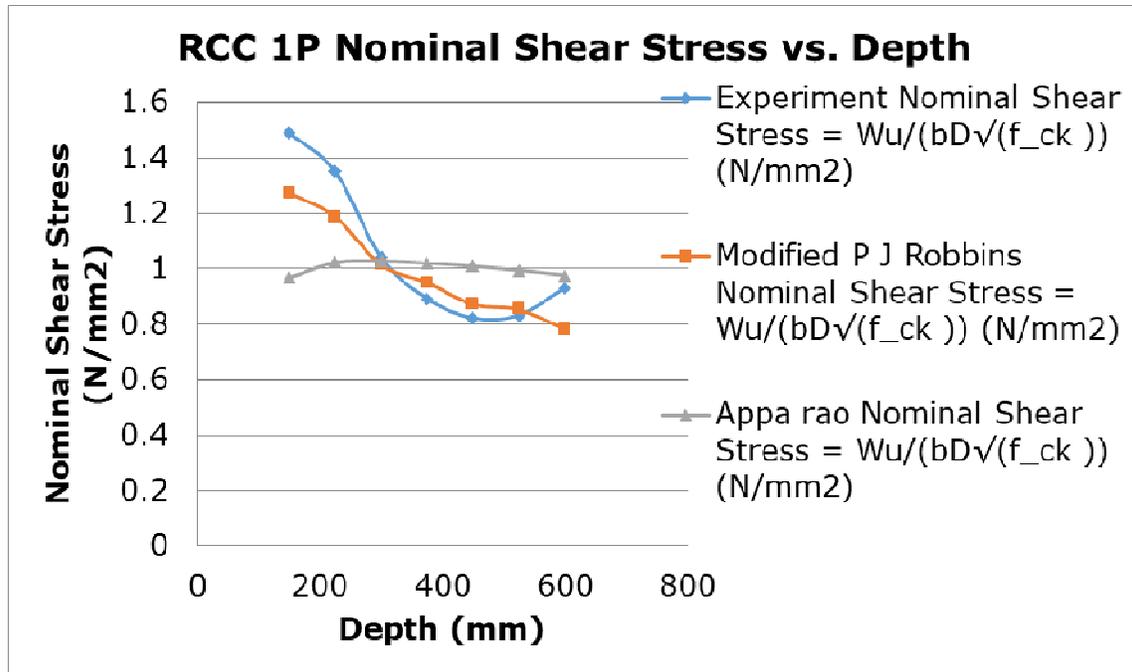
Width (mm)	Depth (mm)	Effective span (mm)	Ultimate Load (Ton) W_u	Fck (N/mm ²)	Experiment Nominal Shear Stress = $W_u / (bD\sqrt{f_{ck}})$ (N/mm ²)	Ultimate Shear Strength by modified P J Robbins formula (Ton)	Modified P J Robbins Nominal Shear Stress = $W_u / (bD\sqrt{f_{ck}})$ (N/mm ²)
75	150	300	12	36	1.78	10.92	1.62
75	225	450	14.6	36	1.45	15.2	1.50
75	300	600	16.8	36.74	1.24	17.5	1.28
75	375	750	19.2	36	1.14	20.48	1.21
75	450	900	23	36.74	1.13	22.6	1.10
75	525	1050	28.1	36	1.19	25.64	1.09
75	600	1200	29	36.74	1.07	27.02	0.99

Table 6-22 Comparison of Experimental Nominal Shear Stress With APPA RAO Formula And MODIFIED P. J. ROBINS Formula For RCC Beams (2P)

