8. MODIFICATION OF SHEAR STRENGTH EQUATION BY INCORPORATING SIZE EFFECT PARAMETER IN EUROCODE (02:2004)

8.1. SHEAR STRESS IN BEAM

Shear stress at failure decreased with increased in member size which termed as size effect. It can be understood by plotting graph of Shear stress vs Depth or size of member. We can consider shear stress criteria in terms of Nominal shear stress and Ultimate shear stress.

Nominal shear stress typically calculated by = $Wu/(bD\sqrt{(fck)})$

Ultimate shear stress typically calculated by = Wu/bD

Where,Wu = Ultimate load

f_{ck} = Characteristic Compressive cube strength in N/mm^2

b = Width of specimen in mm D = Depth of specimen in mm

Nominal shear stress at failure was calculated by using above formula for RCC, PFRC and SFRC. The graph plotted Nominal shear stress vs. Effective depth of beam.

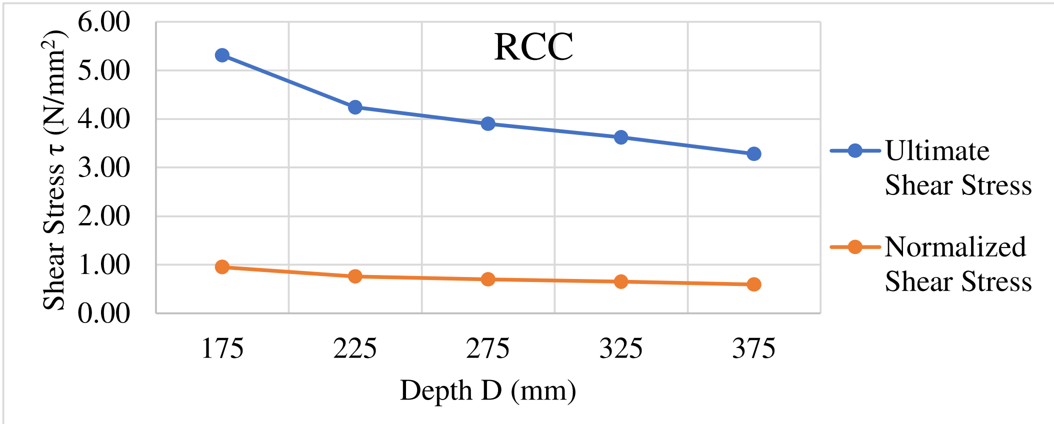
8.2. SHEAR STRESS OF TESTED BEAMS (RCC,PFRC, SFRC)

Table 8.1 Shear Stress of Tested Beam

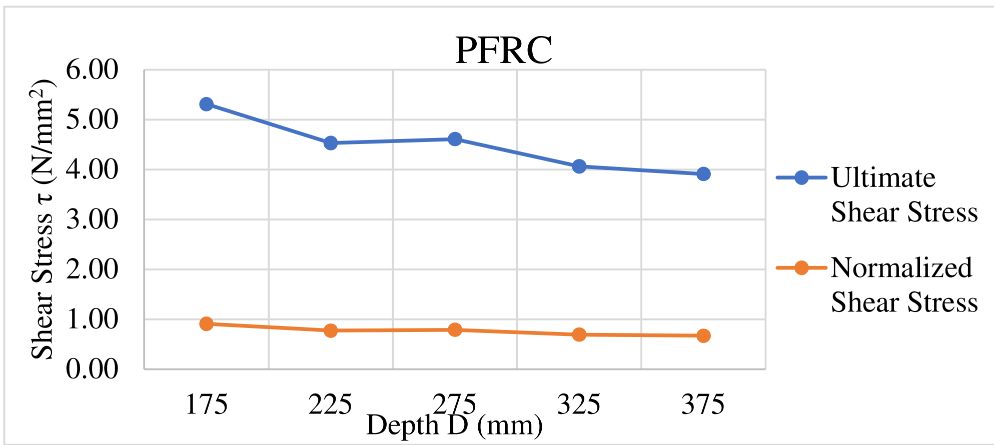
Beam	**Width**	**Depth**	**F_{ck}**	**W_u Test**	**Shear Stress of Tested Beams**	
					Nominal Shear stress	**Ultimate Shear stress**
	(mm)	(mm)	(N/mm^2)	(Ton)	(N/mm^2)	(N/mm^2)
F/RCC	75	175	31.11	7.10	0.95	5.31
A_1/RCC	75	225	31.11	7.30	0.76	4.24
H/RCC	75	275	31.11	8.20	0.70	3.90
I/RCC	75	325	31.11	9.00	0.65	3.62
J/RCC	75	375	31.11	9.40	0.59	3.28
F/PFRC	75	175	34.25	7.10	0.91	5.31
A_1/PFRC	75	225	34.25	7.80	0.77	4.53
H/PFRC	75	275	34.25	9.70	0.79	4.61
I/PFRC	75	325	34.25	10.10	0.69	4.06
J/PFRC	75	375	34.25	11.20	0.67	3.91
F/SFRC	75	175	31.78	7.30	0.97	5.46
A_1/SFRC	75	225	31.78	7.90	0.81	4.59
H/SFRC	75	275	31.78	12.20	1.03	5.80
I/SFRC	75	325	31.78	12.50	0.89	5.03
J/SFRC	75	375	31.78	13.60	0.84	4.74

