UNIVERSITY OF JOHANNESBURG

PROGRAM	:	BACCALAUREUS INGENERIAE *CIVIL ENGINEERING*
SUBJECT	:	**GEOTECHNICAL ENGINEERING 3B**
CODE	:	**GTG3B21**
DATE	:	SSA EXAMINATION JUN 2016
DURATION	:	3h
WEIGHT	:	50: 50
TOTAL MARKS	:	100

ASSESSOR	:	DR. M FERENTINOU
MODERATOR	:	PROF. FN OKONTA
NUMBER OF PAGES	:	3 PAGES, 2 ANNEXURES, GRAPH PAPER,

File Number

INSTRUCTIONS	:	ONLY ONE POCKET CALCULATOR PER CANDIDATE MAY BE USED. QUESTIONS PAPERS MUST BE HANDED IN ANSWER ALL QUESTIONS. COMPLETE THE FRONT PAGE OF THE EXAMINATION BOOKLET CORRECTLY WITH RESPECT TO DETAILS CONCERNING YOUR NAME, STUDENT NUMBER, DATE, EXAMINATION SEAT NUMBER AND QUESTIONS ANSWERED.

QUESTION 1

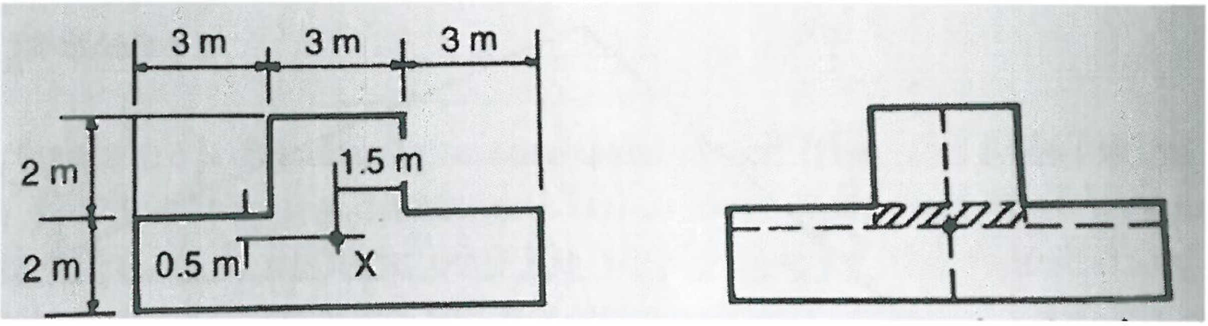
The components of stress tensor are given as follows: σ_x= 210kPa σ_y= 375.00kPa and τ_{xy}= 75kPa.

a. Determine the magnitude and directions, of major and minor principal stresses.
b. Determine the magnitude and directions of the maximum shear stress.
c. Determine the normal and shear stresses acting on a soil element inclined 55° from the horizontal plane. Give both analytical and graphical solution.

QUESTION 2 (20 MARKS)

The plan of a foundation is given below. The uniform pressure on soil is P = 40kN/m^2.

a. Determine the vertical stress increments due to the foundation load to a depth of 5m below point X. (You can use the selection rectangles indicated in the Figure.
b. Determine the vertical stress increment at a point 3m below the foundation and 4m from its centre along one of the axis of the axis of symmetry.

