DEVELOPMENT OF SENSITIVITY-BASED MODEL FOR FLEXURAL FAILURE OF SINGLY REINFORCED CONCRETE SLABS BASED ON EURO CODE 2:1995

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ABSTRACT

This research presents mathematical models for checking the effect of variation in key designed parameters on the structural collapse of singly reinforced concrete solid slabs in buildings during construction due to flexural failure based on Euro Code (EC) 2, 1995. Structural collapses are widely experience globally and this has been due to improper management arising from variations application in structural key parameters during construction. This therefore calls for development of explicit model for easy check of the effect of variation in key parameters on structural collapse of reinforced concrete members during construction based on EC2, 1995. The key parameters considered are; characteristic strength of reinforcement, grade of concrete, diameter and spacing of tension reinforcement, effective depth of tension reinforcement, applied moment. Sensitivity analysis was applied to study the effect of variation in the key parameters on the moment capacity. The results of sensitivity analysis were utilized in regression analysis to develop simplified equations for estimating the moment capacity of the slab. Computer programme was developed based on EC2 using Java to verify the model. Flexure safety factor was checked based on EC2, 1995 requirements. Forty five (45) numerical examples were taken to verify the validity of the model with the developed computer programme at 5% significance level using Chi-squared as an instrument for sensitivity-based model for flexural failure of singly reinforced concrete slab. The results shows that the model is adequate at 5% significance level for checking flexural failure of singly reinforced concrete slab at construction based on Euro Code, EC2, 1995. It was recommended that the construction practitioners should consider the diverse effect of change in key parameters during construction, otherwise the developed model should be strictly considered for quick safety check especially deflection safety of a solid slab during construction

Keywords: *JAVA Programming, Sensitivity, Moment Capacity, Key Parameters, Flexural Failure*

1.0 INTRODUCTION

Design of Concrete Structure, *General Rules and Rules for Building* are mostly carried out based on British or European Standards (BS or EC2). However, whether the design has been based on British or European Standard, structural collapses are widely experience globally and this has been of great concern to structural designers. Seemingly, the phenomenon is due to improper management arising from variations application in structural key parameters during construction as investigated by many researchers.

The incidence of building collapse globally including Nigeria has been on increase. Many studies have been carried out on building collapse in Nigeria by some researchers like Ali, 2012; Atume, 2012; Salan, 1996; Matawal,(2012; Matawa and Oyang,, 2012; NBBRI, 2011a,b,c, 2012; Wardhana and Hadippprìono, 2003; Taiwo and Afolani, 2011 just but to mention a few, and all states the probable causes and the possible solutions. Though much research have been conducted on frequent collapse of buildings in Nigeria and measure to reducing or curbing the collapse suggested by Adebayo, 2000,2005, 2006; Arayela and Adam, 2001; Ayinuola and Olalusi, 2004; Bamisele, 2000; Ede, 2010a, 2010b, 201); Ezeage, 2007; Yusuf, 2002 there is still room for further research as the phenomenon does not show sign of abating.

Sensitivity analysis of the effect of variation in key parameters on the resistance of reinforced concrete members has been carried out by many researchers (Ali, 2012; Dias, 1996; Hamby, 1994; Lind, 1983; Nowak and Tabsh 1989; Oloyede, Omooguo amd Akinjare, 2010; Oyenuga, 2011; Oyewande, 1992). Despite these previous studies, development of sensitivity-based regression

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model for checking key parameters in structural collapses of reinforced concrete member under flexure based on EC2, 1995 have not been given much attention. Similarly, sensitivity-based model as a construction management tool for estimating the influence of variation on the safety of any reinforced concrete member during construction is yet to be developed Although, detailed structural design could be used to achieve this during construction however, significant expertise effort is required.

There seemingly variation in the key parameters of the structural members at the construction due to some reasons that are best known to the site engineers or contractors (Cowan, 1989; Roddis, 1993; Salan, 1996). At the construction these key parameters of the structural elements are altered either to reduce the cost or unavailability of some materials as specified in the design or introduction of hollow members like pipes and so on which decrease the effective area of the concrete. This therefore calls for development of explicit model for easy check of the effect of variation in key parameters on structural collapse of reinforced concrete members during construction. The use of explicit the model will ensure that structural members meet the minimum safety criterial during construction thus reducing the risk of structural collapse.

Consequently, this paper presents sensitivity-based regression model for checking the effect of variations in key parameters on the flexure collapse of singly reinforced concrete solid slab of building at the construction based on EC2:1995 using partial differential sensitivity analysis and regression .The proposed collapse check model considered sis key design parameters in structural collapse of reinforced concrete slabs namely: Characteristic strength of reinforcement and concrete; Diameter and spacing of tension reinforcement provided; Effective depth of tension reinforcement; Design span of slab; Fixed end condition of slab and Ultimate design load.