8.2.1. Graphical Representation of Size Effect for RCC Beams

Graph 8-1 Size Effect for RCC Beam series

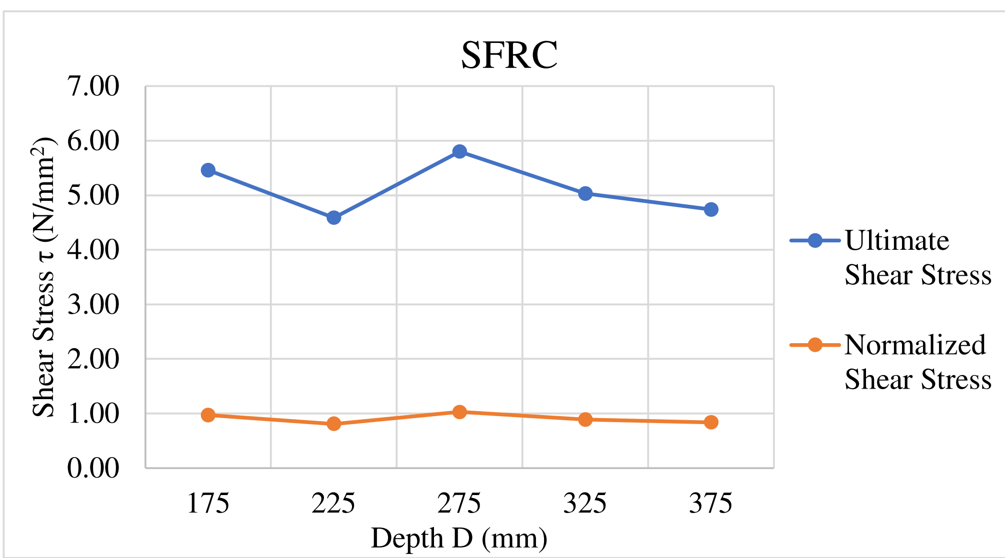


8.2.2. Graphical Representation Of Size Effect For PFRC Beams



Graph 8-2Size Effect for PFRC Beam series

8.2.3. Graphical Representation Of Size Effect For SFRC Beams



Graph 8-3 Size Effect for SFRC Beam Series

It reveals from RCC specimen (Graph 8-1), PFRC specimen (Grpah 8-2) and SFRC specimen (Graph 8-3) that the Nominal shear stress is almost linear while the Ultimate shear stress is decreasing with increasing the depth of the beam.

8.3. MODIFICATION OF EUROCODE EQUATION BY INCORPORATING SIZE EFFECT PARAMETER

In Moderate Deep beam initially during application of load in concrete member develops Flexure cracks develop at soffit of beam in Flexure zone. During further progressive load develops shear crack in shear zone. Finally, the Moderate deep beam fails under Flexure shear failure.

Many Researchers are working on the concept to suggest the Prediction of shear strength for Moderate Deep Beam. Researchers are trying to evaluate the shear strength of structural beam members using different theories, formulas and methods.

In this research work attempts are made to evaluate the shear strength of Moderate Deep beams calculated by incorporating size effect parameter in **Original equation given by Eurocode-02:2004[7]** (Cl. 6.2.2, Equation no. 6.2.a, Page no. 85).

$V_u = V_c + V_{lr}$

$$W_{eq} = 2V_u = 2\left[0.18\left(1 + \sqrt{\frac{200}{d}}\right)\left(\sqrt[3]{100 p_t f_{ck}}\right) b\, D\right] \text{Mpa} \quad \text{..........} \quad (8.1)$$

Where; W_{eq}= Beam Shear Strength by Equation in Mpa

b = Width of beam in mm

D = Overall depth of beam in mm

d = Effective Depth of beam in mm

p_t = Reinforcement ratio $\frac{Ast}{bd}$

Ast = Area of tensile reinforcement in mm^2.

f_{ck} = Compressive strength of concrete in Mpa.

8.3.1. Assumptions:

- Size effect factor S_f is function of a/d (i.e. Shear span to effective depth) ratio.
- Effect of Fibers considered separately and Fiber factor is function of Fiber volume (V_f), Aspect ratio (d_f/l_f), where d_f is diameter of fiber and l_f is length of fiber.
- size effect parameter (S_f) is incorporate in Original Eurocode-02 : 2004 equation.
- concrete strength (V_c) only.

8.4. INCORPORATION OF SIZE EFFECT PARAMETER (SF) BY NON-LINEAR REGRESSION ANALYSIS METHOD

A statistical technique is used for investigating and modeling the relationship among variables. It is easy to use and applies to many situations. This technique makes possible to estimate the unknown values of one variable from this Regression Analysis.

There are two variables. Independent variable and Dependent variable. The Independent variables are to be predicted and Constants are finding using Software. The dependent variable is taken as input data in the software.

These are widely used accepted methods for performing Regression Analysis. The first easiest method is the linear regression. The second one is general method which is known as non-linear regression.

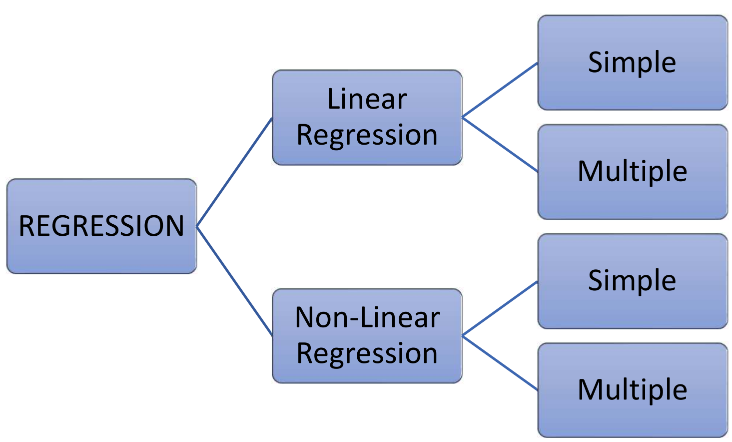


Figure 8-1 Chart for the Types of Regression Analysis

8.4.1. Non-Linear Regression Analysis

The Objective of Non-linear Regression Analysis is to determine the best fit parameters for a model by minimizing the chosen metric function. Here non-linear regression differs from linear one is the model has a nonlinear dependence on the unknown parameters. The process of merit function minimizing is an iterative approach. The process starts with some initial estimates then becomes a starting point for the next iteration. This iteration continues until the merit function effectively stops decreasing.