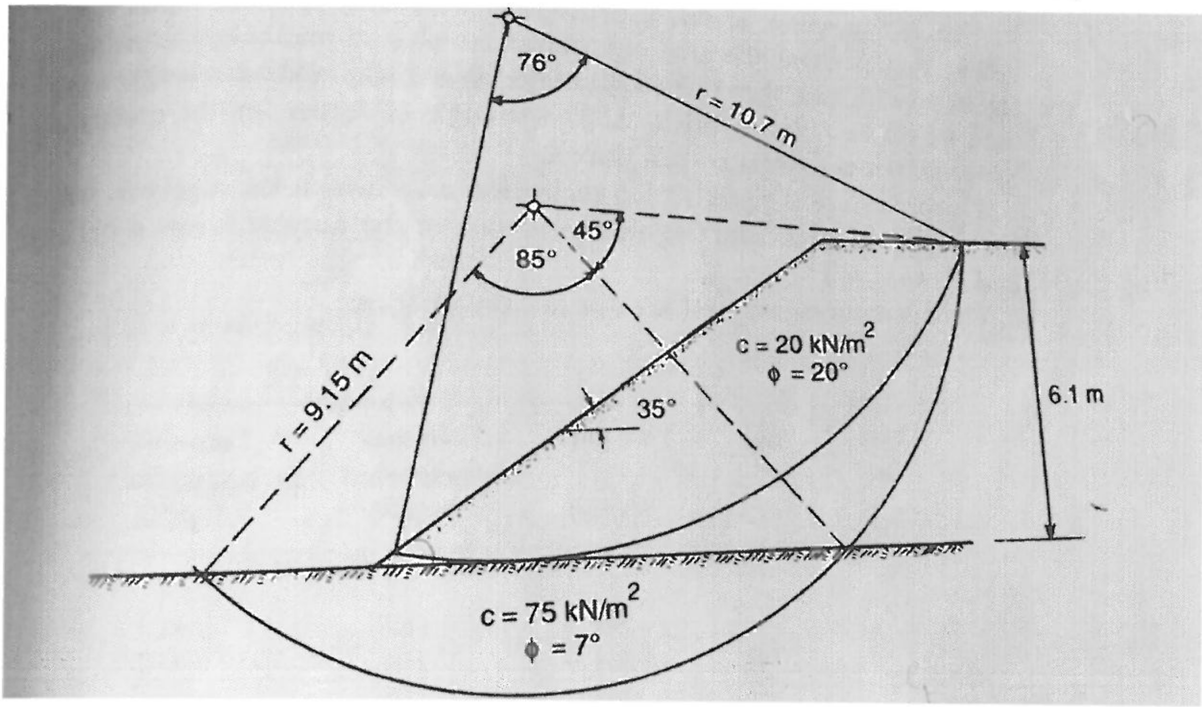


QUESTION 3 (10 MARKS)

A soft, normally consolidated clay layer is 15m thick with a natural moisture content w = 45%. The clay has a saturated unit weight γ_{sat} = 17.2kN/m^3, a particle specific gravity G_s = 2.68 and a liquid limit LL = 65%. A foundation load will subject the centre of the layer to vertical stress increase of 10.0kN/m^2. Determine the value of the settlement of the foundation, if ground water level is at the surface of the clay.

QUESTION 4 (30 MARKS)

The embankment in the figure below is made up from a soil with c = 20kN/m^2 and φ = 20°. The soil on which the embankment sits has φ = 7° and c = 75kN/m^2. For both soils γ = 19.3kN/m^3. Determine the factor of safety only for the shallow and dip slip surfaces shown.



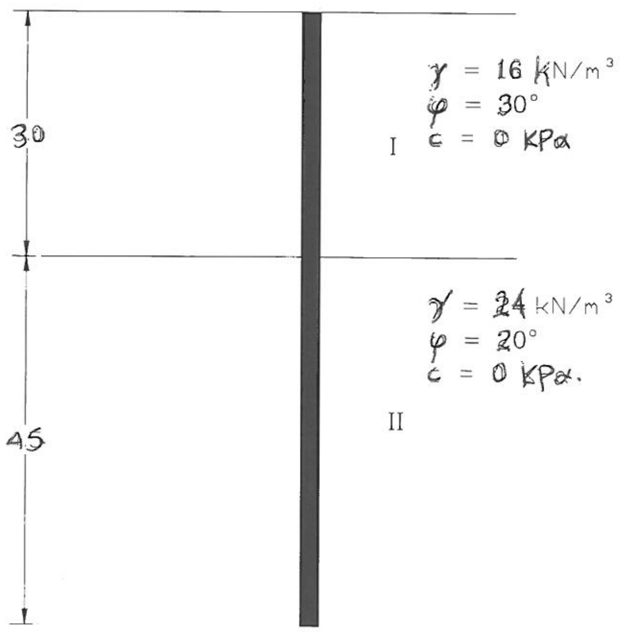
QUESTION 5 (20 MARKS)

Details of the soil retained behind a smooth wall are given in the Figure below. The upper layer I of sand of unit weight $\gamma = 16 kN/m^3$, having shear strength parameters $c = 0$ and $\varphi = 30^\circ$ and a lower layer II of sandy clay of unit weight $\gamma = 24 kN/m^3$ having shear strength parameters $c = 0$ and $\varphi = 20^\circ$.

a. Draw the diagram of the pressure distribution on the back of the wall and

b. determine the total horizontal active thrust acting on the back of the wall.