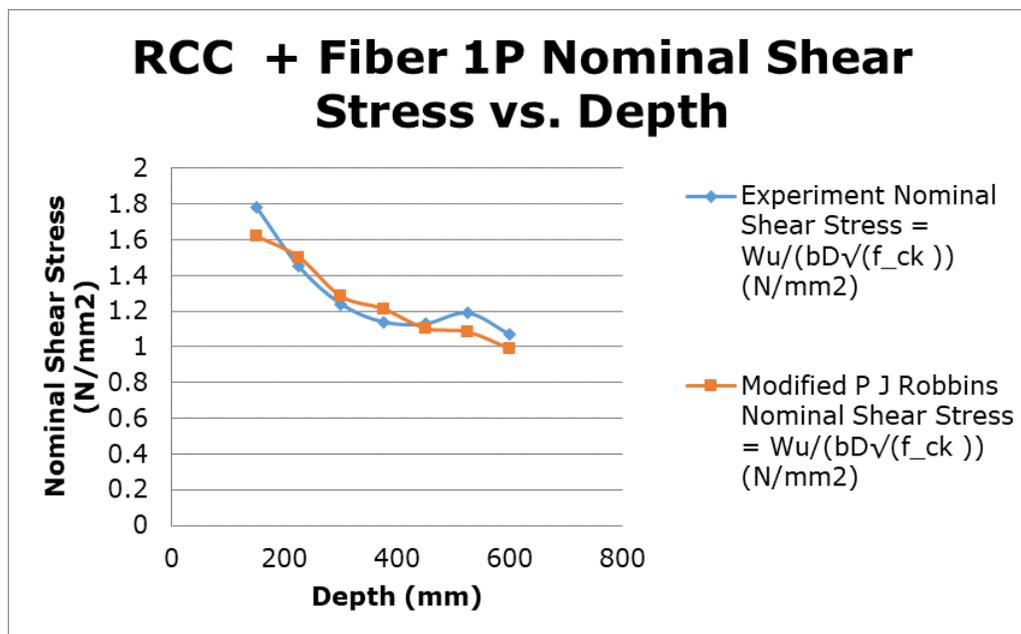
Width (mm)	Depth (mm)	Effective span (mm)	Ultimate Load (Ton) W_u	F_{ck} (N/mm ²)	Experiment Nominal Shear Stress = $W_u / (bD\sqrt{f_{ck}})$ (N/mm ²)	Ultimate Shear Strength by Modified P J Robins formula (Ton)	Modified P J Robins Nominal Shear Stress = $W_u / (bD\sqrt{f_{ck}})$ (N/mm ²)	Ultimate Shear Strength by P J Robins formula (Ton)	P J Robins Nominal Shear Stress = $W_u / (bD\sqrt{f_{ck}})$ (N/mm ²)
75	150	300	9	36	1.34	10.5	1.56	12.64	1.87
75	225	450	18	36	1.78	14.72	1.45	19.12	1.89
75	300	600	21.9	36	1.63	16.66	1.23	23.46	1.74
75	375	750	21.3	36	1.27	19.76	1.17	29.5	1.75
75	450	900	24.1	36	1.2	21.8	1.08	34.6	1.71
75	525	1050	22	36	0.94	24.96	1.06	41.58	1.76
75	600	1200	26	36	0.97	26.18	0.97	45.92	1.70

Table 6-23 Comparison of Experimental Nominal Shear Stress With Modified P. J. ROBINS Formula for Fibrous Beams (2P)