Here in this research work, model equation is generated for prediction of shear strength for Moderate Deep Beam by using Regression Analysis in SPSS software. In the equation shear strength (dependent variable) is function of **Shear span to depth ratio, Compressive strength of concrete** for RCC beam sand **Volume of Fiber and Aspect ratio for** PFRC and SFRC beams**.** It is taken into consideration with a constant.

The original shear strength equation as per eq.8.1 is;

$$W_{eq} = 2V_u = 2\left[0.18\left(1+\sqrt{\frac{200}{d}}\right)\left(\sqrt[3]{100ptfck}\right)(\text{ bd })\right]\text{Ton} \ldots\ldots\ldots\ldots (8.2)$$

Hence; W_{exp} / W_{eq} = dependent variable (Y)

a/d = independent variable (x)

Model equation is: $\frac{\text{Wexp}}{\text{Weq}} = A\left(\frac{a}{d}\right)^B$

Where;

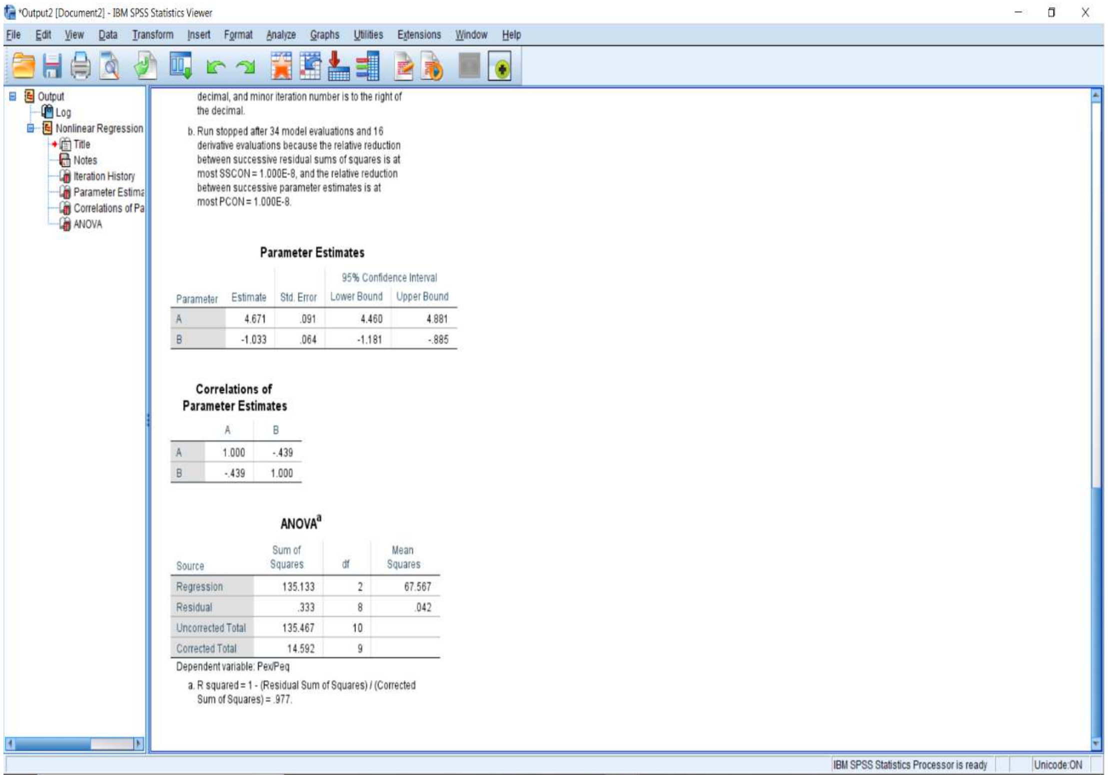
A and B are constants of Regression Analysis.

To find out the values of the constant, iterative Nonlinear Regression Analysis was carried out with SPSS software. Iteration starts with 0.01, and 0.01 for A, and B respectively.

8.5. ITERATIVE DATA ANALYSIS IN SPSS FOR MODEL EQUATION

Data of 84 Beams specimens from Past Thesis are used for Regression Analysis. Explanation of procedure for iterative nonlinear analysis in SPSS software.

Output file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Output
Log
Nonlinear Regression
Title
Notes
Iteration History
Parameter Estima
Correlations of Pa
ANOVA

decimal, and minor iteration number is to the right of the decimal.

b. Run stopped after 34 model evaluations and 16 derivative evaluations because the relative reduction between successive residual sums of squares is at most SSCON = 1.000E-8, and the relative reduction between successive parameter estimates is at most PCON = 1.000E-8.

Parameter Estimates

Parameter	Estimate	Std. Error	95% Confidence Interval Lower Bound	Upper Bound
A	4.671	.091	4.460	4.881
B	-1.033	.064	-1.181	-.885

Correlations of Parameter Estimates

	A	B
A	1.000	-.439
B	-.439	1.000

ANOVA[a]

Source	Sum of Squares	df	Mean Squares
Regression	135.133	2	67.567
Residual	.333	8	.042
Uncorrected Total	135.467	10	
Corrected Total	14.592	9	

Dependent variable: Pex/Peq

a. R squared = 1 - (Residual Sum of Squares) / (Corrected Sum of Squares) = .977.

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Figure 8-2 SPSS 16.0 Results

From the above Regression Analysis values of the constants obtained are summarized below,

A	4.761
B	-1.003

Model equation is: $\frac{\text{Wexp}}{\text{Weq}} = A\left(\frac{\text{a}}{d}\right)^{B}$

In Above equation B is the power of a/d ratio. As per analysis it is negative means it represent d/a ratio as multiplying factor with A. Same procedure as explained above was repeated for PFRC and SFRC by adding a Fiber factor $\beta * V_f \frac{lf}{df}\sqrt{fck}$ with a constant β. Multiple linear Regression Analysis was adopted to find value of constant β. Values of β are tabulated below,

For PFRC Beams, β	0.07
For SFRC Beams, β	1.17

8.6. MODIFIED SHEAR STRENGTH FORMULA FOR PREDICTION OF SHEAR STRENGTH OF MODERATE DEEP BEAMS EUROCODE-02:2004[7]

A Non-linear Regression Analysis was adopted to Modify the formula given by Eurocode-02:2004 by taking Shear span to depth ratio, Compressive strength of concrete for RCC beams and Volume of Fiber and Aspect ratio for PFRC and SFRC beams.

