Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2013/2014

COURSE NAME	:	TRANSPORTATION ENGINEERING
COURSE CODE	:	BFT 4033/BFT 40303
PROGRAMME	:	4 BFF
DATE OF EXAMINATION	:	DECEMBER 2013/JANUARY 2014
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

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

Q1 Water perform in the wave field orbital motions in two different conditions such as large depth/short waves and short depth/long waves (Figure **Q1(a)** and Figure **Q1(b)**). Studies like JONSWAP have shown that wind-generated wave properties depend on wind speed V_W and fetch$F$, the angle-average length the wind is blowing over the water. Based on the data collection, maximum heightof wave is 2.0 meters with the angle of 35° and data of wind speed are10 m/sec, 15 m/sec and 20 m/sec (Figure **Q1(c)**). k = 0.301 m^{-1}.You are asked to

(a) Determine wave dispersion and phase speed for short wave and long wave (15 marks)

(b) Determine average wave height and wave period due to the wind (10 marks)

Q2 The local authority in BatuPahat is planning to construct an airport for standard aircraft of Boeing 727-200 (design aircraft). The following Table **1** gives the average annual departures and maximum take-off weight of each aircraft type expected to use the airport pavement. Table **2** shows conversion factors for converting from one aircraft (landing gear) type to another. The airport will be designed using three layers: Hotmix-asphalt, Base course and Subbase course (CBR 25%) with CBR Subgrade of 6% (Figure **Q2(a)**). Based on current situation,

(a) Determine Equivalent Dual-Gear Departures, Wheel load and Equivalent Annual Departures for Design Aircraft (each of aircraft) (15 marks)

(b) Determine the total thickness of pavement and thickness of each layer (using Figure **Q2(b)** and Figure **Q2(c)**) (10 marks)

Q3 LocalGovernment of Railway Project is constructing a railway track for Railway class-II with design speed of 120 km/hr. The rail loading concepts can be seen at Figure **Q3**. Train axle load = 18 tonnage and stiffness modulus, k = 175.5 kg/cm^2. It is planned to use rail type of R.54 which elasticity modulus is 2×10^6 kg/cm^2 and inertia moment is 2346 cm^4. Based on that information and using Talbot equations, you are asked to:

(a) Determine maximum deflection, Y. (10 marks)

(b) Determine seat load, Q (10 marks)

(c) Determine *Modulus of Track Elasticity*, u if tie spacing is 50 cm. (5 marks)

Q4 A new airport in Parit Raja has been proposed to help relieve the Senai International Airport. The airport is expected to receive commercial traffic with the Boeing 737-200 as the critical aircraft (cross wind=16 km/hr). For this analysis use the FAA application for wind rose available in wind data produced by Jabatan Meteorologi Malaysia. The scale of wind speed is 0-3 km/hr, 4-6, 7-10, 11-16, 17-21, 22-27, 28-33, 33-40, 41 km/hr and over (Figure **Q4**). Based on information you are asked to:

(a) Determine the optimal runway orientation (use Figure **Q4**) (15 marks)

(b) Design the layout of runway (orientation, Clear Way and Stop Way) (10 marks)

- END OF QUESTION –

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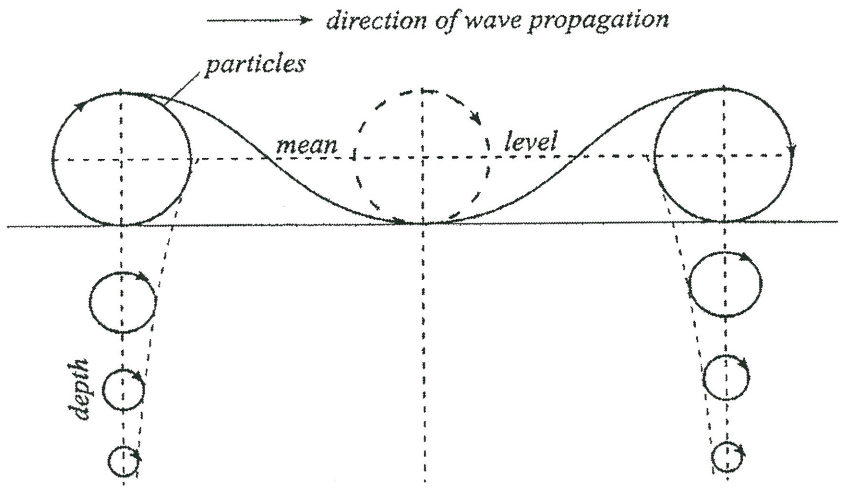