Determine its point of application, (use Coulomb theory).



APPENDIX

You may use any of the following equations and tables

$$\tau = \sqrt{\left(\frac{\sigma_z - \sigma_x}{2}\right)^2 + \tau_{zx}^2}$$

$$\sigma_1 = \frac{\sigma_x + \sigma_z}{2} + \sqrt{\left(\frac{\sigma_x - \sigma_z}{2}\right)^2 + \tau_{zx}^2}$$

$$\sigma_3 = \frac{\sigma_x + \sigma_z}{2} - \sqrt{\left(\frac{\sigma_x - \sigma_z}{2}\right)^2 + \tau_{zx}^2}$$

$$\tau_{max} = \frac{\sigma_1 - \sigma_3}{2}$$

$$\theta_1 = \frac{1}{2}\cos^{-1}\sqrt{\frac{1}{1 + [2\tau_{zx}/(\sigma_z - \sigma_x)]^2}}$$

$$\sigma = \frac{\sigma_1 + \sigma_3}{2} \pm \frac{\sigma_1 - \sigma_3}{2}\cos 2\theta$$

$$\tau = \frac{\sigma_1 - \sigma_3}{2}\sin 2\theta$$

$$\tau_n = -\frac{(\sigma_x - \sigma_y)}{2}\sin 2\theta + \tau_{xy}\cos 2\theta$$

$$\sigma_n = \frac{(\sigma_x + \sigma_y)}{2} + \frac{(\sigma_x - \sigma_y)}{2}\cos 2\theta + \tau_{xy}\sin 2\theta$$