The obtained model was compared with the EC2, 1995 formula at 5% significance level using Chi-squared as an instrument for sensitivity-based model for flexural failure of singly reinforced concrete slab.

2.0 METHODOLOGY

The sensitivity-based model for checking key parameters in structural collapse of singly reinforced concrete slab under flexure encompasses the: formation of theoretical safety; moment capacity and effective depth of tension reinforcement; sensitivity and regression analysis of singly reinforced concrete solid slab under construction. Similarly, develop computer programme to verify and validate the model at 5% significance level using Chi-squared based on EC2. 21995.

2.1 Formulation of Safety theoretical equation of Slab under Flexure

The safety of structural members depends on its resistance and loads effects which can be expressed in term of limit state function (g).

According to Limit state principle, the safety margin, g of a structural member is given by equation (1)

$$g = g_c - g_a \qquad (1)$$

Where g is the safety margin, g_c is the resistance and, g_a is applied resultant load effects on the member.

Dividing equation (1) by g_a, to set the safety margin, g in % yielded equation (2) (Mohammed, 2014)

$$\frac{g_c}{g_a} = g + 1 \qquad (2)$$

The factor of safety, λ as defined by Mohammed, 2014 is

$$\lambda = 1 + g \qquad (3)$$

Replacing $1 + g$ in equation (2) yielded equation (4) which is the factor of safety against failure of slab in this study according to Mohammed, 2014.

$$\lambda = \frac{g_c}{g_a} .. > 1.00 \qquad (4)$$

Equation (4) is a limit state equation now defined the safety region $\lambda . > 1.00$, defined the failure region, and $\lambda = 1.00$ defined the boundary between the safety and failure regions. This implies that if $\lambda > 1.00$, the slab is safe otherwise the slab has failed.

According to EC2, 1995 when the depth of slab is less than or equal to 200mm, the major flexure failure of the slab is due to moment capacity. According to Mohammed, 2014 the flexural safety factor of a slab is defined as in equation (5)

$$\lambda_f = \frac{M_c}{M_a} = \left[E_1 \frac{\phi^2 f_y}{S_t}\left(d_{prov} - E_2 \frac{\phi^2 f_y}{S_t f_{cu}}\right)\right] \times 10^{-6} / \alpha F L^2 > 1.00 \quad (5)$$

Where; M_c - Moment capacity, M_a - applied moment due to factor loads (dead and imposed), and λ_f - flexural safety factor.

Similarly, the deflection safety factor of a slab is defined as

$$\lambda_d = \frac{d_{prov}}{d_{req}} = \frac{d_{prov} \times \varepsilon mf}{L} > 1.00$$

Where L is the effective span of the main reinforcement in millimeters, ε is the span-effective depth ratio, and mf is the modification factor respectively.

2.2. Moment Capacity Formula

Considering a rectangular singly reinforced concrete slab section with: yield strength of reinforcement, $\mathrm{f_y}$; compressive strength of concrete, $\mathrm{f_{cu}}$; the design moment capacity results from the internal compressive force, $\mathrm{F_{cc}}$ and internal tensile force, (T) separated by the lever arm (Z) as presented in Figure 1.

T = stress $\times$ area of action $= 0.87 f_{yk} \times A_{pr}$ (EC2, 1995)

$\mathrm{F_{cc}}$ = stress $\times$ area of action $= 0.56 f_{ck} \times bY$ (EC2, 1995)

Where; $\mathrm{A_{prov}}$ is the area of tension reinforced provided, b is the width of the slab and Y is the depth of stress block.

Having, $\mathrm{T} = \mathrm{F_{cc}}$, from equilibrium

$$0.87 f_{yk} A_{pr} = 0.45 f_{ck} bY \quad \text{(EC2, 1995)} \quad (6)$$

From equation (6) the depth of stress block is given by Equation (7), (EC2, 1995)

$$Y = \frac{0.87 f_{yk} A_{prov}}{0.56 f_{ck} b} \quad (7)$$

Taking moment about the compressive force ($\mathrm{F_{cc}}$) in the concrete, the moment capacity ($\mathrm{M_c}$) of a slab is given by Equation (8), (EC2, 1995)

$$M_c = 0.87 f_{yk} A_{pr} (d_{pr} - 0.5Y) \quad (8)$$

Replacing Y from equation (2.8) and simplifying yields the moment capacity equation, $\mathrm{M_c}$, of a singly reinforced concrete rectangular section gives Equation (9), (EC2, 1995)

$$M_c = \left[683.296 \frac{\emptyset^2 f_{yk}}{S_t}\left(d_{pr} - 0.610 \frac{\emptyset^2 f_{yk}}{S_t f_{ck}}\right)\right] \times 10^{-6}\ kNm \quad (9)$$