FIGURE Q1(a): Large depth/Short wave

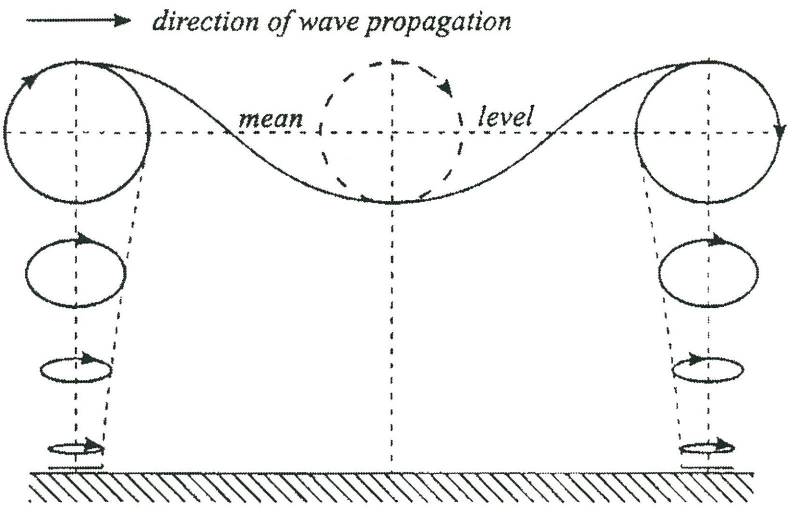

FIGURE Q1(b): Small depth/Long wave

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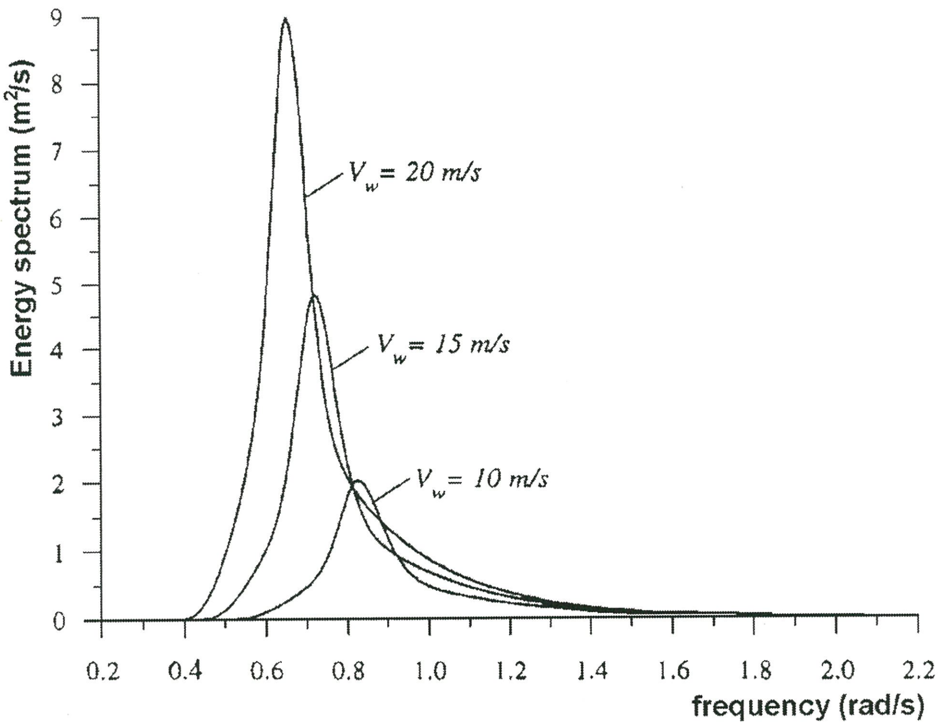

FIGURE Q1(c): Wind speed – frequency – energy data

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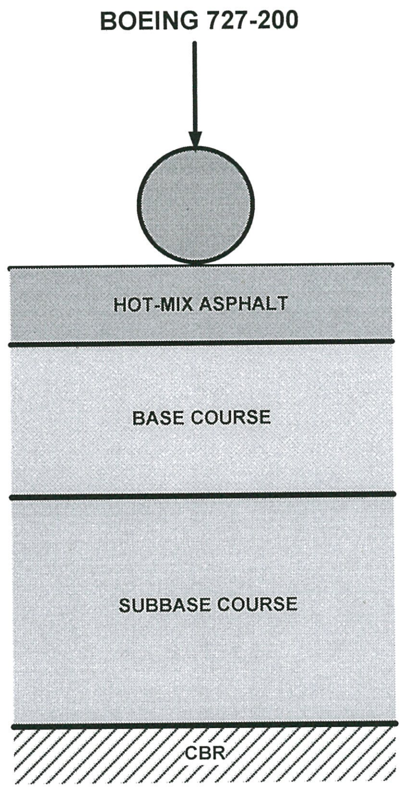