$$s_c = m_v \Delta\sigma' H$$

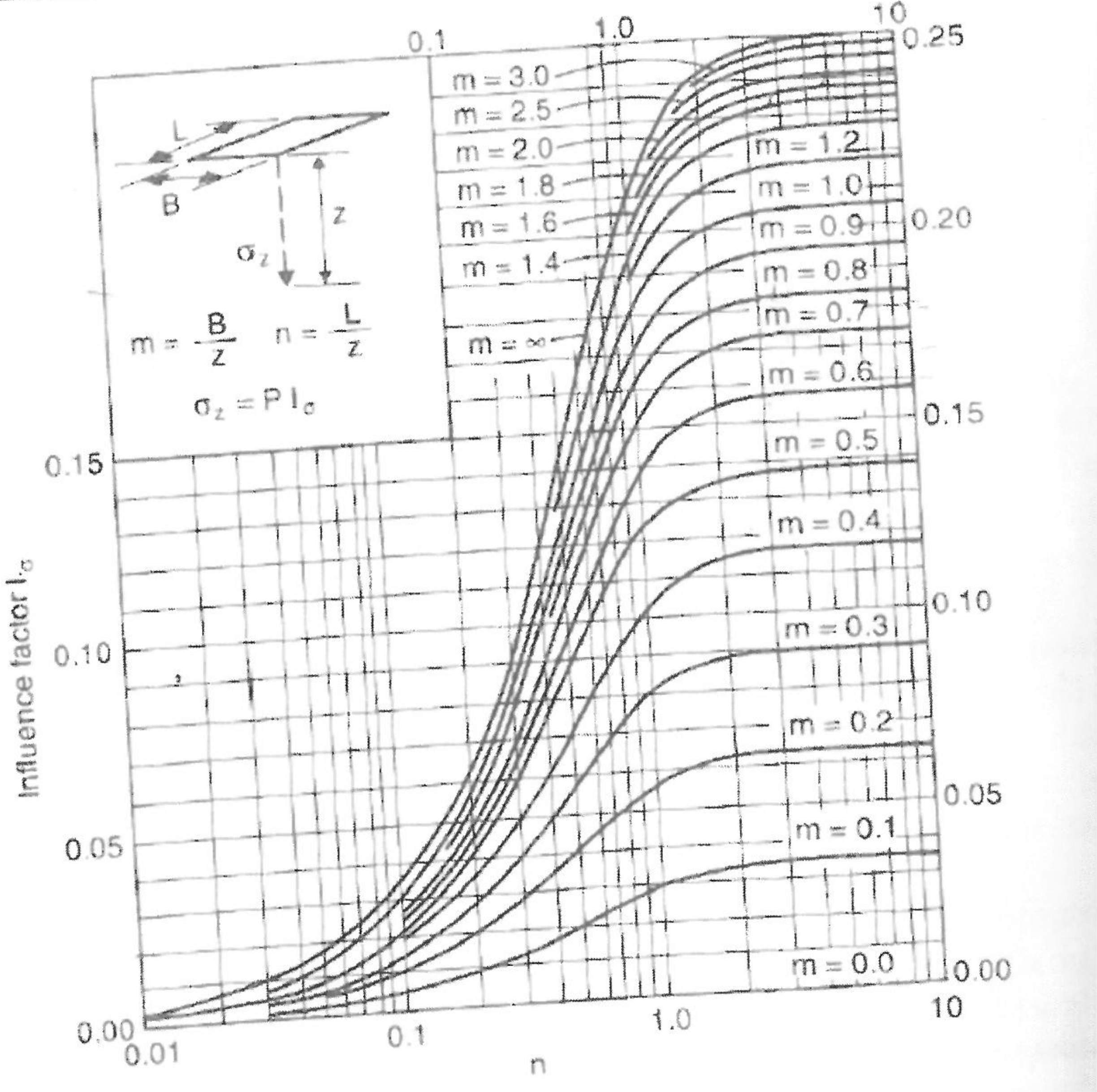
$$s_c = \frac{e_0 - e_1}{1 + e_0} H$$

$$Cc := 0.009\,(wL - 10\%)$$

$$\delta c = \frac{C_c}{1+e_0}\log\frac{\sigma_1'}{\sigma_0'}H$$

$$s_c = \frac{C_c \log(\sigma_1'/\sigma_0')}{1+e_0}H$$

Soil Mechanics



$$F = \frac{c' L_a + \tan\phi' \Sigma(W\cos\alpha - ul)}{\Sigma W \sin\alpha}$$

$$K_a = \frac{1-\sin\phi}{1+\sin\phi}$$

$$K_p = \frac{1 + \sin\phi}{1 - \sin\phi}$$

$$P_a = \frac{1}{2}K_a\gamma H^2 \quad P_p = \frac{1}{2}K_p\gamma H^2$$

$$K_a = \left(\frac{\frac{\sin(\alpha - \phi)}{\sin\alpha}}{\sqrt{[\sin(\alpha + \delta)]} + \sqrt{\left[\frac{\sin(\phi + \delta)\sin(\phi - \beta)}{\sin(\alpha - \beta)}\right]}} \right)^2$$

$$K_p = \left(\frac{\frac{\sin(\alpha + \phi)}{\sin\alpha}}{\sqrt{[\sin(\alpha - \delta)]} - \sqrt{\left[\frac{\sin(\phi + \delta)\sin(\phi + \beta)}{\sin(\alpha - \beta)}\right]}} \right)^2$$

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ASSESSOR	:	DR. M FERENTINOU
MODERATOR	:	PROF. FN OKONTA
NUMBER OF PAGES	:	3 PAGES, 2 ANNEXURES, GRAPH PAPER, SEMI-LOGARITHMIC GRAPH PAPER

FILE NO

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QUESTION 1 (20 MARKS)

The components of stress tensor are given as follows: σ_x= 25kPa σ_y= 50kPa and τ_{xy}= -70kPa.

a. Determine the magnitude and directions, of major and minor principal stresses.
b. Determine the magnitude and directions of the maximum shear stress.
c. Determine the normal and shear stresses acting on a soil element inclined 30° from the horizontal plane. Give both analytical and graphical solution.

