Universiti Tun Hussein Onn Malaysia

# UNIVERSITI TUN HUSSEIN ONN MALAYSIA

## FINAL EXAMINATION
## SEMESTER II
## SESSION 2022/2023

| | | |
|---|---|---|
| COURSE NAME | : | COASTAL AND HARBOUR ENGINEERING |
| COURSE CODE | : | BFW 40303 |
| PROGRAMME CODE | : | BFF |
| EXAMINATION DATE | : | JULY/ AUGUST 2023 |
| DURATION | : | 3 HOURS |
| INSTRUCTIONS | 1. | ANSWER ANY **FOUR (4)** QUESTIONS ONLY. |
| | 2. | THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED BOOK.** |
| | 3. | STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK |

THIS QUESTION PAPER CONSISTS OF **THIRTEEN (13)** PAGES

**Q1** (a) It is a remarkable fact that beaches around the world are quite similar in composition and shape. The beach profile, which is a cross section of the beach taken perpendicular to the shoreline, is generally composed of four sections; offshore, nearshore, beach and coast. With aid of sketch, explain in detail development of all these sections.

(7 marks)

(b) On the basis of your knowledge, list and discuss **THREE (3)** coastal erosion techniques for an eroding sandy beach. Suggest **ONE (1)** new technique can be applied for coastal erosion protection in sandy coast.

(8 marks)

(c) A sinusoidal wave with amplitude $a = 0.25$ m and wave period $T = 7.5$ s propagates over a depth $d = 6$ m. Calculate horizontal displacement $\xi$ and vertical displacement $\zeta$ at:

(i) Depth $z = 0$ and phase angle $\theta = \frac{\pi}{2}$

(ii) Depth $z = -d$ and phase angle $\theta = \frac{\pi}{2}$

(10 marks)

**Q2** (a) With aid of sketch, briefly explain the wave processes of

(i) Breaking
(ii) Refraction
(iii) Diffraction
(iv) Reflection

(12 marks)

(b) A 2.0 m high deepwater wave is propagating towards a 1:20 beach, with its crest making an angle of 30° with shoreline. As the wave moves into shallower water, its speed reduces from 10 m/s to 5 m/s. Compute the wave height and depth at breaking.

(13 marks)

**Q3** (a) Explain **THREE (3)** controlled factors in wind generated waves and briefly describe the wave celerity, wind direction and wave frequency measurement on site.

(6 marks)

(b) **FIGURE Q3(b)** shows ocean surface elevation recorded during an event. Determine

(i) Significant wave height $H_s$

(ii) Maximum wave height $H_{\max}$

(iii) Average of the highest 5% of wave height $H_5$

(9 marks)

(c) A wave with $C_o$ = 15.6 m/s, mean water depth, d = 2.3 m and celerity, C = 4.75 m/s has deep water height of 2 m, period of 10 s and $n$ = 1. Assume the wave crest in deep water are oriented at an angle of $35^0$ with the shoreline and that the nearshore bottom contours are essentially straight and parallel to the shoreline. Determine the wave height and crest orientation with respect to the shoreline when the wave propagates into 2.3 m depth of water.

(10 marks)

**Q4** (a) Integrated Shoreline Management Plan (ISMP) by Department of Irrigation & Drainage Malaysia is one of coastal mitigation scheme in Malaysia. Explain the ISMP purpose and how it accomplished the goal?

(10 marks)

(b) Consider the initial platform as shown in **FIGURE Q4(b)**. The waves are from the southwest, and the headland is composed of erodible sand and very durable rock. Describe and sketch the resulting planforms that might you expect:

(i) Just after all the sand has been eroded

(7 marks)

(ii) A considerable time after all the sand has been eroded without any significant additional material supplied by the headland.

(8 marks)

**Q5** (a) Classify the following small amplitude wave based on its relative depth.

(i) Wave with height H = 0.5 m, and length L = 150 m, propagating over a depth d = 10 m.

(ii) Wave with height H = 0.25 m, and length L = 250 m, propagating over a depth d = 6 m.