8.7. DERIVED EQUATION FOR PREDICTION OF SHEAR STRENGTH FOR RCC MODERATE DEEP BEAM

$$V_c = \left[0.84\left(1+\sqrt{\frac{200}{d}}\right)\left(\sqrt[3]{ptfck}\right)\left(\frac{a}{d}\right)^{-1.033} \text{bd}\right] \text{N} \quad \text{............ (8.3)}$$

Where,

V_c= Shear Strength in N

d = Effective of Depth of beam in mm

p_t= Percentage of Steel ($\frac{Ast}{bd}$ x 100%)

A_{st}= Area of Tensile reinforcement in mm^2

f_{ck}= Compressive Strength of concrete in Mpa

a = Shear Span of beam in mm

b = Width of beam in mm

8.8. MODIFIED EQUATION FOR PREDICTION OF SHEAR STRENGTH FOR PFRC MODERATE DEEP BEAM

$$v_c = \left[\left\{0.84\left(1+\sqrt{\frac{200}{d}}\right)\left(\sqrt[3]{ptfck}\right)\left(\frac{a}{d}\right)^{-1.033} \text{bd}\right\} + \beta vf\left(\frac{lf}{df}\right)\right] \text{N} \quad \text{....... (8.4)}$$

Where,

V_c= Shear Strength in N

d = Effective of Depth of beam in mm

p_t= Percentage of Steel ($\frac{Ast}{bd}$ x 100%)

A_{st}= Area of Tensile reinforcement in mm^2

f_{ck}= Compressive Strength of concrete in Mpa

a = Shear Span of beam in mm

b = Width of beam in mm

β= $0.07\sqrt{fck}$ for Monofilament polypropylene fibres

υ_f= Fiber contentby percentage volume of beam in %

$\frac{lf}{df}$ = Aspect ratio of fiber

l_f = Length of Fiber in mm

d_f = Diameter of Fiber in mm

8.9. DERIVED EQUATION FOR PREDICTION OF SHEAR STRENGTH FOR SFRC MODERATE DEEP BEAM

$$V_c = \left[\left\{0.84\left(1+\sqrt{\frac{200}{d}}\right)\left(\sqrt[3]{ptfck}\right)\left(\frac{a}{d}\right)^{-1.033} \text{bd}\right\} + \beta vf\left(\frac{lf}{df}\right)\right]\text{N} \ldots\ldots\ (8.5)$$

Where,

V_c= Shear Strength in N

d = Effective of Depth of beam in mm

p_t= Percentage of Steel ($\frac{Ast}{bd}$ x 100%)