QUESTION 2 (20 MARKS)

A 4.5 square foundation exerts a uniform pressure P = 200kN/m^2 on a soil mass.

a. Determine the vertical stress increments due to the foundation load to a depth of 10m below its centre.
b. Determine the vertical stress increment at a point 3m below the foundation and 4m from its centre along one of the axis of symmetry.

QUESTION 3 (20 MARKS)

The following results were obtained from an oedometer test on a specimen of saturated clay:

Pressure (kN/m^2)	27	54	107	214	429	214	107	54
Void ratio	1.243	1.217	1.144	1.068	0.994	1.001	1.012	1.024

A layer of this clay 8m thick lies below a 4m depth of sand, the water table being at the surface. The saturated unit weight of soils is 19kN/m^3. A 4m depth of fill of unit weight 21kN/m^3 is placed on the sand over an extensive area. Determine the final settlement due to consolidation of the clay.

QUESTION 4 (20 MARKS)

Determine the factor of safety for the given failure surface, for the slope in figure below. The unit weight is γ = 20 kN/m^3, and relevant strength parameters c = 8kPa and φ = 20°. Assume that there is no allowance made for a tension crack to develop. Use Fellenius analysis method.

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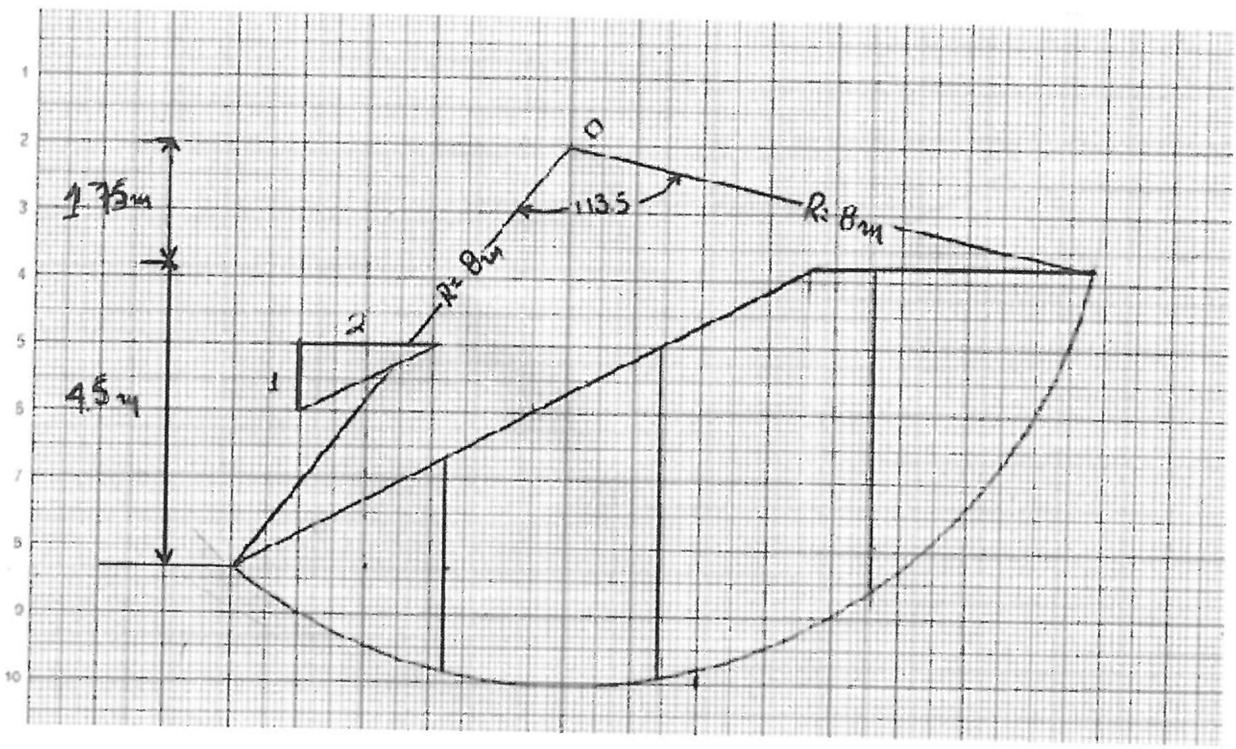
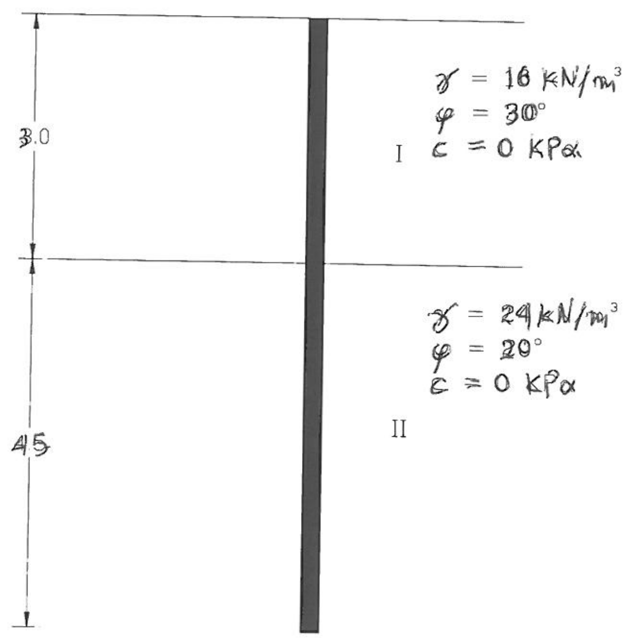


