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Universiti Tun Hussein Onn Malaysia

# UNIVERSITI TUN HUSSEIN ONN MALAYSIA

## FINAL EXAMINATION
## SEMESTER II
## SESSION 2013/2014

| | | |
|---|---|---|
| COURSE NAME | : | COASTAL AND HARBOUR ENGINEERING |
| COURSE CODE | : | BFW40303 |
| PROGRAMME | : | 4 BFF |
| EXAMINATION DATE | : | JUNE 2014 |
| DURATION | : | 3 HOURS |
| INSTRUCTION | : | ANSWER **FOUR (4)** QUESTIONS ONLY |

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

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**Q1** (a) Define the following coastal area morphologies and sketch typical coastal area as follows:

(i) Backshore
(ii) Shoreline
(iii) Coastline
(iv) Berm
(v) Surfzone

(10 marks)

(b) Each coastal project has its own unique characteristics and this implies the variability of the environmental variables. Briefly explain **FIVE (5)** characteristics that effects environmental forces in planning and design of coastal projects.

(15 marks)

**Q2** (a) Briefly explain **TWO (2)** human activities which have negative impacts to coastal environment.

(5 marks)

(b)

| Standard Port | LAT | MLWS | MLWN | MSL | MHWN | MHWS | HAT |
|---|---|---|---|---|---|---|---|
| Port Dickson | –0.1 | 0.3 | 1.1 | 1.5 | 1.9 | 2.8 | 3.4 |

where,

LAT – lowest astronomical tide
MLWS – mean low water springs
MLWN – mean low water neaps
MSL – mean sea level
MHWN – mean high water neaps
MHWS – mean high water springs
HAT – highest astronomical tide

Based on the Port Dickson tidal levels, determine

(i) Mean tidal range at Port Dickson

(2 marks)

(ii) MLWS, MLWN, MHWN, and MHWS with reference to Land Survey Datum (LSD). Note that the Admiralty Chart Datum (ACD) refers to LAT. The ACD is 1.45 m below LSD.

(8 marks)

(c) A wave with height 3 m and period 7 s propagates shoreward from a depth $d =$ 150 m to a depth $d =$ 5 m. Calculate

(i) Wave length and celerity at depths 150 m and 5 m

(10 marks)

**Q3** (a) With the aid of sketches, briefly explain the wave processes of

(i) Breaking

(3 marks)

(ii) Refraction

(3 marks)

(iii) Diffraction

(3 marks)

(iv) Reflection

(3 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 the 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)

**Q4** (a) Based on the coastal camp experience; describe how the wave celerity, wind direction and wave frequency are determined on site.

(6marks)

(b) Figure **Q4** shows the 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 the wave height $H_5$

(9 marks)

(c) Consider the wave respectively, $C_o$ = 15.6 m/s and at d = 2.3 m, C = 4.75 m/s which has a deep water height of 2 m and a period of 10 s and $n$ = 1. Assume the wave crests 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 water 2.3 m deep.

(10 marks)

**Q5** (a) A beach revetment with slope 1:2.5, crest level 4.5 m CD, and foreshore gradient of 1:100 is to be designed. The significant wave height is found to be $H_s$ = 3.0 m, wave period $T_p$ = 10 s, and design water level DWL = 3.5 m CD. Assuming roughness coefficient of rock armour $r$ = 0.50. Determine whether the overtopping performance of the structure is acceptable to justify its use to protect a paved promenade based on Figure **Q5**.

(10 marks)

(b) 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 $R_J$.

(15 marks)