Where $\mathrm{f_{yk}}$ is the characteristic strength of steel, **d** is the effective depth of tension reinforcement, $\mathrm{f_{ck}}$ is the characteristic strength of concrete, $\emptyset$ is the diameter of the tension reinforcement bar and $\mathrm{S_t}$ is the Centre to Centre spacing between tension reinforcement

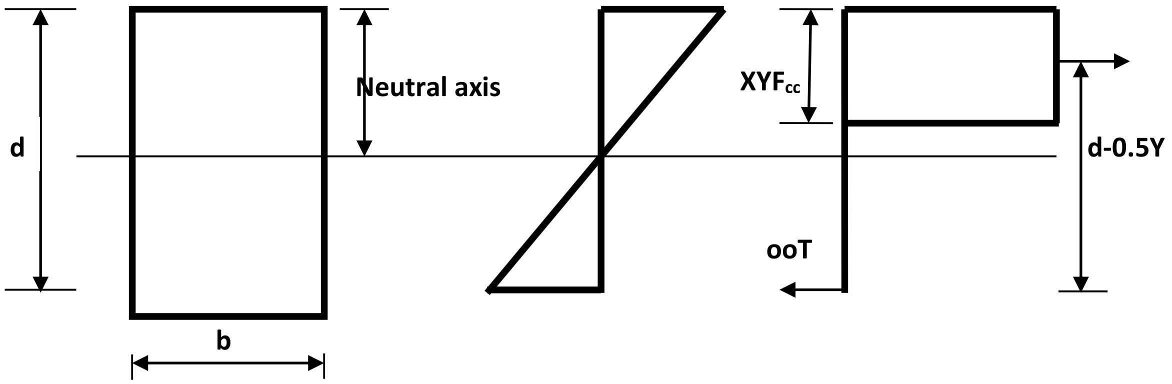

Figure 1: Singly Reinforced Concrete Section with Rectangular Stress Block

Let M_a be the applied moment for two way slab as expressed in equation

$$M_a = \alpha F L^2 (KNm)$$

Where α is the moment coefficient of a slab, L is the short span of the slab, F is the design factored load on a slab.

According to EC2, 1995 the design factored load is defined as

$$F = 1.5Q_k + 1.35G_k$$

Where Q_k, G_k are the unfactored imposed and dead loads on a slab respectively..

2.3. Differential Sensitivity Analysis

In order to conduct differential sensitivity analysis on the moment capacity, $\mathrm{M_c}$ reference data of key parameters of solid slab were used and the data were as presented in Table 1..

Table 1: Reference Value of Key Parameters for Moment Capacity

S/No	Parameter (y_{0i})	Reference Value
1	Characteristic strength of steel, f_{yk}	500N/mm^2
2	Diameter of tension steel bar, ϕ	16mm
3	Spacing of tension steel bars, S_t	300mm c/c
4	Effective depth of tension steel bar, d_{pr}	150mm
5	Characteristic strength of concrete, f_{ck}	30 N/mm^2

The reference data of the key parameters in moment capacity were varied in turn of w = $0\%, 1\%, 2\%, \ . \ . \ . \ , 50\%$, and effect of variations on moment capacity and contribution of each parameter on moment capacity were respectively obtained..

The differential sensitivity coefficient of the moment capacity parameters of slab as provided is given by:

$$\delta \mathrm{M_{cyi}} = \frac{\partial \mathrm{M_c}}{\partial \mathrm{y_i}} \delta \mathrm{y_i} \tag{10}$$

Where; $\mathrm{y_i}$ - the moment capacity parameters of a slab, $\delta\mathrm{y_i}$ - the change in $\mathrm{y_i}$ during construction and is define as:

$$\delta \mathrm{y_i} = 0.01\mathrm{w} \times \mathrm{y_i} \tag{11}$$

Where; w - the % change in, $\mathrm{y_i}$, during construction and is assigned the values, $0\%, 1\%, \ 2\%, \ . \ . \ . \ , \ 50\%$, in this study.

