COMPUTER PROGRAMMING FOR SAFE BEARING CAPACITY CALCULATION OF FOOTING AS PER IS CODE & EUROCODE 7 USING VB-6.0

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ABSTARCT: Geotechnical Engineers are concerned with ensuring adequate safety margin against shear failure of foundations by soil rupture. The process of deciding allowable bearing pressure for footings is iterative in nature as one has to satisfy both shear as well as settlement criteria. It is purposed to prepare a computer program for determination of safe bearing capacity of footing which satisfies shear criteria. In this dissertation a program is prepared in VISUAL BASIC 6.0 due to its user friendly interface and ease to aesthetic appearance. The dissertation deals with the development of software using VB 6.0 for the determination of bearing capacity of footing including different shape, depth, inclination factors, eccentricity, different types of shear failures and effects of water table as per IS 6403: 1981(shear criteria) for isolated footing. The results obtain for SBC from IS 6403:1981(shear criteria) is compared with the Euro code 7.

KEYWORDS: IS Code 6403:1981(shear criteria), Comparison, Eurocode7 and worked example

INTRODUCTION: The most of the structures include building, earth fill concrete dams; it is earth that provides ultimate support. The bearing capacity of foundations is needed for dimensioning the foundation for any structure. Several methods are available for the determination of bearing capacity of shallow foundations and give some of the methods which are commonly used for the purpose. The various methods is applied to different problems of allowable bearing pressure. The safe bearing capacity obtains from program.

It is proposed to prepare a general purpose computer program in visual Basic 6.0 for the shallow foundation proportioning for the given soil strata, design shear strength parameters and compressibility parameters, the safe bearing capacity of the footing with reference to shear criteria can be calculated using this program.

METHODOLOGY

Based on type of soil considered criteria for type of failure.

- Bearing capacity factors, size, shape, inclination and water table correction factors are calculated using codal equations.
- Based on eccentricities effective size of footing is worked out.
- As per the soil type and type of shear failure formula from **IS 6403:1981** is used to calculate net ultimate bearing capacity and then dividing by factor of safety obtained safe bearing capacity.

- INPUTS BY USER:
  - Firstly select type of soil
  - Select criteria for type of failure
  - Input geometry data
  - Input soil parameter, and input the data of cohesion and angle of internal friction
  - Input inclination and eccentricity
  - Input ground water table condition
  - Input factor of safety
    - Click on Analyze by IS code, it will give Ultimate Bearing Capacity and Safe Bearing Capacity, according to IS code
    - Click on Analyze by Euro code, it will give Ultimate Bearing Capacity and Safe Bearing Capacity, according to Euro code
    - For the results of report ,click on text file
    - To input new data, click on New data button

WORKED EXAMPLE:

Reference Book: Rao Gopal Ranjan A.S.R. "Basic and Applied Soil mechanics (Example 15.7, page 526)	
Type of footing	Rectangular
Length	4m
Width	2m
Depth	1.5 m
Cohesion of soil (kN/m^2)	15
Angle Of Internal Friction	25^0
Ground water table	2 m
Unit weight Of Soil (kN/m^3)	18
Inclination Angle of Load	15^0
Eccentricity along width	0.15 m
Factor of safety	3

Table 1: Solution by IS code method

q_{nu}=c N_c d_c S_c i_c +γ D_f (N_q -1)s_q d_q i_q +0.5 γ B N_γ d_γ S_γ i_γ w′

c' = 15 kN/m^2 ϕ = 25

Nc = 20.7 Nq =10.7 and Nγ = 10.9

$\gamma = \gamma_{sat}$ = kN/m^3

q = 18 x 1.5 = 27 kN/m^2

Dw'/B =0.25 (Dw' = 2.0-1.5 = 0.5 m)

So from fig w' = 0.625

e_x = 0.15 m effective width

B' = B- 2e_x = 2-0.3 =1.7 m

Sc = Sq = 1 + 0.2 (B'/L) = 1+0.2(1.7/4.0) =1.025

Sγ =1- 0.4(B'/L) =1 – 0.4(1.7/4.0) = 0.83

$dc = 1 + 0.2(\frac{Df}{B'})\tan(45 + \frac{\phi}{2})$ = 1 + 0.2 (1.5/1.7)tan57.5 = 1.28