(6 marks)

(b) The geometric relationship of moon and sun locations on the Earth's surface results in creation of three different types of tides. With the aid of sketch, explain **THREE (3)** types of tides in the Earth – moon system.

(9 marks)

(c) Determine the volume of fill material V required to nourish a beach with a berm height B = 5.0 m and width Y = 45 m where significant wave height $H_s$ = 3.5 m. The depth of closure H = 6.75 $H_S$, and the sedimentary parameters are $\sigma_{\varphi b} = 0.75$, $\sigma_{\varphi n} = 0.60$, $M_{\varphi b} = 2.30$, $M_{\varphi n} = 1.85$. Ignore the renourishment factor $R_J$.

(10 marks)

**-END OF QUESTIONS-**

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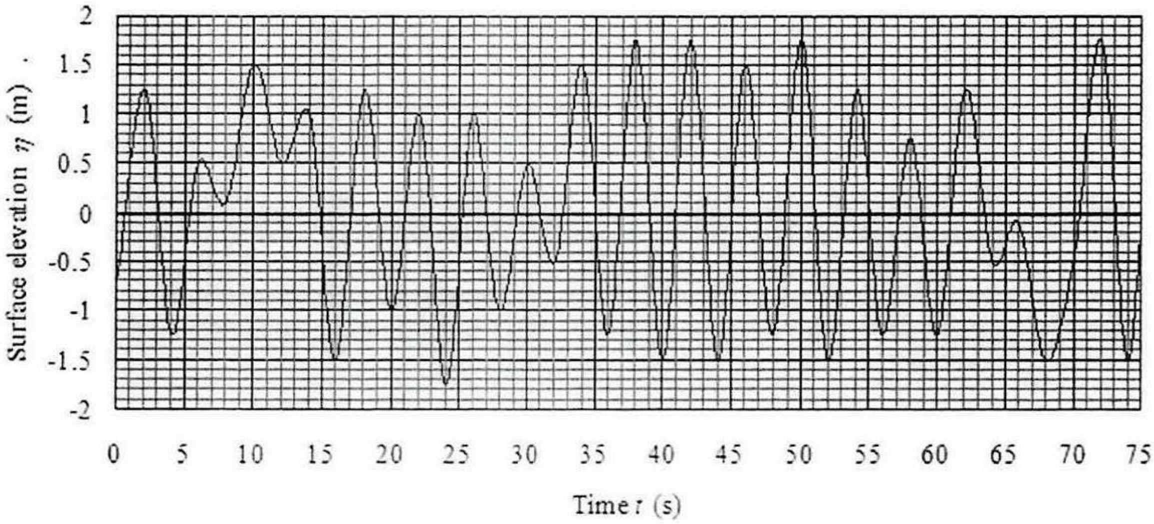


**Figure Q3(b)**

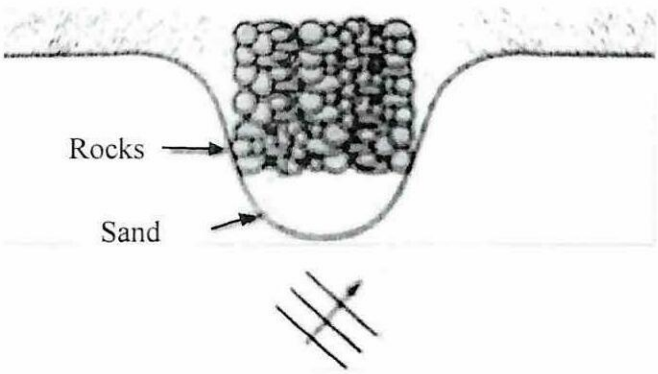


**Figure Q4(b):** Eroding Headland

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**EQUATION:**

$$H_i = H_o K_s K_r$$

where, $K_s = \sqrt{\dfrac{C_o}{C\left[1+\dfrac{\left(\frac{4\pi d}{L}\right)}{\sinh\left(\frac{4\pi d}{L}\right)}\right]}}$ , and $K_r = \sqrt{\dfrac{\cos\alpha_o}{\cos\alpha}}$