The contribution of each parameter to moment capacity, $\mathrm{M_{cy_i}}$, is given by:

$$\mathrm{M_{cy_i}} = \frac{\delta \mathrm{M_{cyi}}}{\sum_{i=1}^{n} \delta \mathrm{M_{cy_i}}} \mathrm{M_c} \tag{12}$$

2.4. Multiple Linear Regression Analysis of Moment Capacity

The sensitivity data were transformed and used in multiple linear regression analysis to obtain equation for estimating moment capacity. Let μ be the ratio of $\mathrm{y_i}$ to $\mathrm{y_{0i}}$ which is defined as:

$$\mu_i = \frac{\mathrm{y_i}}{\mathrm{y_{oi}}} \tag{13}$$

Let assume that the forth root of moment capacity ($\sqrt[4]{\mathrm{M_{cyi}}}$) in accordance to EC 2, 1995 has a linear relationship with, μ_i and is given by:

$$4\sqrt{M_{cyi}} = \beta_o + \beta_{yi}\frac{y_i}{y_{oi}} + \beta_{yi}\frac{y_2}{y_{o2}} + ...\beta_{yn}\frac{y_n}{y_{on}} + e_i \tag{14'}$$

Replacing y_i and y_{oi} in equation (14') yielded equation (14)

$$\sqrt[4]{M_c} = \left(\beta_o + \beta_{fy}\left(\frac{fy}{500}\right) + \beta_\phi\left(\frac{\phi}{16}\right) + \beta_{S_t}\left(\frac{s_t}{300}\right) + \beta_d\left(\frac{d_{pr}}{150}\right) + \beta_{f_{CU}}\left(\frac{f_{cu}}{30}\right) + e_i\right)$$

or

$$M_c = \left(\beta_0 + \beta_{f_y}\left(\frac{f_y}{500}\right) + \beta_\emptyset\left(\frac{\emptyset}{16}\right) + \beta_{S_t}\left(\frac{S_t}{300}\right) + \beta_d\left(\frac{d}{150}\right) + \beta_{f_{cu}}\left(\frac{f_{cu}}{30}\right)\right)^4 \quad (14)$$

Where $\beta_0, \beta_{f_y}, \beta_\emptyset, \beta_{S_t}, \beta_d, \beta_{f_{cu}}$ are the intercept and slopes, and are called regression coefficients, $\mathrm{e_i}$ is the error term and is assume to be uniformly distributed with mean zero and variance, σ^2

Model equation for estimating the moment capacity of a singly reinforced concrete slab of building during construction can be determined based on EC2, 1995 from equation (14)

Substitute equation (14) in (5) yields equation (15) for checking factor of safety against flexural failure of a singly reinforced concrete slab due to variation in flexural parameters during construction based on EC2, 1995.

$$\lambda_f = \begin{pmatrix} \beta_o + \beta_{fy}\left(\dfrac{fy}{500}\right) + \beta_\phi\left(\dfrac{\phi}{16}\right) + \beta_{S_t}\left(\dfrac{S_t}{300}\right) + \\ \beta_d\left(\dfrac{d_{pr}}{150}\right) + \beta_{f_{C_U}}\left(\dfrac{f_{cu}}{30}\right) / FL_x^2 or M_a \end{pmatrix}^4 \Rightarrow 1 \quad (15)$$

Where; M_c- the moment capacity, and M_a - applied resultant moment, and α is the moment coefficient of a slab, L is the design span of the slab, F is the design ultimate load on a slab, d_{pr} is the effective depth of tension reinforcement as provided, f_{yk} is the characteristic strength of steel, f_{ck} is the characteristic strength of concrete, $\emptyset$ is the diameter of the tension reinforcement, S_t is the centre to center spacing between tension reinforcement bars .

Equation (15) is the developed equation for checking key parameters in the flexural collapse of singly reinforced concrete solid slab in buildings during construction in this study in case of variation or changes in the key parameters of the singly reinforced concrete slab.

2.5. Development of Computer Programme

The computer programme was developed to verify the model using JAVA programming language, developed in net beans integrated development environment (IDE) 7.0.

The programme slab efficiency cal implemented one-way, two-way and cantilever slabs. One panel was checked at a time. The programme is divided into segments where all the various input and output are defined. The applied moment coefficient for two-way slab was obtained from the code while applied moment for one-way slab was generated using Chi-square three moment equation. The programme checked for flexural failure of each slab types and sub-types and draw visual inference on whether the slab checked was safe or not and the results were saved and printed. The flow chart depicting the computer programme is as presented in Figure 2.

2.6. Model Validation

Forty Five numerical examples were solved using the obtained model and the computer programme and the results were compared at 5% significance level that the variance of the factor of safety predicted does not exceeded 0.05 using Chi-square, (X_0^2 less than $X_{0.05,44}^2$) as recommended by Montgonery and Runger, (2013)

3.0. Results and Discussion

The relevant data from the sensitivity analysis were utilized in the regression analysis and the data used for regression analysis is as presented in appendix A. The summary of results of the regression analysis is presented in Table 2.