$dq = d\gamma = 1 + 0.1(\frac{Df}{B'})\tan(45 + \frac{\phi}{2})$ =1+ 0.1 (1.5/1.7)tan57.5 = 1.14

$ic = iq = 1 - (\frac{\alpha}{90^\circ})^2$ = 1 – $(15/90)^2$ = 0.69

$i\gamma = 1 - (\frac{\alpha}{\phi})^2$ = 1-$(15/25)^2$ = 0.16

q_{un} = (15 × 20.7 ×1.085 ×1.28 × 0.69)+(27 × 9.7 × 1.085 × 1.14 × 0.69)+(0.5×18×1.7× 10.9×0.83×1.14×0.16×0.625)

= 297.5 + 223.5 + 15 8

= 536.8 kN

Solution by Euro code method:

ϕ = 25 c = 15

$Nq = \tan\ ^2\left(45 + \frac{\varphi}{2}\right) e^{\pi tan\varphi}$ = 10.66

Nv = 2 (Nq - 1) tanϕ = 9.011

Nc = (Nq – 1) tanϕ = 20.72

α = 15

bq = bv = [1-α tanϕ]² = 0.77

bc = bq – (1 – bq) / tanϕ = 0.747

e_x = 0.15 m effective width

B' = B- 2e_x = 2-0.3 =1.7 m and L' = 4

$Sq = 1 + B/L \sin \phi = 1.179$

$Sv = 1 - 0.3\,(B/L) = 0.87$

$Sc = (Sq \times (Nq - 1)) / (Nq - 1) = 1.198$

$q = 18 \times 1.5 = 27$

$q = (c\,Nc\,Sc) + (q\,Nq\,Sq) + (0.5 \times B\,Nv\,Sv)$

$= (15 \times 20.72 \times 1.198) + (27 \times 10.66 \times 1.179) + (0.5 \times 1.7 \times 18 \times 9.01 \times 0.87)$

$= 832.29$

$V = \text{press} \times \text{Area} = 5659.54$

$H = \tan\alpha \times V = 1516.47$

$Mb = (2 + (B/L)) / (1 + (B/L)) = 1.70$

$Ml = (2 + (L/B)) / (1 + (L/B)) = 1.298$

$\tan\theta = (B'/L') \Rightarrow \theta = 23$

$m = Ml \cos^2\theta + Mb \sin^2\theta = 1.359$

$i_q = [1 - H / (V + A'c'\cot \varphi')]^{m}; \quad = 0.89$

$i_\gamma = [1 - H / (V + A'c'\cot \varphi')]^{m+1}. \quad = 1.89$

$i_c = i_q - (1 - i_q) / (N_c \tan \varphi') \quad = 0.882$

$$\boldsymbol{R/A' = c'\,N_c\,b_c\,s_c\,i_c + q'\,N_q\,b_q\,s_q\,i_q + 0.5\,\gamma'\,B'\,N_\gamma\,b_\gamma\,S_\gamma\,i_\gamma}$$

$= (15 \times 20.72 \times 1.19 \times 0.747 \times 0.88) + (27 \times 10.66 \times 1.17 \times 0.77 \times 0.89) + (0.5 \times 1.7 \times 18 \times 9.01 \times 0.87 \times 0.77 \times 1.89)$

$= 654.81$

$R/A_{safe} = 654.81 / 3$

$= 218.27\ \text{kN/m}^2$

RESULTS:

	Net Ultimate Bearing Capacity (kN/m^2)	Safe Bearing Capacity (kN/m^2)
Book Answer	536 .80	178.93
Software Answer IS code	538.57	179.52
Euro code	654.81	218.27