QUESTION 5 (20 MARKS)

Details of the soil retained behind a smooth wall are given in the Figure below. The upper layer I of sand of unit weight $\gamma = 16 kN/m^3$, having shear strength parameters $c = 0$ and $\varphi = 30^\circ$ and a lower layer II of sandy clay of unit weight $\gamma = 24 kN/m^3$ having shear strength parameters $c = 0$ and $\varphi = 20^\circ$.

a. Draw the diagram of the pressure distribution on the back of the wall

b. Determine the total horizontal active thrust acting on the back of the wall, determine its point of application, (use Rankine theory).



APPENDIX

You may use any of the following equations and tables

$$r = \sqrt{\left(\frac{\sigma_z - \sigma_x}{2}\right)^2 + \tau_{zx}^2}$$

$$\sigma_1 = \frac{\sigma_x + \sigma_z}{2} + \sqrt{\left(\frac{\sigma_x - \sigma_z}{2}\right)^2 + \tau_{zx}^2}$$

$$\sigma_3 = \frac{\sigma_x + \sigma_z}{2} - \sqrt{\left(\frac{\sigma_x - \sigma_z}{2}\right)^2 + \tau_{zx}^2}$$

$$\tau_{max} = \frac{\sigma_1 - \sigma_3}{2}$$

$$\theta_1 = \frac{1}{2}\cos^{-1}\sqrt{\frac{1}{1 + [2\tau_{zx}/(\sigma_z - \sigma_x)]^2}}$$

$$\sigma = \frac{\sigma_1 + \sigma_3}{2} \pm \frac{\sigma_1 - \sigma_3}{2}\cos 2\theta$$