FIGURE Q2(a): Pavement structure for Boeing 727-200

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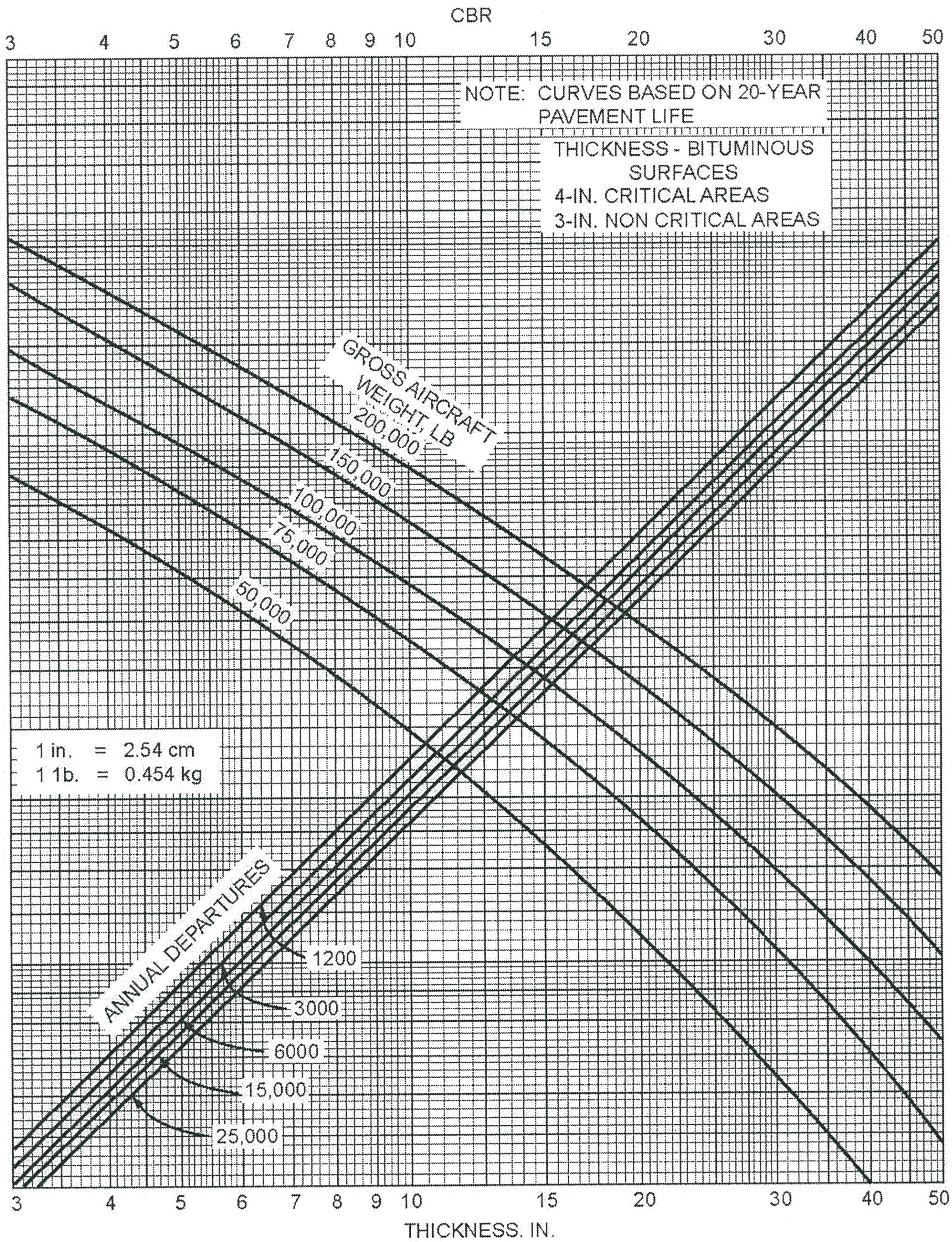