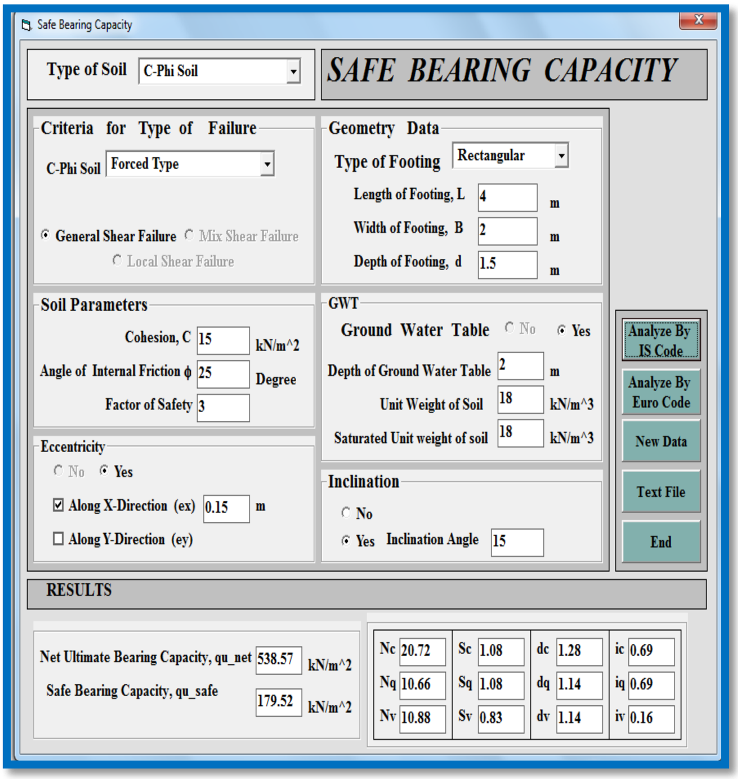

Fig. 1: output of IS code

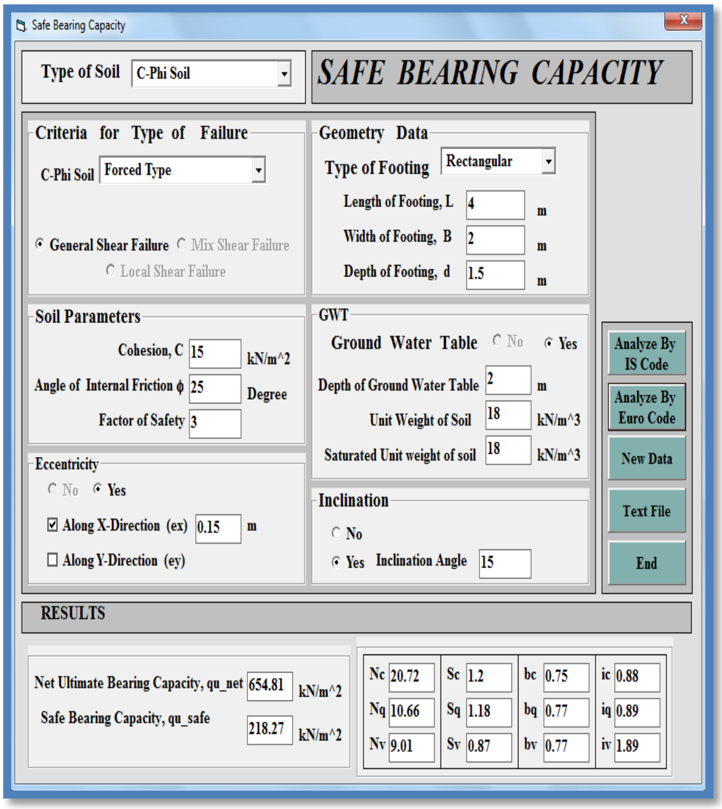

Fig. 1: Analyzed By Euro code

CONCLUSIONS:

- This computer program is versatile because, it gives the satisfactory solution for determination of safe bearing capacity of footing with shear criteria.

- It considers different types of soil, footings and, size, shape, inclination factors, various cases of depth of water table and its effects.

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