Unrefracted deepwater wave height $H_o' = H_o K_r$

Snell's law : $\dfrac{\sin\alpha}{C} = \dfrac{\sin\alpha_o}{C_o}$

$$T_m = 0.82T_p$$

$$R^* = \frac{R_c}{T_m\sqrt{gH_s}}$$

$$Q^* = Ae^{\left(-\frac{BR^*}{r}\right)}$$

$$q = Q^* T_m g H_s$$

$$M_{50} = \frac{\rho_r H_s^3}{K_D \cot\alpha \Delta^3}$$

$$D_{50} = \left(\frac{M_{50}}{\rho_r}\right)^{\frac{1}{3}}$$

$$\Delta = \frac{\rho_r}{\rho_w} - 1$$

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**EQUATION:**

| Characteristic | Transitional water ($0.04 < d/L < 0.5$) | Deep water ($d/L_o \geq 0.5$) |
|---|---|---|
| Wave celerity | $C = \frac{L}{T} = \frac{gT}{2\pi}\tanh\left(\frac{2\pi d}{L}\right)$ | $C_o = \frac{L}{T} = \frac{gT}{2\pi}$ |
| Wave length | $L = \frac{gT^2}{2\pi}\tanh\left(\frac{2\pi d}{L}\right)$ | $L_o = \frac{gT^2}{2\pi}$ |
| Displacement | | |
| a. horizontal | $\xi = -\frac{H}{2}\frac{\cosh\left[2\pi\frac{(z+d)}{L}\right]}{\sinh\left(2\pi\frac{d}{L}\right)}\sin\theta$ | $\xi = -\frac{H}{2}e^{\frac{2\pi z}{L}}\sin\theta$ |
| b. vertical | $\zeta = \frac{H}{2}\frac{\sinh\left[2\pi\frac{(z+d)}{L}\right]}{\sinh\left(2\pi\frac{d}{L}\right)}\cos\theta$ | $\zeta = \frac{H}{2}e^{\frac{2\pi z}{L}}\cos\theta$ |
| Velocity | | |
| a. horizontal | $u = \frac{H}{2}\frac{gT}{L}\frac{\cosh\left[2\pi\frac{(z+d)}{L}\right]}{\cosh\left(2\pi\frac{d}{L}\right)}\cos\theta$ | $u = \frac{\pi H}{T}e^{\frac{2\pi z}{L}}\cos\theta$ |
| b. vertical | $w = \frac{H}{2}\frac{gT}{L}\frac{\sinh\left[2\pi\frac{(z+d)}{L}\right]}{\cosh\left(2\pi\frac{d}{L}\right)}\sin\theta$ | $w = \frac{\pi H}{T}e^{\frac{2\pi z}{L}}\sin\theta$ |
| Acceleration | | |
| a. horizontal | $a_x = \frac{g\pi H}{L}\frac{\cosh\left[2\pi\frac{(z+d)}{L}\right]}{\cosh\left(2\pi\frac{d}{L}\right)}\sin\theta$ | $a_x = 2H\left(\frac{\pi}{T}\right)^2 e^{\frac{2\pi z}{L}}\sin\theta$ |
| b. vertical | $a_z = -\frac{g\pi H}{L}\frac{\sinh\left[2\pi\frac{(z+d)}{L}\right]}{\cosh\left(2\pi\frac{d}{L}\right)}\cos\theta$ | $a_z = -2H\left(\frac{\pi}{T}\right)^2 e^{\frac{2\pi z}{L}}\cos\theta$ |

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Table of Ratio of $H_n/H_s$ from Rayleigh distribution

| $n$ | $H_n/H_s$ |
|---|---|
| 1 | 1.67 |
| 2 | 1.56 |
| 5 | 1.40 |
| 10 | 1.27 |
| 20 | 1.12 |
| 50 | 0.89 |
| 100 | 0.63 |