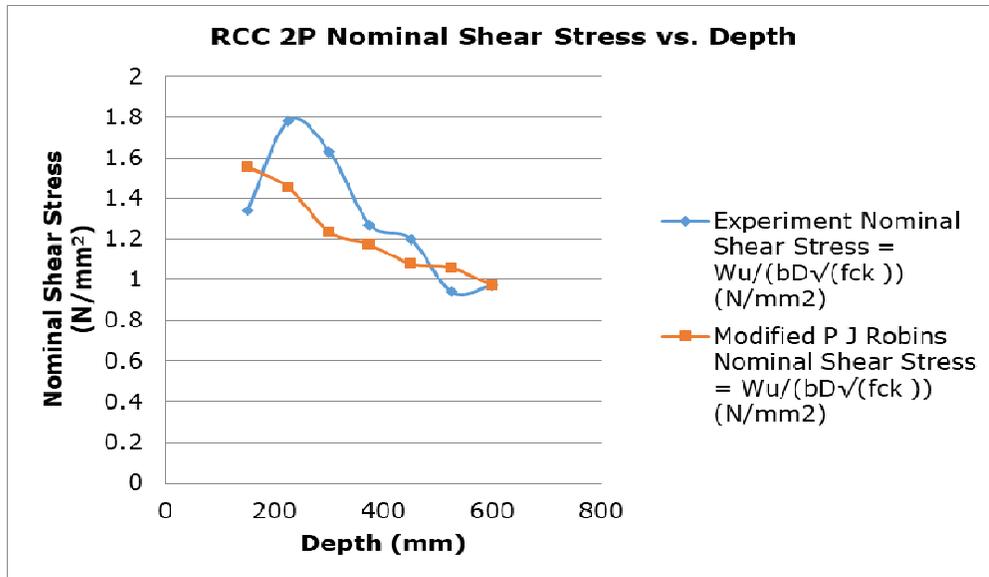
Width (mm)	Depth (mm)	Effective span (mm)	Ultimate Load (Ton) W_u	F_{ck} (N/mm ²)	Experiment Nominal Shear Stress = $W_u / (bD\sqrt{f_{ck}})$ (N/mm ²)	Ultimate Shear Strength by modified P J Robins formula (Ton)	Modified P J Robins Nominal Shear Stress = $W_u / (bD\sqrt{f_{ck}})$ (N/mm ²)	Ultimate Shear Strength by modified P J Robins formula (Ton)	P J Robins Nominal Shear Stress = $W_u / (bD\sqrt{f_{ck}})$ (N/mm ²)
75	150	300	15	38.27	2.16	12.6	1.81	15.16	2.18
75	225	450	20.6	38.27	1.98	17.6	1.69	22.86	2.19
75	300	600	22	38.37	1.58	20.08	1.44	28.28	2.03
75	375	750	25.7	38.27	1.48	23.8	1.37	35.52	2.04
75	450	900	28.6	38.37	1.37	26.3	1.26	41.74	2.00
75	525	1050	29	38.27	1.2	29.96	1.23	49.92	2.05
75	600	1200	31	38.37	1.12	31.54	1.13	55.34	1.99



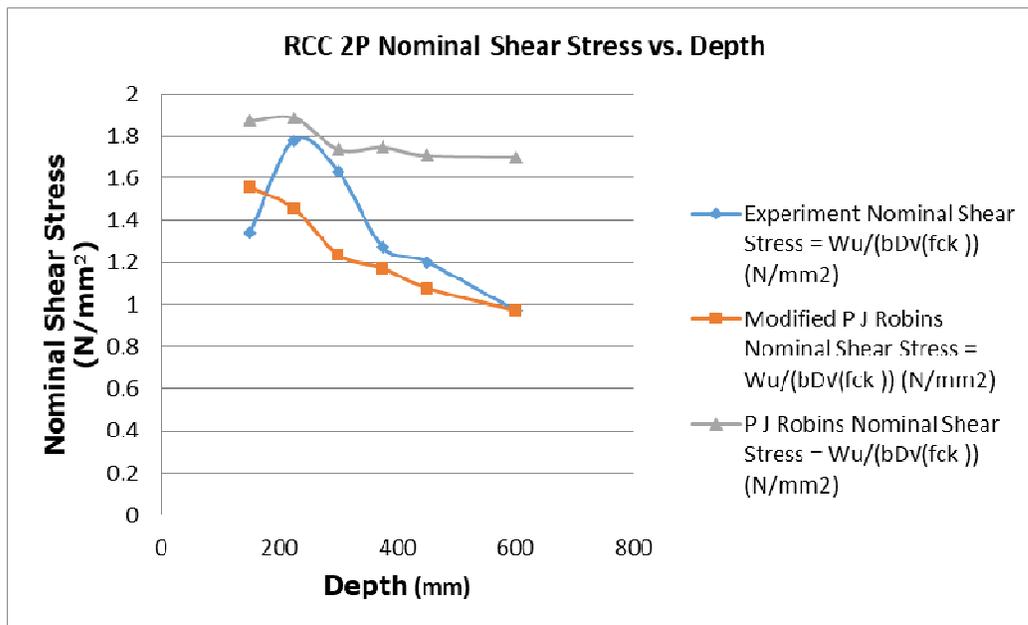
Graph 6-13 Comparison Graph of Experimental Nominal Shear Stress with APPA RAO Formula and MODIFIED P. J. ROBBINS Formula VS. Depth(1P)