A_{st}= Area of Tensile reinforcement in mm^2

f_{ck}= Compressive Strength of concrete in Mpa

a = Shear Span of beam in mm

b = Width of beam in mm

β= $1.17\sqrt{fck}$ for Steel fibres

υ_f= Fiber contentby percentage volume of beam in %

$\frac{lf}{df}$ = Aspect ratio of fiber

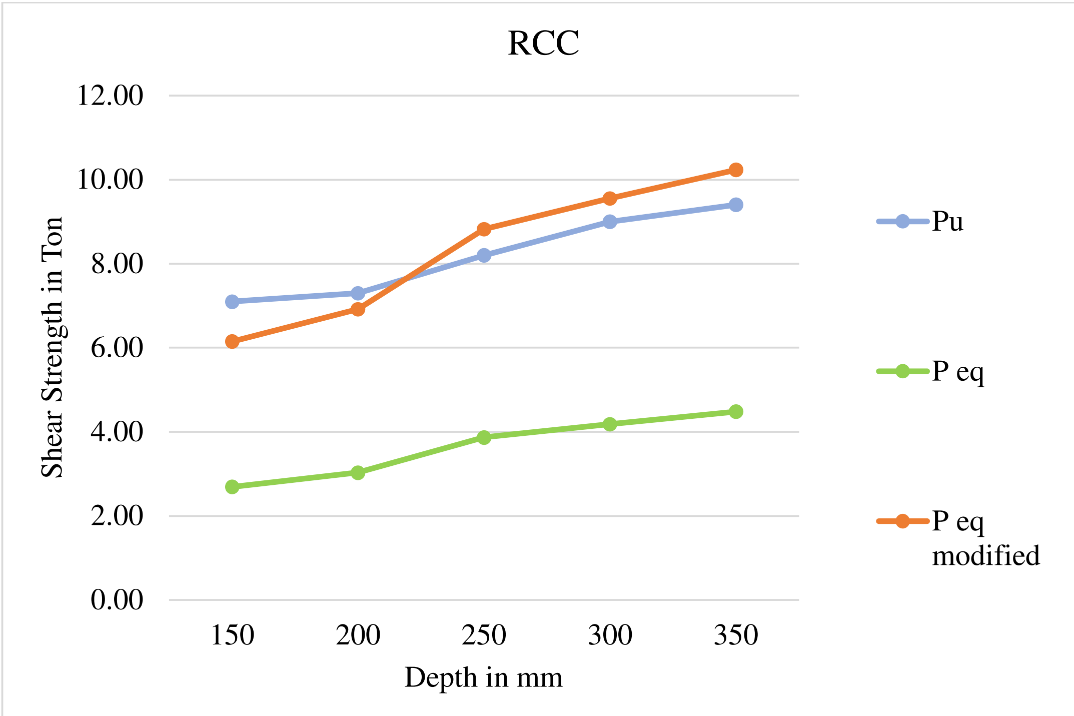
l_f = Length of Fiber in mm

d_f = Diameter of Fiber in mm

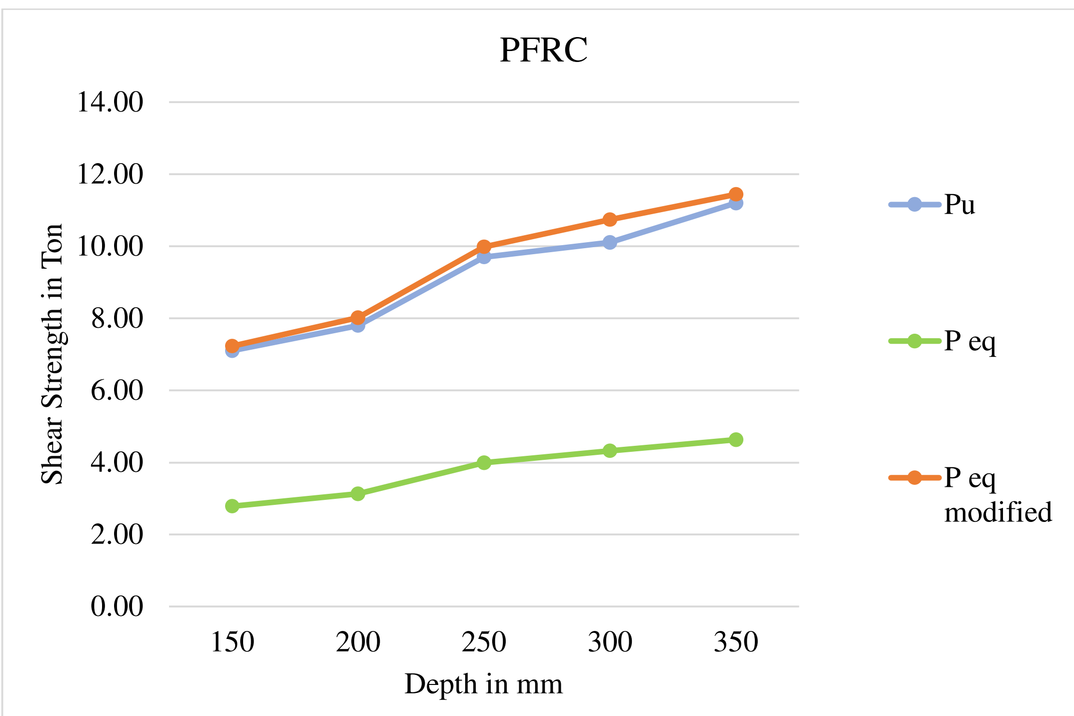
8.10. GRAPHICAL REPRESENTATION OF EXPERIMENTAL SHEAR STRENGTH, SHEAR STRENGTH BY ORIGINAL EQUATION AND SHEAR STRENGTH BY MODIFIED EQUATION

Table 8-2 Comparisons of Shear Strength Values By Experimental, Original Equation And Modified Equation

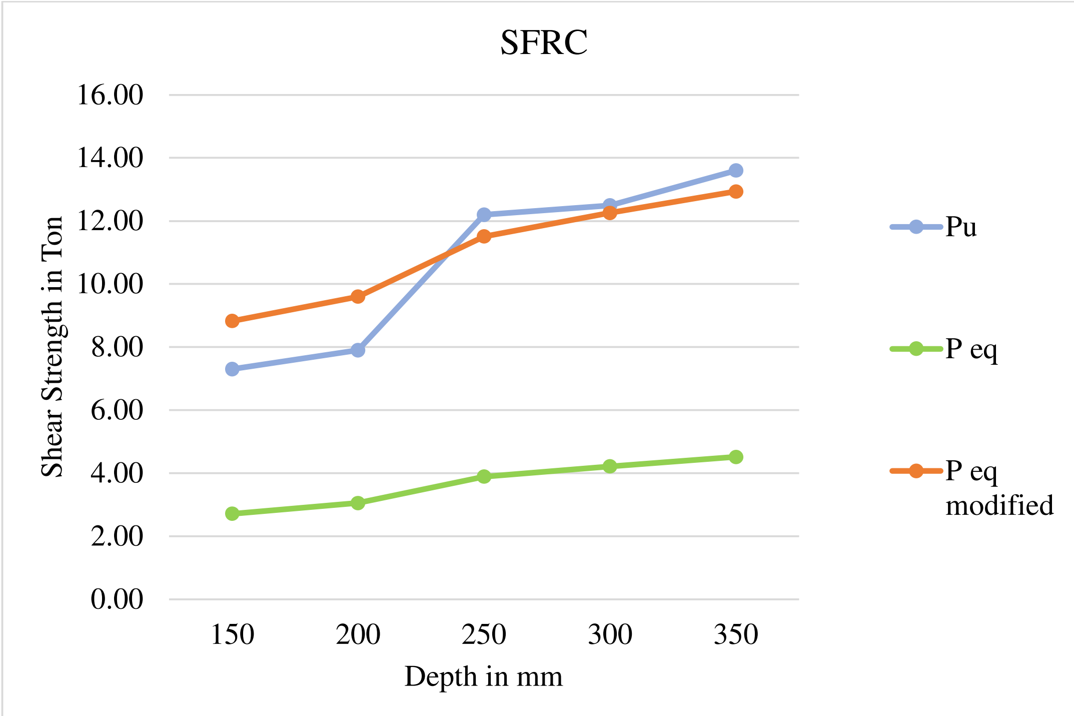
Beam		L_{eff}	b	d	a/d	f_{ck}	A_{st}	Experimental	Original EquationPeq	Modified EquationPeq Modified	$\frac{Pu\ (exp)}{Pu\ original}$	$\frac{Pu\ (exp)}{Pu\ Modified}$
		mm	mm	mm		Mpa	mm^2	Ton	Ton	Ton		
RCC	F	600	75	150	2	31.11	100.5	7.1	2.69	6.15	2.64	1.15
	A_1	800	75	200	2	31.11	100.5	7.3	3.03	6.92	2.41	1.05
	H	1000	75	250	2	31.11	157.1	8.2	3.86	8.82	2.12	0.93
	I	1200	75	300	2	31.11	157.1	9	4.18	9.55	2.15	0.94
	J	1400	75	350	2	31.11	157.1	9.4	4.48	10.23	2.10	0.92
PFRC	F	600	75	150	2	34.25	100.5	7.1	2.78	7.23	2.55	0.98
	A_1	800	75	200	2	34.25	100.5	7.8	3.13	8.02	2.49	0.97
	H	1000	75	250	2	34.25	157.1	9.7	3.99	9.99	2.43	0.97
	I	1200	75	300	2	34.25	157.1	10.1	4.32	10.74	2.34	0.94
	J	1400	75	350	2	34.25	157.1	11.2	4.63	11.44	2.42	0.98
SFRC	F	600	75	150	2	31.78	100.5	7.3	2.71	8.83	2.69	0.83
	A_1	800	75	200	2	31.78	100.5	7.9	3.05	9.6	2.59	0.82
	H	1000	75	250	2	31.78	157.1	12.2	3.89	11.52	3.14	1.06
	I	1200	75	300	2	31.78	157.1	12.5	4.21	12.25	2.97	1.02
	J	1400	75	350	2	31.78	157.1	13.6	4.51	12.94	3.02	1.05