$$\tau = \frac{\sigma_1 - \sigma_3}{2}\sin 2\theta$$

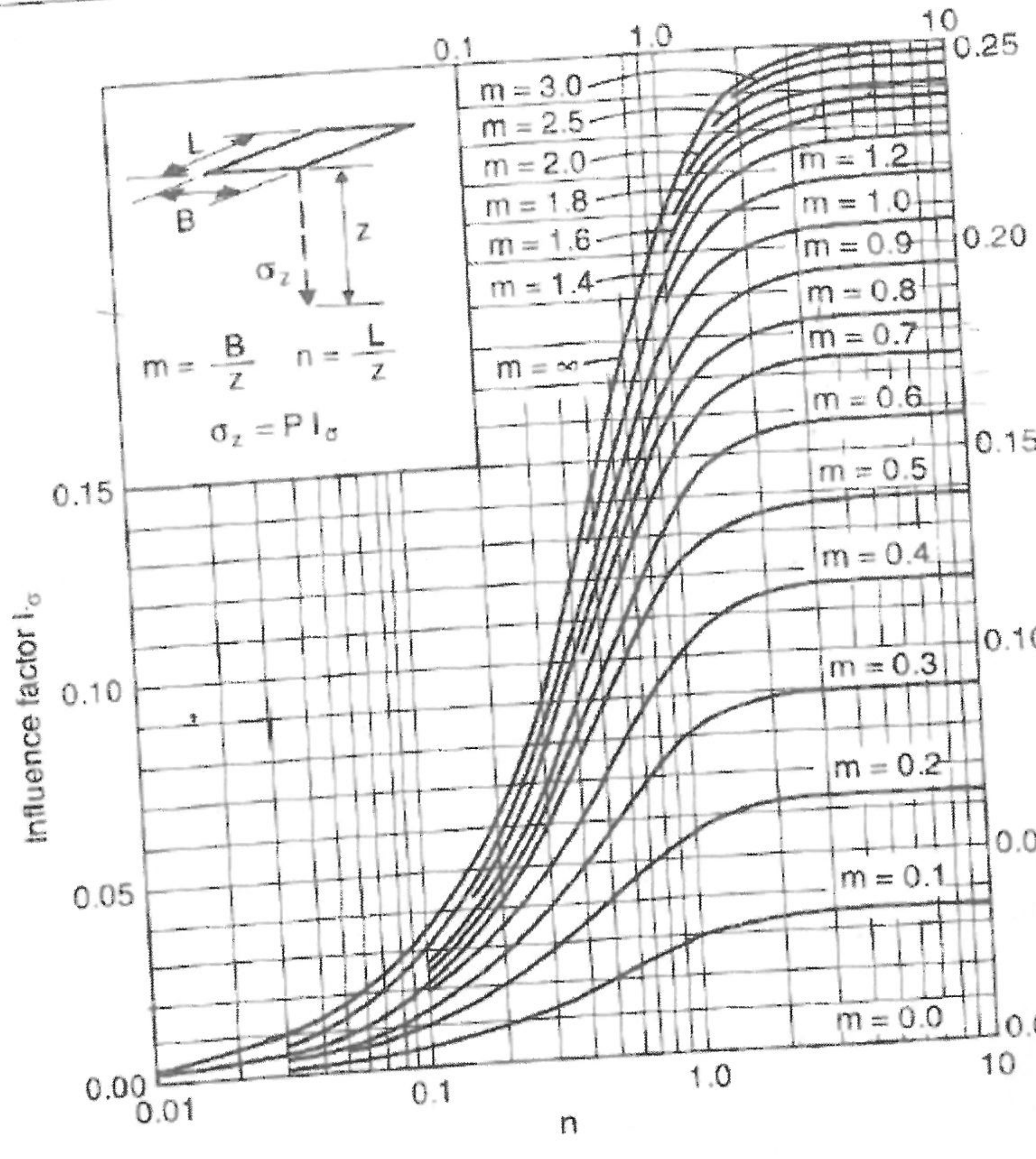
$$\tau_n = -\frac{(\sigma_x - \sigma_y)}{2}\sin 2\theta + \tau_{xy}\cos 2\theta$$

$$\sigma_n = \frac{(\sigma_x + \sigma_y)}{2} + \frac{(\sigma_x - \sigma_y)}{2}\cos 2\theta + \tau_{xy}\sin 2\theta$$