Table of Owen parameters

| Structure slope | $A$ | $B$ |
|---|---|---|
| 1:1.5 | 0.0102 | 20.12 |
| 1:2.0 | 0.0125 | 22.06 |
| 1:2.5 | 0.0145 | 26.10 |
| 1:3.0 | 0.0163 | 31.90 |
| 1:3.5 | 0.0178 | 38.90 |
| 1:4.0 | 0.0192 | 46.96 |
| 1:4.5 | 0.0215 | 55.70 |
| 1:5.0 | 0.0250 | 65.20 |

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Table of Functions of $d/L$ for even increments of $d/L_o$

| $d/L_o$ | $d/L$ | $2\pi d/L$ | tanh $2\pi d/L$ | sinh $2\pi d/L$ | cosh $2\pi d/L$ |
|---|---|---|---|---|---|
| 0.03000 | 0.07135 | 0.4483 | 0.4205 | 0.4634 | 1.1021 |
| 0.03100 | 0.07260 | 0.4562 | 0.4269 | 0.4721 | 1.1059 |
| 0.03200 | 0.07385 | 0.4640 | 0.4333 | 0.4808 | 1.1096 |
| 0.03300 | 0.07507 | 0.4717 | 0.4395 | 0.4894 | 1.1133 |
| 0.03400 | 0.07630 | 0.4794 | 0.4457 | 0.4980 | 1.1171 |
| 0.03500 | 0.07748 | 0.4868 | 0.4517 | 0.5064 | 1.1209 |
| 0.03600 | 0.07867 | 0.4943 | 0.4577 | 0.5147 | 1.1247 |
| 0.03700 | 0.07984 | 0.5017 | 0.4635 | 0.5230 | 1.1285 |
| 0.03800 | 0.08100 | 0.5090 | 0.4691 | 0.5312 | 1.1324 |
| 0.03900 | 0.08215 | 0.5162 | 0.4747 | 0.5394 | 1.1362 |
| 0.06000 | 0.1043 | 0.6553 | 0.5753 | 0.7033 | 1.2225 |
| 0.06100 | 0.1053 | 0.6616 | 0.5794 | 0.7110 | 1.2270 |
| 0.06200 | 0.1063 | 0.6678 | 0.5834 | 0.7187 | 1.2315 |
| 0.06300 | 0.1073 | 0.6739 | 0.5874 | 0.7256 | 1.2355 |
| 0.06400 | 0.1082 | 0.6799 | 0.5914 | 0.7335 | 1.2405 |
| 0.06500 | 0.1092 | 0.6860 | 0.5954 | 0.7411 | 1.2447 |
| 0.06600 | 0.1101 | 0.6920 | 0.5993 | 0.7486 | 1.2492 |
| 0.06700 | 0.1111 | 0.6981 | 0.6031 | 0.7561 | 1.2537 |
| 0.06800 | 0.1120 | 0.7037 | 0.6069 | 0.7633 | 1.2580 |
| 0.06900 | 0.1130 | 0.7099 | 0.6106 | 0.7711 | 1.2628 |
| 0.9000 | 0.9000 | 5.655 | 1.000 | 142.9 | 142.9 |
| 0.9100 | 0.9100 | 5.718 | 1.000 | 152.1 | 152.1 |
| 0.9200 | 0.9200 | 5.781 | 1.000 | 162.0 | 162.0 |
| 0.9300 | 0.9300 | 5.844 | 1.000 | 172.5 | 172.5 |
| 0.9400 | 0.9400 | 5.906 | 1.000 | 183.7 | 183.7 |
| 0.9500 | 0.9500 | 5.969 | 1.000 | 195.6 | 195.6 |
| 0.9600 | 0.9600 | 6.032 | 1.000 | 208.2 | 208.2 |
| 0.9700 | 0.9700 | 6.095 | 1.000 | 221.7 | 221.7 |
| 0.9800 | 0.9800 | 6.158 | 1.000 | 236.1 | 236.1 |
| 0.9900 | 0.9900 | 6.220 | 1.000 | 251.4 | 251.4 |