Graph 8-4Comparisons Of Shear Strength Values For RCC Beams



Graph 8-5 Comparisons Of Shear Strength Values For PFRC Beams



Graph 8-6 Comparisons Of Shear Strength Values For SFRC Beams

Size Effect parameter such as Shear span to depth ratio, Compressive strength of concrete for RCC beams and Volume of Fiber and Aspect ratio for PFRC and SFRC beams incorporate in Original equation given by Eurocode-02:2004. Table 8-2 reveals that the Ratio of Experimental results to Modified Eurocode equation results in nearly Unity for RCC Beams, PFRC Beams and SFRC Beams.

In RCC beam (Graph 8-4), PFRC beam (Graph 8-5) and SFRC beam (Graph 8-6) the Shear strength of the beam is almost similar in experimental results and Modified Eurocode equation after incorporating size effect parameter.

It is observed from Table 8-3 that All data taken from Past thesis work.The Experimental results and Modified Eurocode equationresults are almost similar while other researcher, code ACI 318:2008 [5], Zsutty and G. Apppa Rao and R Sudarshan[41] results not in the close range with experimental results.

8.11. COMPARISON OF ULTIMATE SHEAR STRENGTH OF VARIOUS PAST THESIS BEAM DATA BY TEST RESULTS, ORIGINAL EC-02 EQUATION AND VARIOUS OTHER RESEARCHER'S EQUATIONS.

Table 8-3 Comparison Of Ultimate Shear Strength Of Various Beam Data Of Past Thesis With Other Researcher's Equations

Beam	b	d	L	a/d	Þst (%)	fck	Experimental, Pex	EC-02 :2004[7]	EC-02 modified	ACI - 318 : 2008[5]	Zsutty	G. Appa Rao and R Sundaresan[41]
	mm	mm	mm			N/mm^2	Ton	Ton	Ton	Ton	Ton	Ton
D30	150	270	1300	2.22	0.39	20	8.5	6.95	14.23	3.59	15.50	12.05
D40	150	370	1300	1.62	0.41	20	13.2	10.33	14.28	4.92	32.87	21.17
D50	150	470	1300	1.28	0.32	20	21.3	12.83	26.55	6.25	53.04	29.18
D30	150	270	1300	2.22	0.39	20	10.9	6.95	14.23	3.59	15.50	12.05
D40	150	370	1300	1.62	0.41	20	13.4	10.33	14.28	4.92	32.87	21.17
D30	150	270	1300	2.22	0.39	20	11	6.95	14.23	3.59	15.50	12.05
D40	150	370	1300	1.62	0.41	20	16.5	10.33	19.28	4.92	32.87	21.17
D30	150	270	1300	2.22	0.39	20	9.5	6.95	10.23	3.59	15.50	12.05
D40	150	370	1300	1.62	0.41	20	15.4	10.33	19.28	4.92	32.87	21.17
D30	150	270	1300	2.22	0.39	20	10.9	6.95	10.23	3.59	15.50	12.05
D40	150	370	1300	1.62	0.41	20	16.9	10.33	19.28	4.92	32.87	21.17
D30	150	270	1300	2.22	0.39	20	9.2	6.95	10.23	3.59	15.50	12.05
D40	150	370	1300	1.62	0.41	20	13.08	10.33	14.28	4.92	32.87	21.17
D50	150	470	1300	1.28	0.32	20	22.4	12.83	26.55	6.25	53.04	29.18
D30	150	270	1300	2.22	0.39	49	13.4	9.37	19.18	5.62	20.90	18.87