FIGURE Q2(b): Graph of flexible pavement thickness for dual-wheel gear

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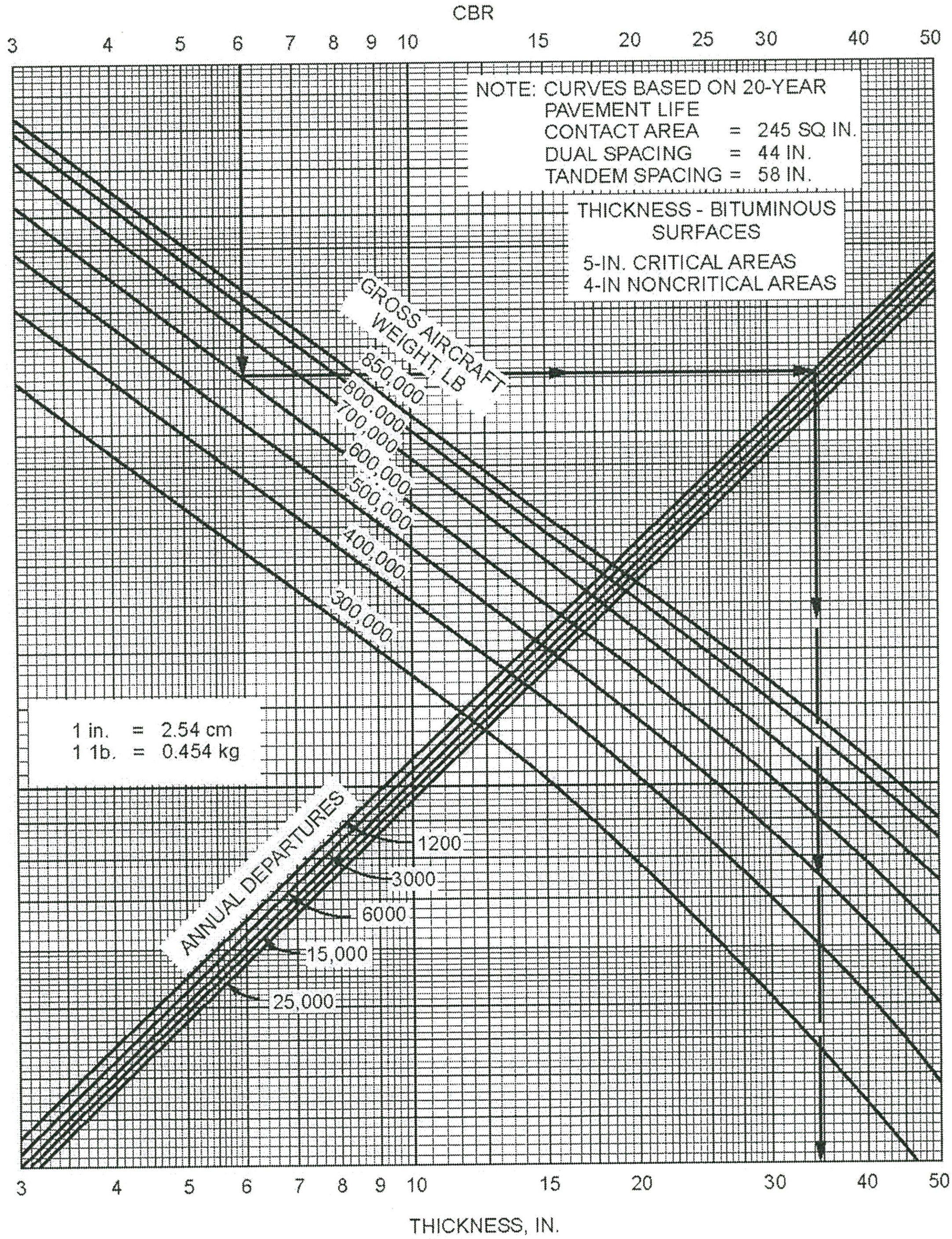