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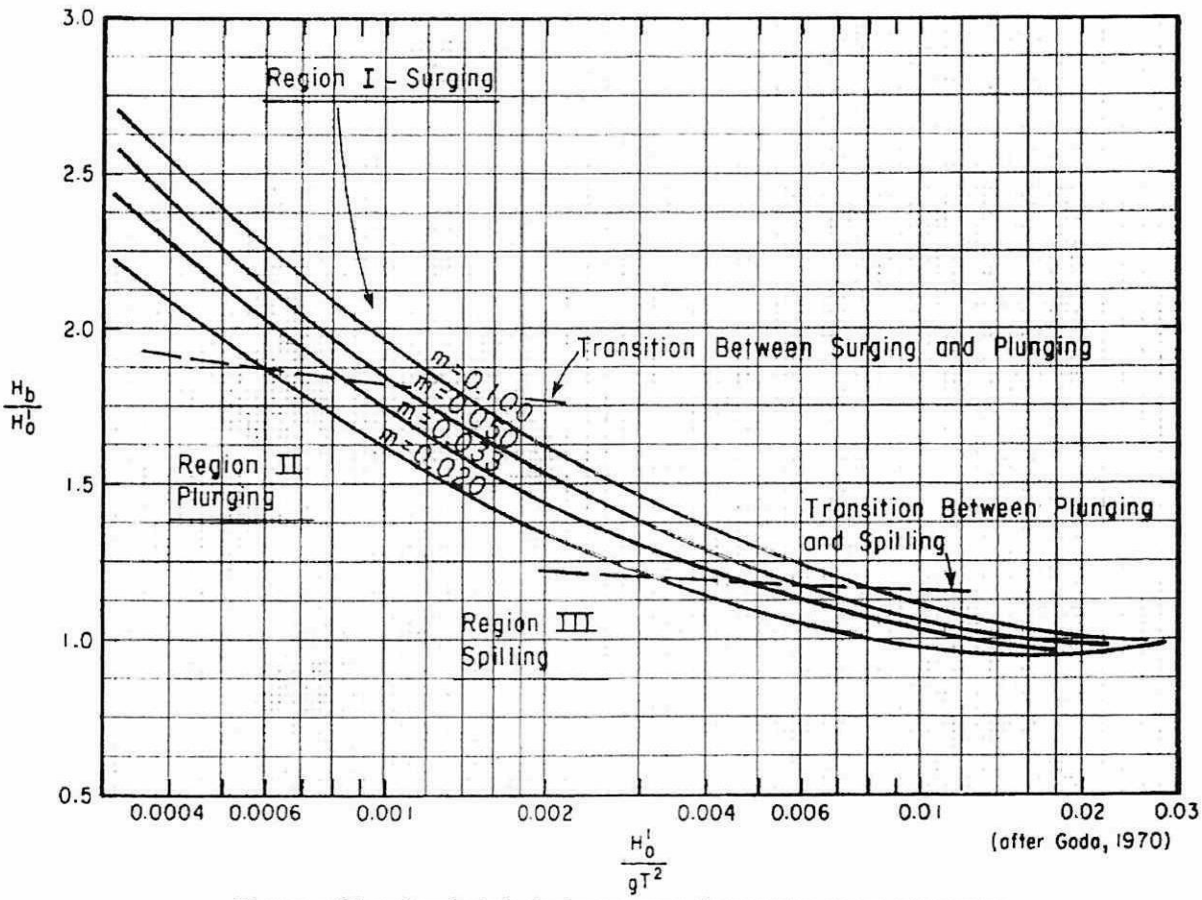