**- END OF QUESTION –**

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**Supplementary Equations**

$$H_i = H_o K_s K_r$$

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

Unrefracted deepwater wave height $H'_o = H_o K_r$

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

$$T_m = 0.82 T_p$$

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

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

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

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

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

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

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| 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 1:** 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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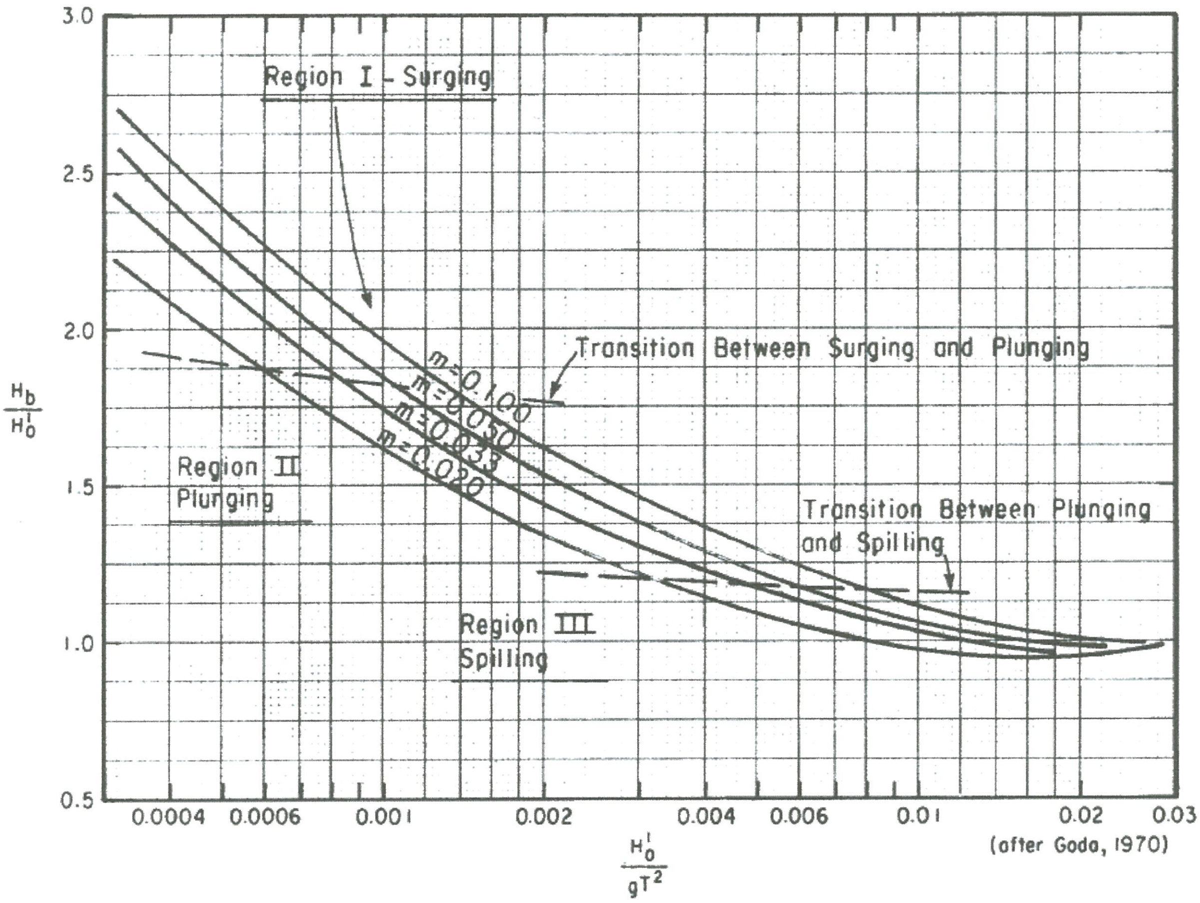