FIGURE Q2(c): Graph of flexible pavement thickness for Boeing 747-100

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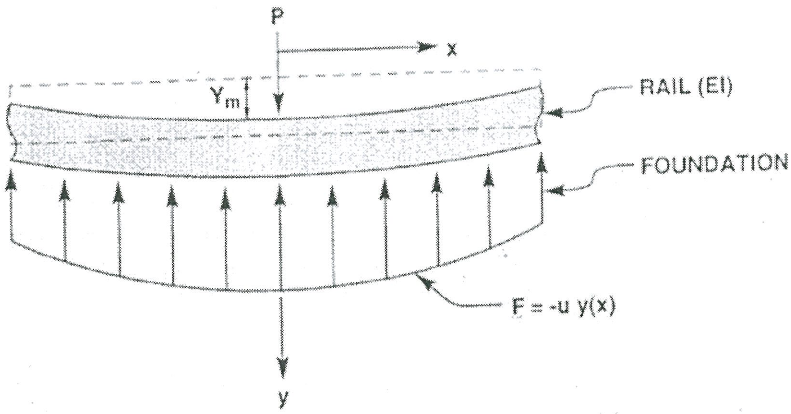

FIGURE Q3: Rail loading concepts

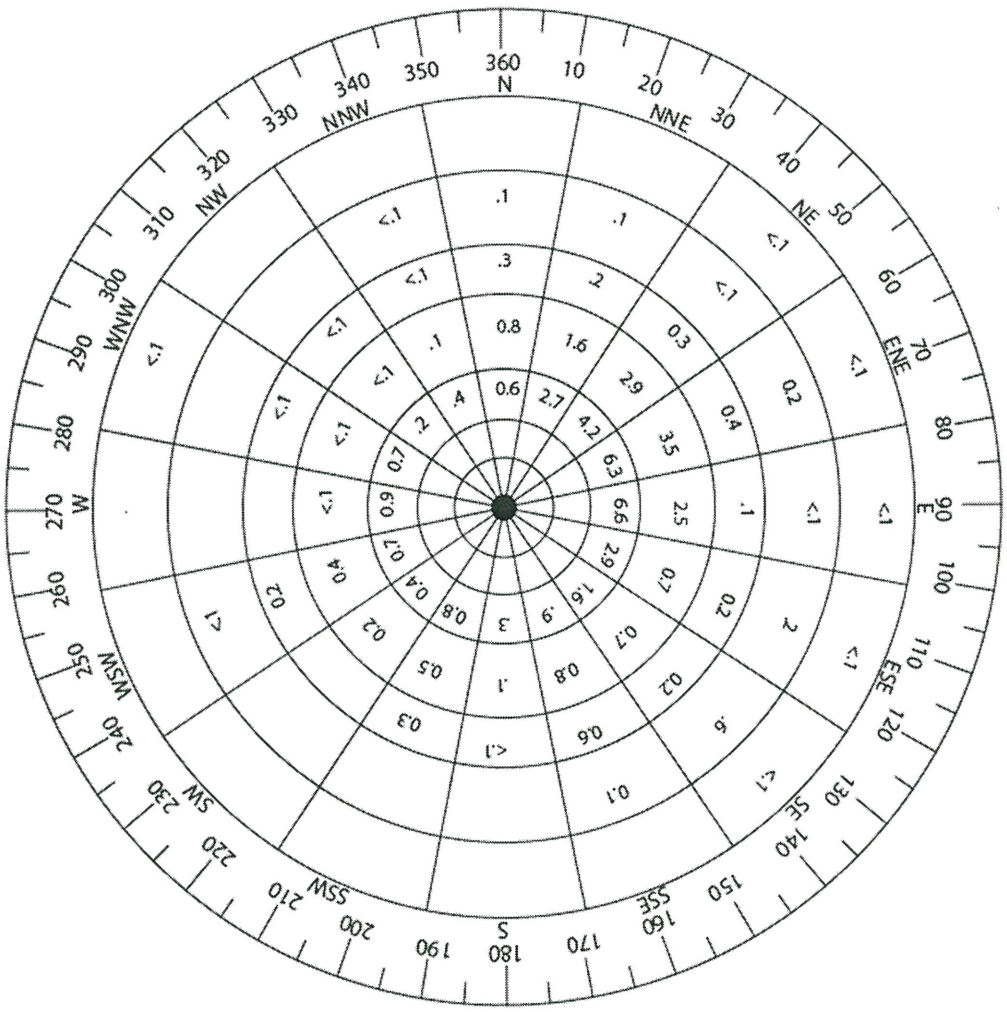

FIGURE Q4: Wind Rose

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Table 1: Data average annual departures and maximum take-off weight of each aircraft

Aircraft	Gear type	Average annual departures	Max Take-Off Weight (lb)
727-100	Dual	3500	150,000
727-200	Dual	9100	190,500
707-320B	Dual tandem	3000	327,000
DC-10-30	Dual	5800	108,000
737-200	Dual	2650	115,500
747-100	Double dual tandem	80	700,000