$$s_c = m_v \Delta\sigma' H$$

$$s_c = \frac{e_0 - e_1}{1 + e_0}H$$

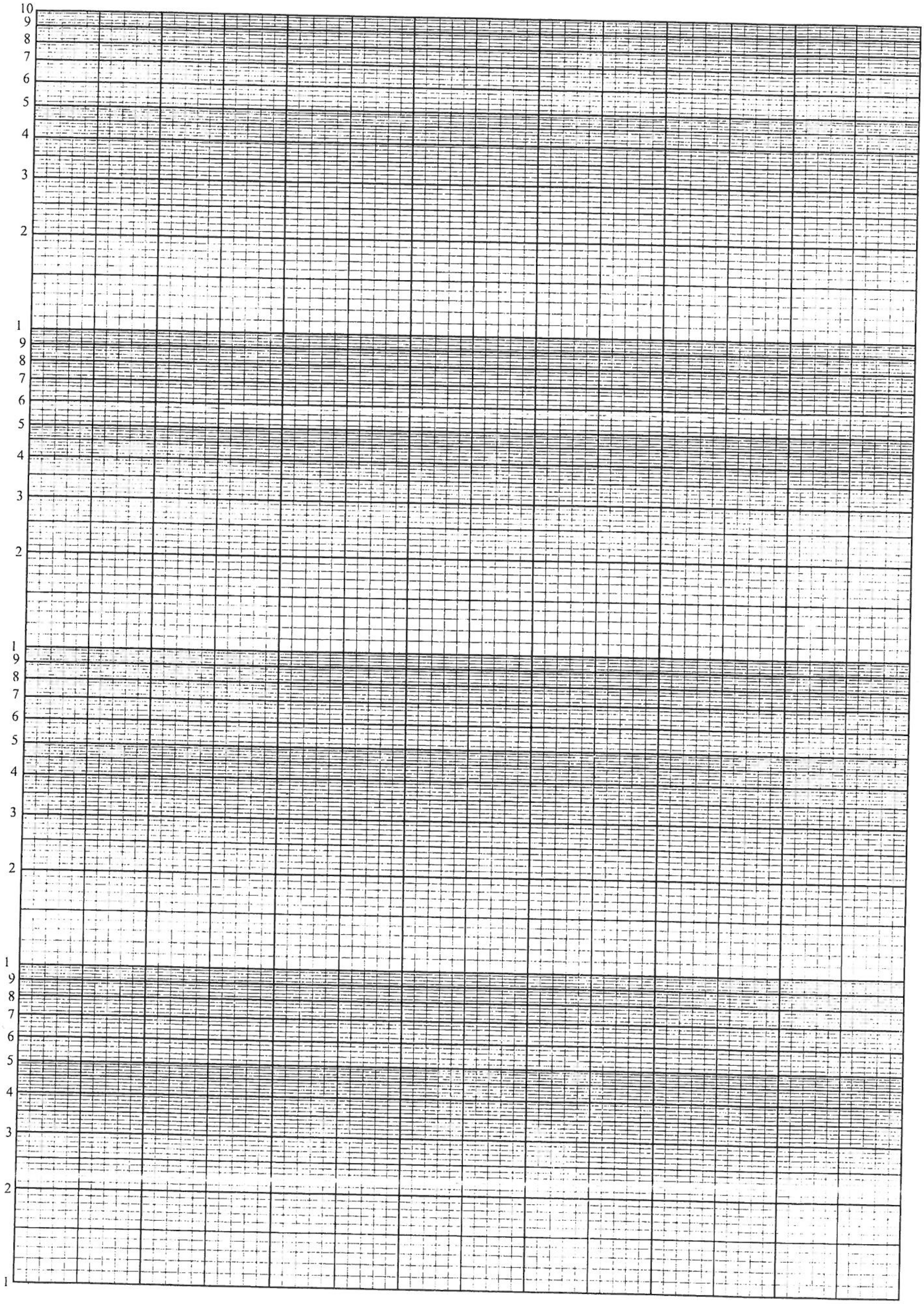
$$s_c = \frac{C_c \log(\sigma'_1/\sigma'_0)}{1 + e_0}H$$



$$F = \frac{c' L_a + \tan\phi' \Sigma(W\cos\alpha - ul)}{\Sigma W \sin\alpha}$$

$$K_a = \frac{1 - \sin\phi}{1 + \sin\phi}$$

$$K_p = \frac{1 + \sin\phi}{1 - \sin\phi} \qquad P_a = \frac{1}{2} K_a \gamma H^2$$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