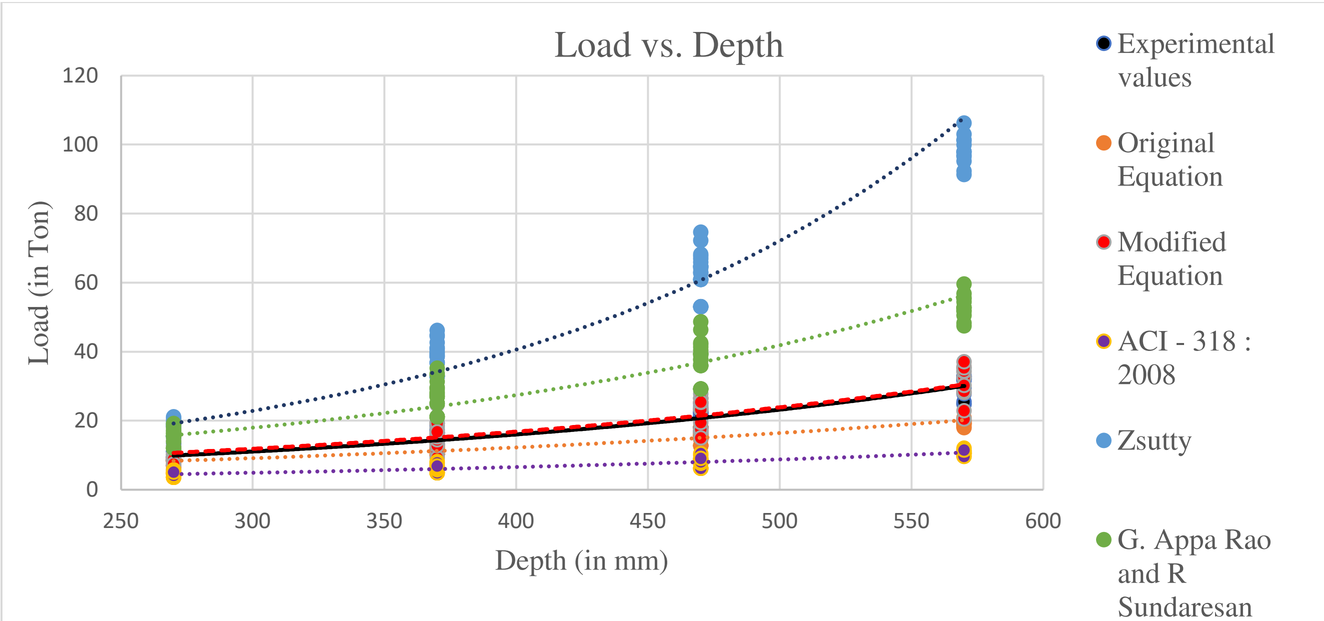
Beam	b	d	L	a/d	þst (%)	fck	Experimental, Pex	EC-02 :2004[7]	EC-02 modified	ACI - 318 : 2008[5]	Zsutty	G. Appa Rao and R Sundaresan[41]
	mm	mm	mm			N/mm^2	Ton	Ton	Ton	Ton	Ton	Ton
D30	150	270	1300	2.22	0.39	47.21	13.7	9.25	14.94	5.52	20.64	18.52
D60	150	570	1300	1.05	0.26	43.7	32.5	19.91	28.19	11.20	101.23	55.44
D30	150	270	1300	2.22	0.39	41.32	15.10	8.85	18.12	5.16	19.74	17.33
D40	150	370	1300	1.62	0.41	43.78	18.50	13.41	18.01	7.28	42.68	31.33
D30	150	270	1300	2.22	0.39	36.28	9.50	8.48	7.98	4.84	18.90	16.23
D40	150	370	1300	1.62	0.41	28.00	10.30	11.55	10.71	5.82	36.77	25.05
D50	150	470	1300	1.28	0.32	36.40	18.10	15.66	16.83	8.43	64.76	39.36
D60	150	570	1300	1.05	0.26	39.56	32.10	19.26	35.71	10.66	97.92	52.75
D30	150	270	1300	2.22	0.39	33.67	8.50	8.27	7.29	4.66	18.44	15.64
D40	150	370	1300	1.62	0.41	32.50	16.50	12.14	14.42	6.27	38.64	26.99
D50	150	470	1300	1.28	0.32	30.36	20.90	14.74	23.50	7.70	60.96	35.95
D30	150	270	1300	2.22	0.39	20.00	9.50	6.95	7.23	3.59	15.50	12.05
D40	150	370	1300	1.62	0.41	20.00	10.30	10.33	9.28	4.92	32.87	21.17
D50	150	470	1300	1.28	0.32	20.00	18.10	12.83	16.55	6.25	53.04	29.18
D30	150	270	1300	2.22	0.39	20.00	8.50	6.95	7.23	3.59	15.50	12.05
D40	150	370	1300	1.62	0.41	20.00	16.50	10.33	19.28	4.92	32.87	21.17
D50	150	470	1300	1.28	0.32	20.00	16.90	12.83	16.55	6.25	53.04	29.18

Beam	b	d	L	a/d	þst (%)	fck	Experimental, Pex	EC-02 :2004[7]	EC-02 modified	ACI - 318 : 2008[5]	Zsutty	G. Appa Rao and R Sundaresan[41]
	mm	mm	mm			N/mm^2	Ton	Ton	Ton	Ton	Ton	Ton
D30	150	270	1300	2.22	0.39	50.55	8.50	9.47	9.38	5.71	21.11	19.16
D40	150	370	1300	1.62	0.41	50.55	13.20	14.07	13.88	7.82	44.77	33.66
D50	150	470	1300	1.28	0.32	50.55	21.30	17.47	23.41	9.94	72.25	46.39
D60	150	570	1300	1.05	0.26	50.55	31.70	20.90	32.58	12.05	106.26	59.63
D30	150	270	1300	2.22	0.39	38.03	11.20	8.61	12.63	4.95	19.20	16.62
D40	150	370	1300	1.62	0.41	38.03	17.20	12.79	16.27	6.78	40.72	29.20
D60	150	570	1300	1.05	0.26	38.03	32.80	19.01	34.20	10.45	96.64	51.72
D30	150	270	1300	2.22	0.39	33.22	9.20	8.23	10.05	4.63	18.36	15.54
D40	150	370	1300	1.62	0.41	33.22	19.30	12.23	24.67	6.34	38.93	27.29
D50	150	470	1300	1.28	0.32	33.22	22.40	15.19	25.19	8.05	62.81	37.60
D60	150	570	1300	1.05	0.26	33.22	24.80	18.17	20.49	9.77	92.38	48.34
D30 S0	150	270	1300	2.22	0.39	37.24	8.50	8.55	8.69	4.90	19.07	16.45
D40 S0	150	370	1300	1.62	0.41	55.31	13.20	14.50	14.10	8.18	46.14	35.21
D50 S0	150	470	1300	1.28	0.32	55.75	21.30	18.05	23.51	10.43	74.64	48.71
D30 S0	150	270	1300	2.22	0.39	32.22	11.20	8.15	16.68	4.56	18.17	15.30
D40 S0	150	370	1300	1.62	0.41	49.64	14.20	13.98	15.64	7.75	44.50	33.36
D50 S0	150	470	1300	1.28	0.32	38.32	24.80	15.93	27.82	8.65	65.87	40.39