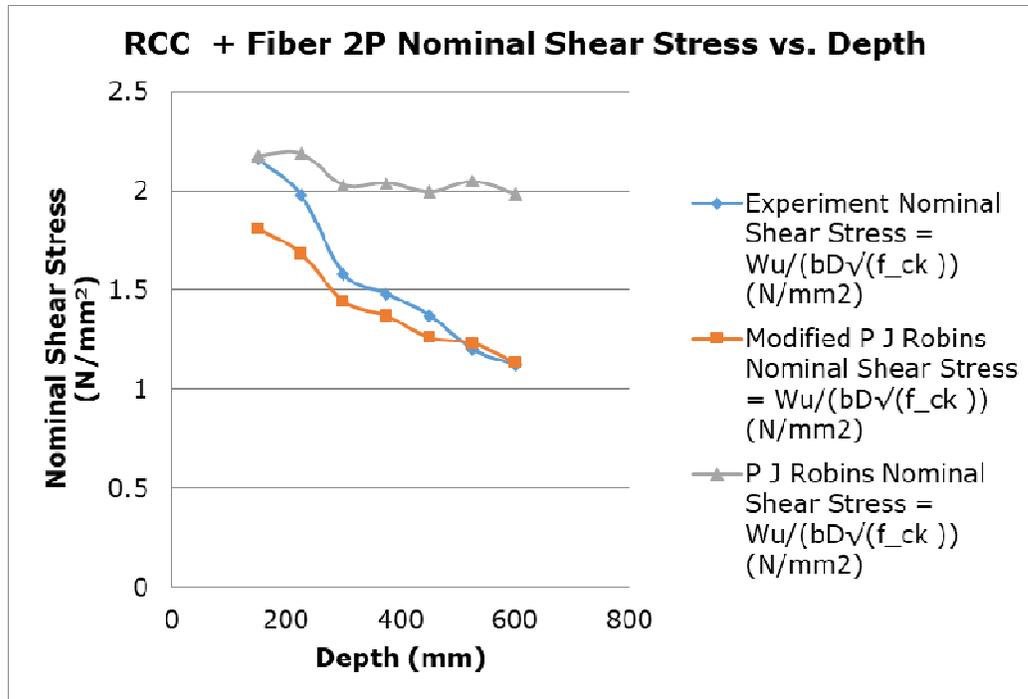
Graph 6-14 Comparison Graph of Experimental Nominal Shear Stress with MODIFIED P. J. ROBBINS Formula VS. Depth(1P)



Graph 6-15 Graphical Representation of Experimental Nominal Shear Stress With P. J. ROBINS Formula And MODIFIED P. J. ROBINS Formula VS. Depth For RCC series



Graph 6-16 Graphical Representation of Experimental Nominal Shear Stress with P J ROBINS Formula And MODIFIED P. J. ROBINS Formula VS. Depth After Omitting Beam R525 S1050



Graph 6-17 Comparison Graph of Experimental Nominal Shear Stress With MODIFIED P. J. ROBINS Formula VS. Depth For Fibrous Series

The original equation of Mr. P J ROBINS seems Uniform Nominal shear stress in all beams. It is prime requirement to incorporate the size effect parameter in P J ROBINS formula. The experimental Nominal shear stress decreases as the member depth increases so the BAZANT size effect parameter incorporated in to Mr. P J ROBINS formula. From Graph 6-13,14,15,16,17 reveals that by using Modified P J ROBINS formula, the Nominal shear stress is very close to experimental Nominal Shear Stress.

It reveals from Table 6-20,21,22,23 that Experimental results of the present research work are compare with Modified Mr. P J ROBINS formula and the results show that $\pm 15\%$ of variation in case of RCC beams and $\pm 10\%$ of variation in case of Fibrous beams. This shows importance of size effect parameter in Shear Strength Equation.