From the solution of regression analysis the equation for estimating moment capacity of singly reinforced concrete slab is given by equation (17) in accordance to EC2, 1995

$$\sqrt[4]{M_C} = 0.46 + 0.599\left(\frac{f_{yk}}{500}\right) + 1.118\left(\frac{\phi}{16}\right) - 0.599\left(\frac{S_t}{300}\right) + 0.634\left(\frac{d_{pr}}{150}\right) + 0.037\left(\frac{f_{ck}}{30}\right) \quad (17)$$

Hence the equation for checking key parameters in the flexural collapse of singly reinforced concrete solid slab during construction in this study using Chi-square in accordance to EC2, 1995 becomes:

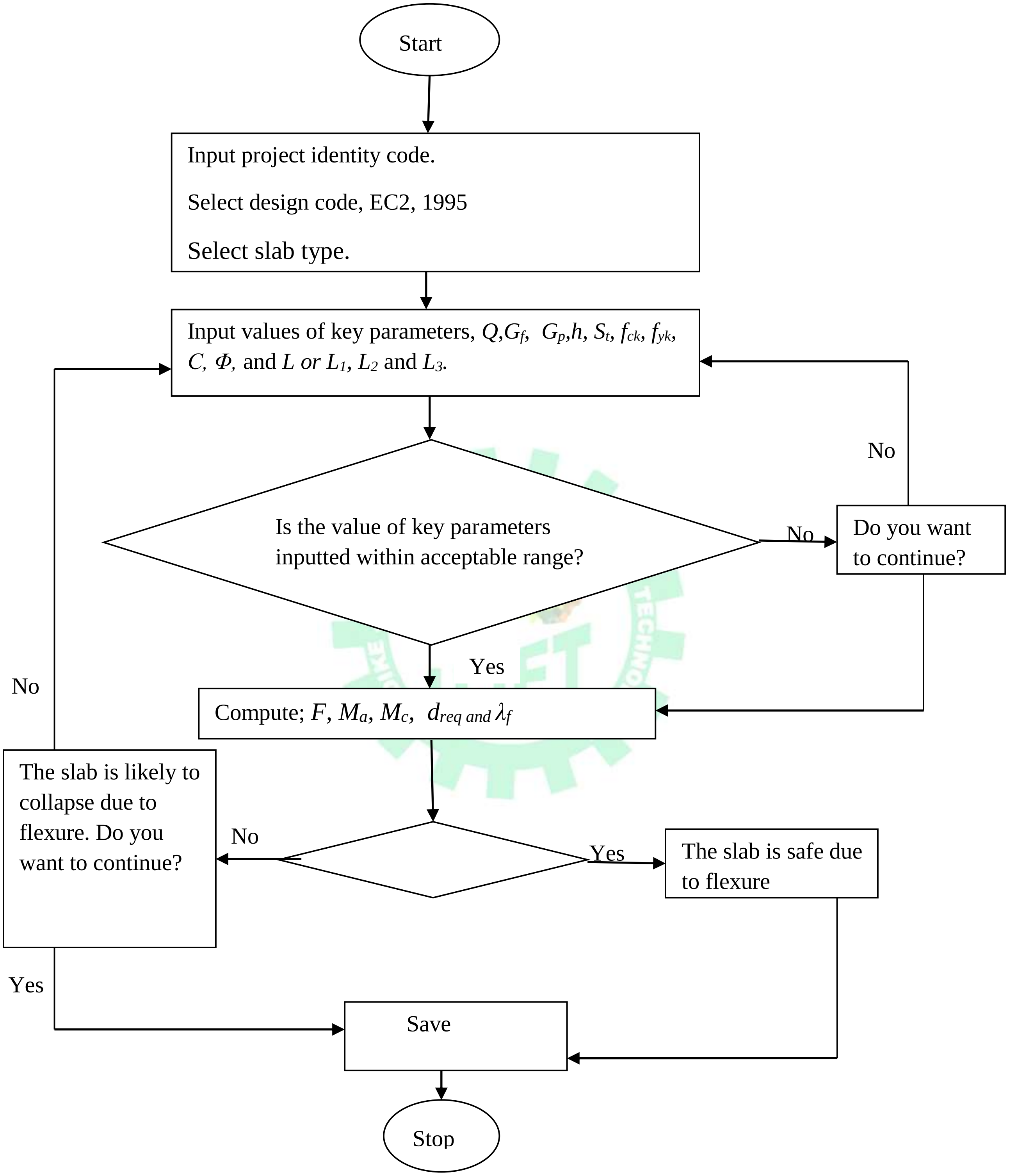

Figure 2: The Flow chart for checking flexural failure of singly reinforced concrete solid slabs in buildings during construction.