**FIGURE 1:** Breaker height index versus deepwater wave steepness

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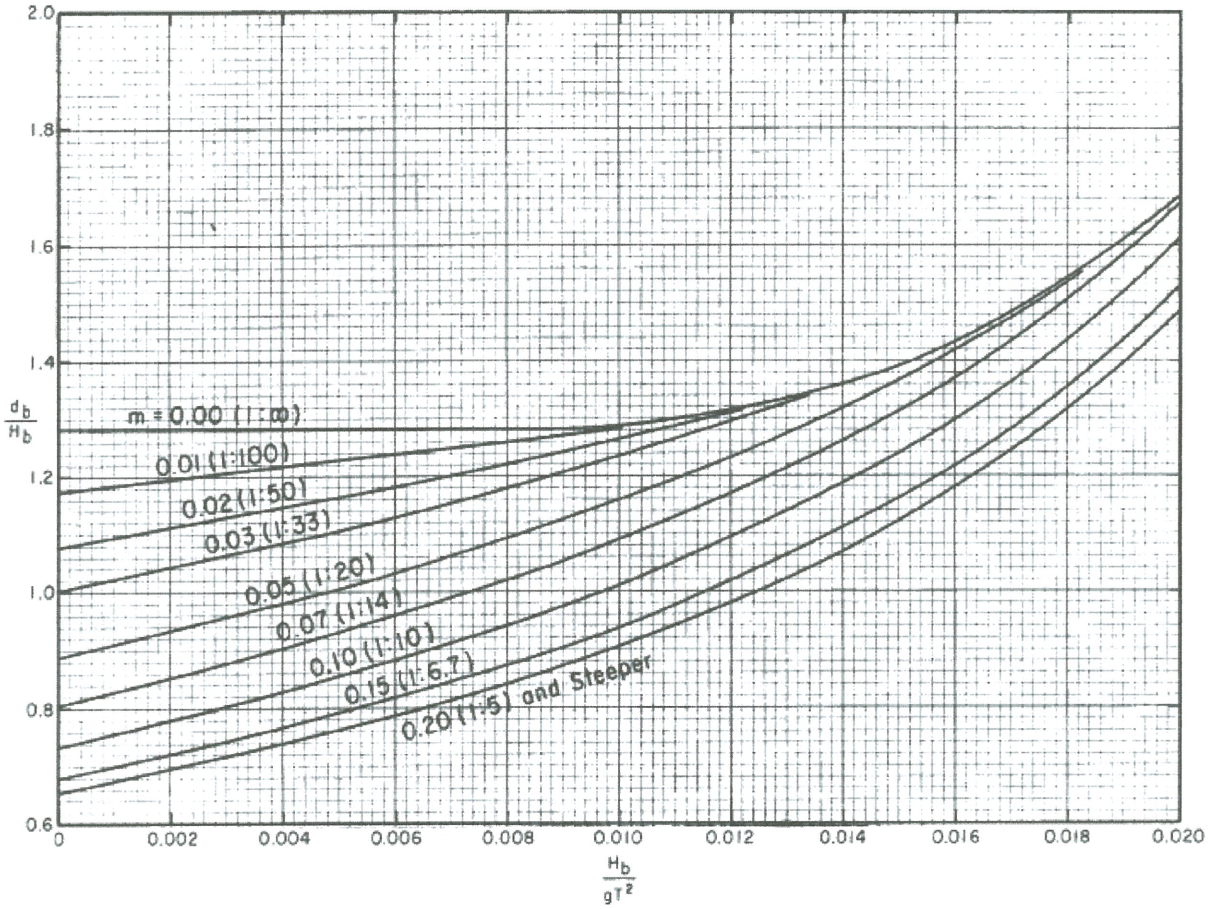


**FIGURE 2**: Breaker index versus wave steepness

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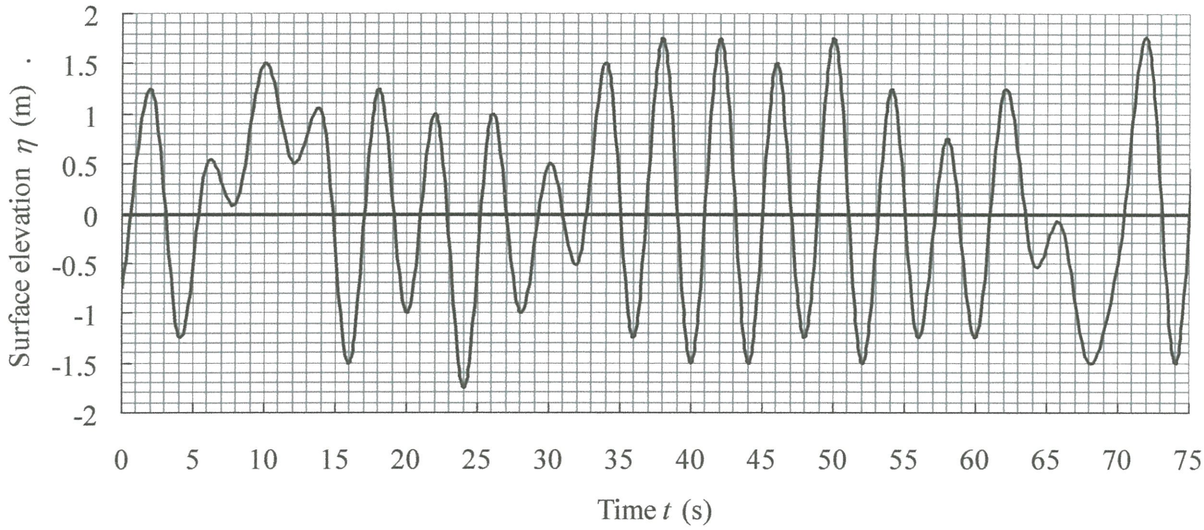