Figure of breaker height index versus deepwater wave steepness

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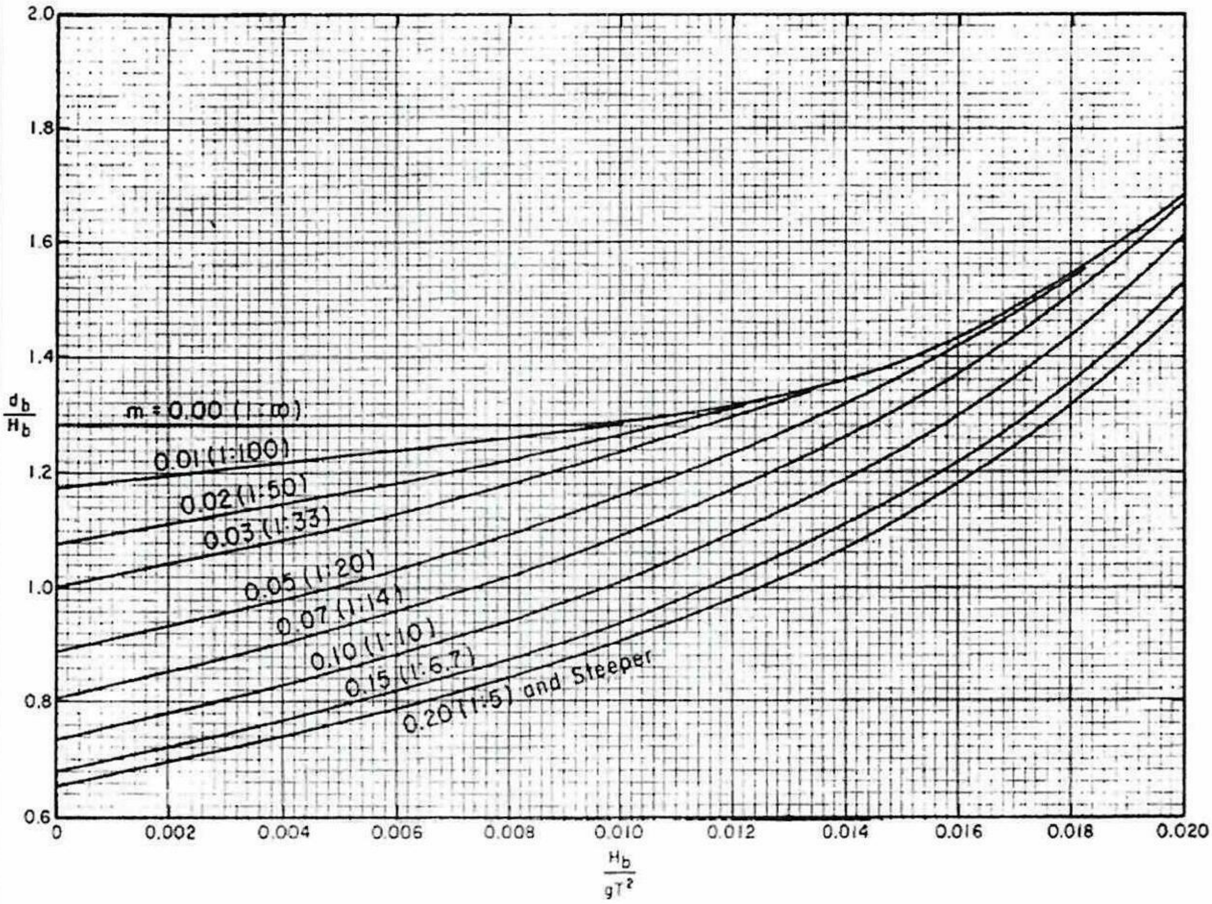