Table 2: Multiple regression for effects of key parameters on moment capacity Regression: Forth root of moment capacity against variations in key parameters in accordance to EC 2, 1995

$$Observation\ = 51,\ Coefficient\ of\ determination, R^{2} = \ 0.9998\ ,$$

$$Adjusted\ R^{2}\ =\ 0.9994,\qquad Standard\ error = 0.002\ ,\qquad \beta_{0} = 0.460\ ,$$

$$\beta_{f_y} = 0.599\ , \beta_{\emptyset} = 1.118,\ \beta_{S_t} = -0.599\ ,\ \beta_{d} = 0.634\ ,\ \beta_{f_{cu}} = 0.037$$

$$\lambda_f = \begin{pmatrix} 0.46 + 0.599\left(\dfrac{fy}{500}\right) + 1.118\left(\dfrac{\phi}{16}\right) + 0.599\left(\dfrac{s_t}{300}\right) \\ + 0.634\left(\dfrac{d_{pr}}{150}\right) + 0.037\left(\dfrac{f_{cu}}{30}\right) / FL_x^2 or M_a \end{pmatrix}^4 \Rightarrow 1$$

3.1. Model Validation

The results of the comparison of flexural collapse factor using the obtained model and formula in EC2: 1995 at 5% significance level that the variance of the flexural collapse factor predicted does not exceed 0.05 using Chi-square is as presented in Table 3.

Table 3: Comparison of Flexural Safety Factor based on EC2, 1995

S/No	Factor of Safety using Computer	Factor of Safety Using Model		
	λfc	λfm	λ_{fc} -λ_{fm}	$(\lambda_{cf} - \lambda_{fm})^3$
1	13.8	13.03	0.765	0.585
2	1.13	1.2	-0.075	0.006
3	4.53	4.37	0.164	0.027
4	6.07	6.41	-0.338	0.114
5	0.78	0.82	-0.038	0.001
6	1.98	2.06	-0.084	0.007
7	3.81	3.91	-0.099	0.01
8	0.7	0.92	-0.214	0.046
9	3.37	3.21	0.165	0.027
10	0.73	0.82	-0.087	0.008
11	2.86	3.01	-0.153	0.024
12	15.08	14.34	0.741	0.549
13	4.16	3.67	0.488	0.239
14	0.74	0.79	-0.047	0.002
15	1.78	1.95	-0.174	0.03
16	0.71	0.73	-0.023	0.001

17	2.02	2.16	-0.143	0.021
18	0.8	0.84	-0.043	0.002
19	1.3	1.4	-0.096	0.009
20	2.21	2.24	-0.031	0.001
21	2.81	2.62	0.199	0.04
22	5.66	4.82	0.836	0.7
23	3.22	3.25	-0.029	0.001
24	0.84	0.92	-0.083	0.007
25	3.41	3.65	-0.239	0.057
26	1.94	2.33	-0.388	0.151
27	1.13	1.16	-0.035	0.001
28	0.65	0.67	-0.013	0
29	0.69	0.76	-0.068	0.005
30	1.26	1.33	-0.077	0.006
31	8.8	8.63	0.166	0.028
32	5.02	5.92	-0.895	0.801
33	0.87	0.97	-0.095	0.009
34	1.1	1.07	0.024	0.001
35	3.32	2.96	0.364	0.133
36	0.33	0.36	-0.03	0.001
37	0.6	0.69	-0.082	0.007
38	0.7	0.75	-0.051	0.003
39	0.55	0.61	-0.061	0.004
40	1.26	1.41	-0.142	0.02
41	1.75	1.83	-0.08	0.006
42	2.77	2.69	0.078	0.006
43	1.42	1.41	0.01	0
44	0.57	0.54	0.033	0.001
45	0.9	0.98	-0.081	0.007

Variance, $S^2 = \frac{\sum(\lambda_c - \lambda_m)^2}{n-1} = 0.060$

The calculated Chi-square, $X_0^2 = \frac{(n-1)S^2}{\sigma_0^2} = \frac{44(0.04071)}{0.05} = 52.80$

From the Chi-square Table, $X^2_{0.05,44} = 60.30 > 52.80$ then we accept that the variance of the flexural safety factor predicted using the obtained model equation based on EC2, 1995 has not exceeded 0.05. This show that the model is acceptable at 5% significance level.

4.0. CONCLUSIONS

Based on the analysis of the results obtained from the research the following conclusions were made:

1 Sensitivity-based model indicates that the effective depth, diameter, strength and spacing of tension reinforcement have a much greater influence on moment capacity of a singly reinforced concrete solid slab than that of the concrete strength alone.