Table 2: Conversion factors for converting from one aircraft type to another

To convert from	To	Multiply departures by
Single wheel	Dual wheel	0.8
Single wheel	Dual tandem	0.5
Dual wheel	Single wheel	1.3
Dual wheel	Dual tandem	0.6
Dual tandem	Single wheel	2.0
Dual tandem	Dual wheel	1.7
Double dual tandem	Dual tandem	1.0
Double dual tandem	Dual wheel	1.7

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dispersion relation $\omega = \sqrt{gk \tanh(kH)}$

phase speed $c = \frac{\omega}{k} = \sqrt{\frac{g}{k} \tanh(kH)}$

short wave limit $kH >> 1$ then $\tanh kH \approx 1$

$$\omega = \sqrt{gk} \quad , \quad c = \sqrt{\frac{g}{k}} = \sqrt{\frac{g\lambda}{2\pi}}$$

long wave limit $kH << 1$ then $\tanh kH \approx kH$

$$\omega = \sqrt{gH}k \quad , \quad c = \sqrt{gH}$$

Significant wave height $h_s = 0.0016\, V_W \sqrt{\frac{F}{g}}$

Wave period (spectral pike) $T = 0.286\left(\frac{V_W F}{g^2}\right)^{\frac{1}{3}}$

DR. ING. JOEWONO PRASETIJO

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$$\eta * = 0.75(1+\cos\beta)H_{\max}$$

β = direction of waves with respect to breakwater normal
(for waves approaching normal to breakwater, $\beta = 0$)

$$p_1 = 0.5(1+\cos\beta)(\alpha_1 + \alpha_2\cos^2\beta)\gamma H_{\max}$$

$$p_2 = \begin{cases} \left(1-\dfrac{h_c}{\eta *}\right)p_1 & \text{for } \eta * > h_c \\ 0 & \text{for } \eta * \le h_c \end{cases}$$

$$p_3 = \alpha_3 p_1$$

Effect of wave period on pressure distribution:

$$\alpha_1 = 0.6 + 0.5\left(\frac{2kh_s}{\sinh 2kh_s}\right)^2$$

minimum = 0.6 (deep water), maximum = 1.1 (shallow)

Increase in wave pressure due to shallow mound:

$$\alpha_2 = \text{minimum of } \frac{h_b - d}{3h_b}\left(\frac{H_{\max}}{d}\right)^2 \text{ or } \frac{2d}{H_{\max}}$$

Linear pressure distribution:

$$\alpha_3 = 1 - \frac{h_w - h_c}{h_s}\left(1 - \frac{1}{\cosh kh_s}\right)$$

h_b = water depth at $5H_s$ seaward of breakwater

Radiation stress considerations show the reflected wave causes a set-up (h_o) at the vertical wall:

$$h_o = \frac{\pi H^2}{L}\coth kh$$

Increase in pressure due to the standing wave:

$$p_1 = \frac{1+\chi}{2}\left[\frac{\gamma H}{\cosh kh}\right]$$

where χ = wave reflection coefficient (1.0 for vertical wall with total reflection)

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(1) wave crest (subscript *e*):

$$R_e = \frac{(h+H+h_o)(\gamma h + p_1)}{2} - \frac{\gamma h^2}{2}$$

$$M_e = \frac{(h+H+h_o)^2(\gamma h + p_1)}{6} - \frac{\gamma h^3}{6}$$

(2) wave trough (subscript *i*):

$$R_i = \frac{\gamma h^2}{2} - \frac{(h+h_o-H)(\gamma h - p_1)}{2}$$

$$M_e = \frac{\gamma h^3}{6} - \frac{(h+h_o-H)^2(\gamma h - p_1)}{6}$$

$$Wheel\ load = 95\% \frac{maximum\ take-off\ weight}{number\ of\ wheels\ on\ landing\ gears}$$

$$\log R_1 = \left(\frac{W_2}{W_1}\right)^{\frac{1}{2}} \log R_2$$

$$P_d = P_s\left[1 + 0.01\left(\frac{v}{1{,}609} - 5\right)\right]$$

$$\lambda = \left(\frac{k}{4EI}\right)^{\frac{1}{4}}$$

$$M_m = \frac{P_d}{4\,\lambda}$$

$$y(x) = \frac{P\,\lambda}{2\,k} e^{-\lambda x}(\cos \lambda x + \sin \lambda x)$$

$$u = \frac{P}{S}$$