Figure of breaker index versus wave steepness

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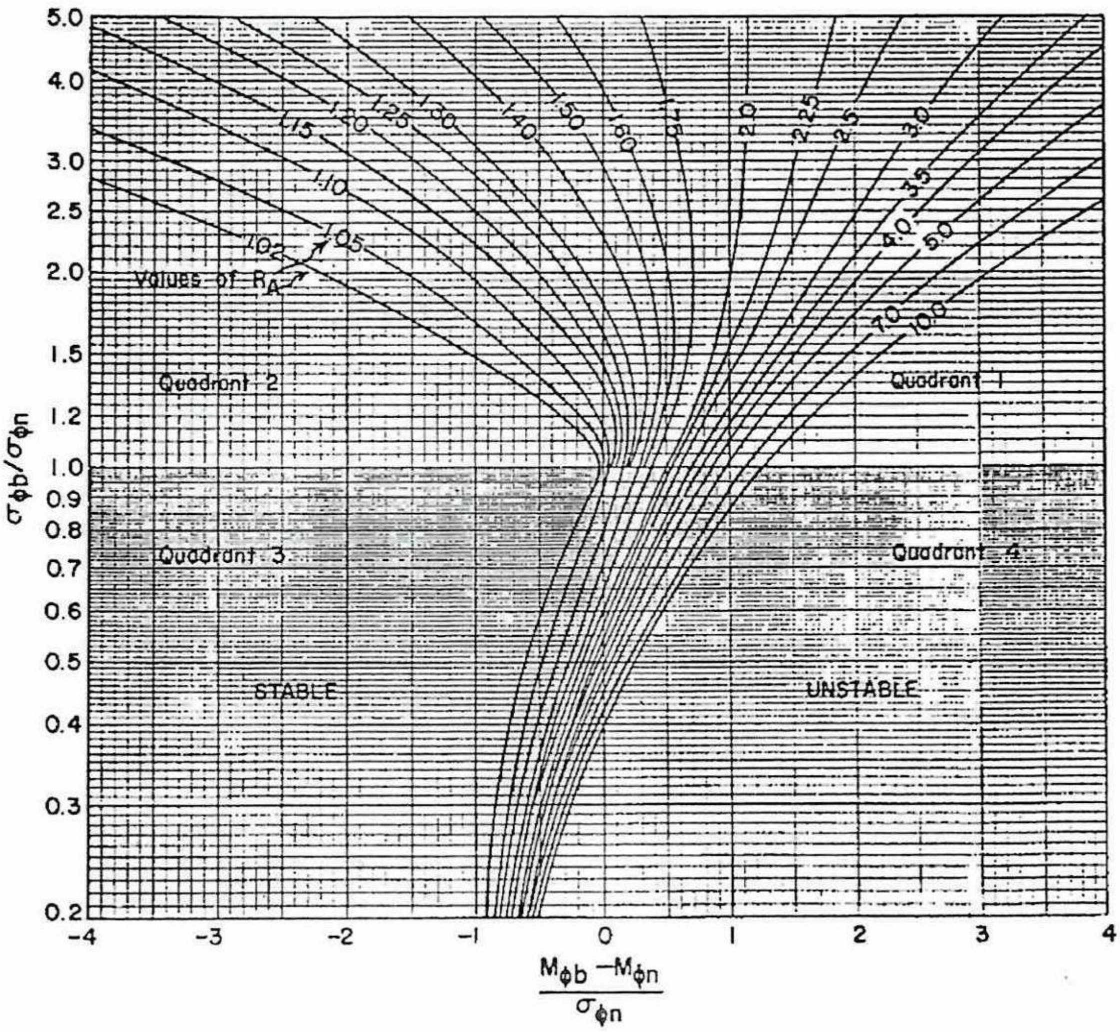


Figure of Isolines of the adjusted SPM fill factor RA

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Table of Relationship between $M_\phi$ and $\sigma_\phi$ of the native material and borrow material

| Case | Quadrant | Relationship of phi means | Relationship of phi standard deviations |
|---|---|---|---|
| I | 1 | $M_{\phi b} > M_{\phi n}$ borrow material is finer than native material | $\sigma_{\phi b} > \sigma_{\phi n}$ borrow material is more poorly sorted than native material |
| II | 2 | $M_{\phi b} < M_{\phi n}$ borrow material is coarser than native material | |
| III | 3 | $M_{\phi b} < M_{\phi n}$ borrow material is coarser than native material | $\sigma_{\phi b} < \sigma_{\phi n}$ borrow material is better sorted than native material |
| IV | 4 | $M_{\phi b} > M_{\phi n}$ borrow material is finer than native material | |