Beam	b	d	L	a/d	þst (%)	fck	Experimental, Pex	EC-02 :2004[7]	EC-02 modified	ACI - 318 : 2008[5]	Zsutty	G. Appa Rao and R Sundaresan[41]
	mm	mm	mm			N/mm^2	Ton	Ton	Ton	Ton	Ton	Ton
D60 S 0	150	570	1300	1.05	0.26	38.30	32.80	19.05	34.40	10.49	96.87	51.90
D30 S 0	150	270	1300	2.22	0.39	33.81	9.20	8.28	9.95	4.67	18.46	15.67
D40 S 0	150	370	1300	1.62	0.41	34.00	14.60	12.33	14.94	6.41	39.23	27.61
D50 S 0	150	470	1300	1.28	0.32	35.56	22.40	15.54	26.39	8.33	64.25	38.90
D60 S 0	150	570	1300	1.05	0.26	43.81	24.80	19.93	28.27	11.22	101.31	55.51
D30 S 0	150	270	1300	2.22	0.39	36.28	9.50	8.48	9.35	4.84	18.90	16.23
D40 S 0	150	370	1300	1.62	0.41	28.00	10.30	11.55	12.75	5.82	36.77	25.05
D50 S 0	150	470	1300	1.28	0.32	36.40	18.10	15.66	16.83	8.43	64.76	39.36
D60 S 0	150	570	1300	1.05	0.26	39.56	32.10	19.26	35.31	10.66	97.92	52.75
D30 S 0	150	270	1300	2.22	0.39	33.67	8.50	8.27	8.93	4.66	18.44	15.64
D40 S 0	150	370	1300	1.62	0.41	32.50	14.90	12.14	14.42	6.27	38.64	26.99
D50 S 0	150	470	1300	1.28	0.32	30.36	20.90	14.74	23.25	7.70	60.96	35.95
D30 S 0	150	270	1300	2.22	0.39	36.28	9.50	8.48	8.86	4.84	18.90	16.23
D40 S 0	150	370	1300	1.62	0.41	28.00	10.30	11.55	12.75	5.82	36.77	25.05
D50 S 0	150	470	1300	1.28	0.32	36.40	18.10	15.66	16.83	8.43	64.76	39.36
D60 S 0	150	570	1300	1.05	0.26	39.56	32.10	19.26	35.31	10.66	97.92	52.75
D30 S 0	150	270	1300	2.22	0.39	33.60	8.50	8.26	8.91	4.65	18.43	15.62

Beam	b	d	L	a/d	þst (%)	fck	Experimental, Pex	EC-02 :2004[7]	EC-02 Modified	ACI - 318 : 2008[5]	Zsutty	G. Appa Rao and R Sundaresan[41]
	mm	mm	mm			N/mm^2	Ton	Ton	Ton	Ton	Ton	Ton
D40 S 0	150	370	1300	1.62	0.41	32.50	16.50	12.14	14.42	6.27	38.64	26.99
D50 S 0	150	470	1300	1.28	0.32	30.36	16.90	14.74	17.50	7.70	60.96	35.95
D30 S 5	150	270	1300	2.22	0.39	39.65	8.50	8.73	7.37	5.05	19.47	16.97
D40 S 5	150	370	1300	1.62	0.41	35.34	15.00	12.49	15.40	6.54	39.74	28.14
D50 S 5	150	470	1300	1.28	0.32	40.14	24.10	16.18	15.00	8.85	66.90	41.33
D60 S 5	150	570	1300	1.05	0.26	36.34	25.50	18.72	22.93	10.22	95.19	50.56
D30 S 5	150	270	1300	2.22	0.39	43.59	10.50	9.01	12.45	5.30	20.10	17.80
D40 S 5	150	370	1300	1.62	0.41	39.07	17.40	12.91	16.60	6.88	41.09	29.59
D50 S 5	150	470	1300	1.28	0.32	41.56	22.10	16.37	19.47	9.01	67.68	42.06
D60 S 5	150	570	1300	1.05	0.26	42.05	33.00	19.65	37.07	10.99	99.94	54.38
D30 S 7.5	150	270	1300	2.22	0.39	26.59	6.00	7.64	5.64	4.14	17.04	13.90
D40 S 7.5	150	370	1300	1.62	0.41	35.07	16.20	12.45	15.30	6.51	39.64	28.04
D50 S 7.5	150	470	1300	1.28	0.32	33.56	23.00	15.24	25.32	8.10	63.03	37.79
D60 S 7.5	150	570	1300	1.05	0.26	32.05	29.50	17.95	28.53	9.59	91.29	47.48
D30 S 7.5	150	270	1300	2.22	0.39	40.53	12.80	8.79	18.00	5.11	19.61	17.16
D40 S 7.5	150	370	1300	1.62	0.41	39.02	16.50	12.90	16.80	6.87	41.07	29.57
D50 S 7.5	150	470	1300	1.28	0.32	42.51	22.00	16.49	25.39	9.11	68.19	42.54
D60 S 7.5	150	570	1300	1.05	0.26	45.99	27.80	20.25	30.20	11.49	102.96	56.87

8.12. GRAPHICAL REPRESENTATION COMPARISON OF ULTIMATE SHEAR STRENGTH OF VARIOUS PAST THESIS BEAM DATA BY ORIGINAL EC-02 EQUATION, MODIFIED EQUATION AND TEST RESULTS.



Graph 8-7 Comparison of Ultimate Shear Strength of Various Past Thesis Beam

It reveals from Graph 8-7 that by Incorporating Size Effect parameter in Eurocode equation the Experimental results are almost consistent and within approximation almost in close range. The final values differ slightly with Modified Eurocode equation.

The Modified Equation results nearly close to the Experimental Results. Other Researchers G App Rao , Zsutty and ACI – 318 results are not close to experimental results.