This also agrees with Ali, (2012) and Dias,(1996);

2 The model is adequate at 5% significance level for checking the effect of variation in key parameters on the flexural collapse of singly reinforced concrete solid slabs of buildings during construction.

3 Practitioners should be educated on the consequence of change in key parameters during construction. There is need for practitioners to develop similar model for other structural members in buildings for quick safety checks during construction

4 The computer programme could be used for checking flexural failure of singly reinforced concrete slabs in buildings during construction based on EC2, 1995.

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Appendix A: Effect of Variations in Key Parameters on Moment Capacity (BS EC2, 1995)

	Value of Key Parameters Provided during Construction (y_i)					Total M_{ci} (kNm)	Forth root of total M_c(kNm)	Effect of Key Parameters on Forth root of Moment Capacity (M_{cy})					
% change w(%)	f_y(N/mm^2)	Φ (mm)	S_t(mm)	d_{pr} (mm)	f_{cu}(N/mm^2)			M_{cfy}(kNm)	$M_{c\Phi}$ (kNm)	M_{cSt}(kNm)	M_{cd} (kNm)	M_{cfcu}(kNm)	μ
0.00	500.000	12.000	300.000	150.000	30.000	23.7984	2.2087	0.6910	1.3821	-0.6910	0.7814	0.0452	1.00
1.00	495.000	11.880	297.000	148.500	29.700	23.0915	2.1921	0.6858	1.3717	-0.6858	0.7756	0.0449	0.99
2.00	490.000	11.760	294.000	147.000	29.400	22.3988	2.1755	0.6806	1.3613	-0.6806	0.7697	0.0445	0.98
3.00	485.000	11.640	291.000	145.500	29.100	21.7201	2.1588	0.6754	1.3509	-0.6754	0.7638	0.0442	0.97
4.00	480.000	11.520	288.000	144.000	28.800	21.0553	2.1421	0.6702	1.3404	-0.6702	0.7579	0.0438	0.96
5.00	475.000	11.400	285.000	142.500	28.500	20.4041	2.1253	0.6650	1.3299	-0.6650	0.7519	0.0435	0.95
6.00	470.000	11.280	282.000	141.000	28.200	19.7666	2.1085	0.6597	1.3194	-0.6597	0.7460	0.0431	0.94
7.00	465.000	11.160	279.000	139.500	27.900	19.1424	2.0917	0.6544	1.3089	-0.6544	0.7400	0.0428	0.93
8.00	460.000	11.040	276.000	138.000	27.600	18.5315	2.0748	0.6491	1.2983	-0.6491	0.7341	0.0425	0.92
9.00	455.000	10.920	273.000	136.500	27.300	17.9338	2.0579	0.6438	1.2877	-0.6438	0.7281	0.0421	0.91
10.00	450.000	10.800	270.000	135.000	27.000	17.3490	2.0409	0.6385	1.2771	-0.6385	0.7221	0.0418	0.90
11.00	445.000	10.680	267.000	133.500	26.700	16.7771	2.0239	0.6332	1.2664	-0.6332	0.7160	0.0414	0.89
12.00	440.000	10.560	264.000	132.000	26.400	16.2179	2.0068	0.6279	1.2557	-0.6279	0.7100	0.0411	0.88
13.00	435.000	10.440	261.000	130.500	26.100	15.6713	1.9896	0.6225	1.2450	-0.6225	0.7039	0.0407	0.87
14.00	430.000	10.320	258.000	129.000	25.800	15.1371	1.9725	0.6171	1.2343	-0.6171	0.6979	0.0404	0.86
15.00	425.000	10.200	255.000	127.500	25.500	14.6152	1.9552	0.6117	1.2235	-0.6117	0.6918	0.0400	0.85
16.00	420.000	10.080	252.000	126.000	25.200	14.1054	1.9380	0.6063	1.2127	-0.6063	0.6856	0.0397	0.84
17.00	415.000	9.960	249.000	124.500	24.900	13.6076	1.9206	0.6009	1.2018	-0.6009	0.6795	0.0393	0.83
18.00	410.000	9.840	246.000	123.000	24.600	13.1217	1.9033	0.5955	1.1910	-0.5955	0.6734	0.0389	0.82
19.00	405.000	9.720	243.000	121.500	24.300	12.6474	1.8858	0.5900	1.1800	-0.5900	0.6672	0.0386	0.81
20.00	400.000	9.600	240.000	120.000	24.000	12.1848	1.8683	0.5845	1.1691	-0.5845	0.6610	0.0382	0.80
21.00	395.000	9.480	237.000	118.500	23.700	11.7335	1.8508	0.5791	1.1581	-0.5791	0.6548	0.0379	0.79
22.00	390.000	9.360	234.000	117.000	23.400	11.2936	1.8332	0.5735	1.1471	-0.5735	0.6486	0.0375	0.78
23.00	385.000	9.240	231.000	115.500	23.100	10.8647	1.8155	0.5680	1.1361	-0.5680	0.6423	0.0371	0.77
24.00	380.000	9.120	228.000	114.000	22.800	10.4469	1.7978	0.5625	1.1250	-0.5625	0.6361	0.0368	0.76
25.00	375.000	9.000	225.000	112.500	22.500	10.0399	1.7801	0.5569	1.1139	-0.5569	0.6298	0.0364	0.75