**Figure Q4**

**TABLE 2:** 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 3:** 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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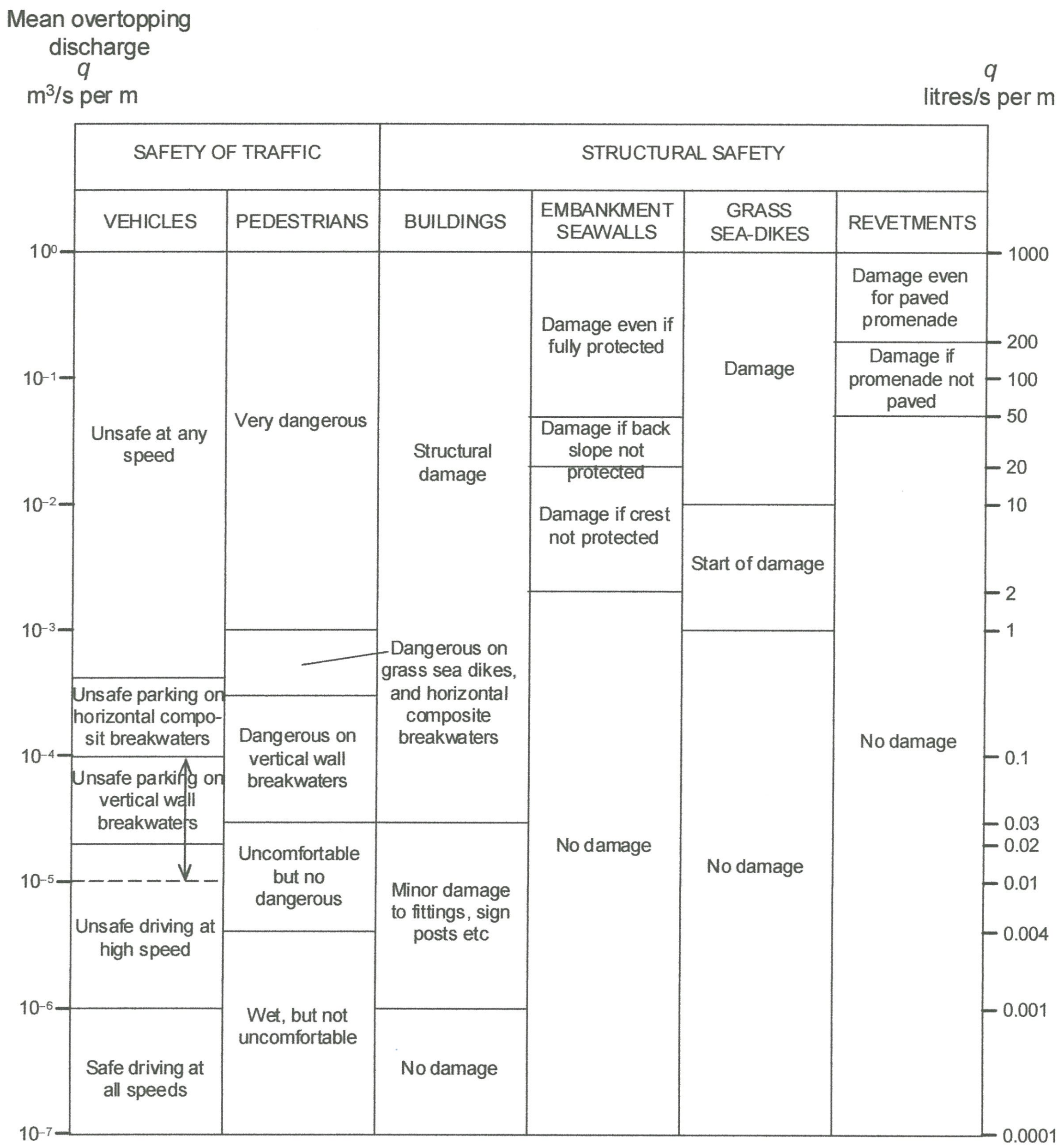


**Figure Q5**

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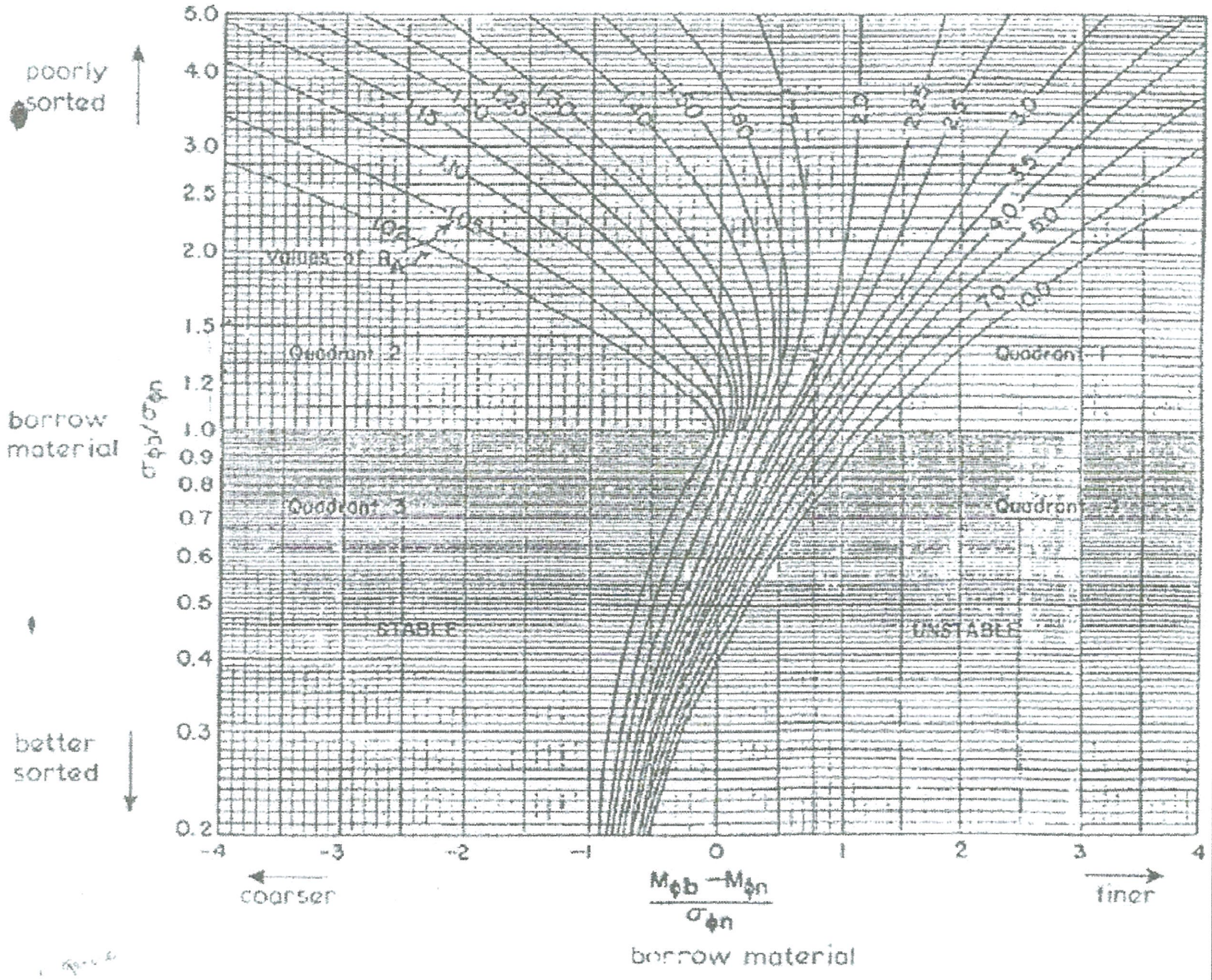


**FIGURE 3:** Isolines of the adjusted SPM fill factor $R_A$

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**TABLE 4**: 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 | |