26.00	370.000	8.880	222.000	111.000	22.200	9.6437	1.7622	0.5513	1.1027	-0.5513	0.6235	0.0361	0.74
27.00	365.000	8.760	219.000	109.500	21.900	9.2580	1.7443	0.5457	1.0915	-0.5457	0.6171	0.0357	0.73
28.00	360.000	8.640	216.000	108.000	21.600	8.8827	1.7264	0.5401	1.0803	-0.5401	0.6108	0.0353	0.72
29.00	355.000	8.520	213.000	106.500	21.300	8.5177	1.7084	0.5345	1.0690	-0.5345	0.6044	0.0350	0.71
30.00	350.000	8.400	210.000	105.000	21.000	8.1628	1.6903	0.5288	1.0577	-0.5288	0.5980	0.0346	0.70
31.00	345.000	8.280	207.000	103.500	20.700	7.8180	1.6721	0.5232	1.0463	-0.5232	0.5916	0.0342	0.69
32.00	340.000	8.160	204.000	102.000	20.400	7.4830	1.6539	0.5175	1.0349	-0.5175	0.5852	0.0338	0.68
33.00	335.000	8.040	201.000	100.500	20.100	7.1577	1.6357	0.5117	1.0235	-0.5117	0.5787	0.0335	0.67
34.00	330.000	7.920	198.000	99.000	19.800	6.8419	1.6173	0.5060	1.0120	-0.5060	0.5722	0.0331	0.66
35.00	325.000	7.800	195.000	97.500	19.500	6.5356	1.5989	0.5002	1.0005	-0.5002	0.5657	0.0327	0.65
36.00	320.000	7.680	192.000	96.000	19.200	6.2386	1.5804	0.4945	0.9889	-0.4945	0.5591	0.0323	0.64
37.00	315.000	7.560	189.000	94.500	18.900	5.9507	1.5619	0.4887	0.9773	-0.4887	0.5526	0.0320	0.63
38.00	310.000	7.440	186.000	93.000	18.600	5.6718	1.5432	0.4828	0.9657	-0.4828	0.5460	0.0316	0.62
39.00	305.000	7.320	183.000	91.500	18.300	5.4018	1.5245	0.4770	0.9540	-0.4770	0.5394	0.0312	0.61
40.00	300.000	7.200	180.000	90.000	18.000	5.1405	1.5057	0.4711	0.9422	-0.4711	0.5327	0.0308	0.60
41.00	295.000	7.080	177.000	88.500	17.700	4.8877	1.4869	0.4652	0.9304	-0.4652	0.5261	0.0304	0.59
42.00	290.000	6.960	174.000	87.000	17.400	4.6433	1.4679	0.4593	0.9186	-0.4593	0.5194	0.0300	0.58
43.00	285.000	6.840	171.000	85.500	17.100	4.4073	1.4489	0.4533	0.9067	-0.4533	0.5126	0.0296	0.57
44.00	280.000	6.720	168.000	84.000	16.800	4.1794	1.4298	0.4473	0.8947	-0.4473	0.5059	0.0293	0.56
45.00	275.000	6.600	165.000	82.500	16.500	3.9595	1.4106	0.4413	0.8827	-0.4413	0.4991	0.0289	0.55
46.00	270.000	6.480	162.000	81.000	16.200	3.7474	1.3913	0.4353	0.8706	-0.4353	0.4922	0.0285	0.54
47.00	265.000	6.360	159.000	79.500	15.900	3.5430	1.3720	0.4292	0.8585	-0.4292	0.4854	0.0281	0.53
48.00	260.000	6.240	156.000	78.000	15.600	3.3462	1.3525	0.4232	0.8463	-0.4232	0.4785	0.0277	0.52
49.00	255.000	6.120	153.000	76.500	15.300	3.1569	1.3330	0.4170	0.8341	-0.4170	0.4716	0.0273	0.51
50.00	250.000	6.000	150.000	75.000	15.000	2.9748	1.3133	0.4109	0.8218	-0.4109	0.4646	0.0269	0.50