Journal of Advanced Research in Ocean Engineering 4(3) (2018) 124-134
http://dx.doi.org/10.5574/JAROE.2018.4.3.124

Development of Wind Induced Wave Predict Using Revisited Methods

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(Manuscript Received July 30 2018; Revised August 25, 2018; Accepted September 12, 2018)

Abstract

In this study, when the stability of the structure against the ocean wave is considered for designing the offshore structures in the Pacific, Indian ocean and Atlantic regions where the cyclone is largely generated, the ocean wave caused by the cyclone as well as the storm surge which called wind induced wave shall be predicted accurately for the purpose of judgment. The predicted wind induced wave was evaluated by comparing the outcome results the model test of Nobuhiro Matsunaga (1996) and Conventional Experiment forms such as Jonswap spectral forms(Carter, 1982), Simplified Donelan / Jonswap forms(Wilson 1965), Donelan spectral forms(Donelan 1980), Revised SPM forms(Schafer Lake 2005, 2007, 2008), SPM forms(CERC 1977), the CEM forms(Kazeminezhad et al., 2005), SMB forms(Sverdrup Munk and Bretschneider 1947,1954, 1970), and Revised Wilson forms(Wilson 1965, Goda 2003). Most of these conventional experiment forms confirmed a good match when the fetch length is less than 10 km. However, normal cyclone fetch length is more than 100km, With this fetch length, the comparison result is 10.4% of deviation when used Jonswap spectral forms(Carter, 1982) but the deviation of the other forms is around 74% due to boundary limit of fetch and wind duration. Therefore, in this study, we proposed the revised forms after comparing these results with the model results. We confirmed that the deviation range is around 10% based on revisited experiment forms. Since the model test was carried out in the small water tank, the scale up factor was applied to the mode test results in order to obtain similar results to the actual environment from revisited forms.

Keywords: Wind induced Wave, Revisited Forms, Jonswap spectral forms, Simplified Donelan / Jonswap forms, Donelan spectral forms, Revised SPM forms, SPM forms, CEM forms, SMB forms, Revised Wilson forms, Nobuhiro Matsunaga Model Test

1. Introduction

The knowledge of wind induced wave characteristics is the most important issue for almost any engineering activity in inland and coastal waters as shown in Figure 1.1.

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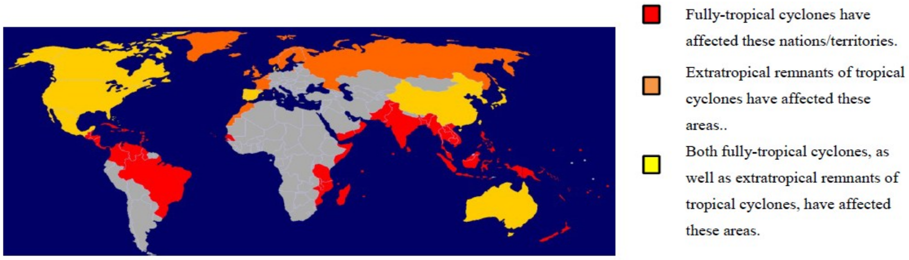

Fig 1.1 Map of Tropical Cyclone Affected Areas

Natural disasters with strong winds such as cyclones, and storms occur all over the world frequently. When occurring, wind induced waves caused by strong winds will cause huge damage to offshore structures. Figure 1.1 shows the map of areas in the world affected by tropical cyclones. In this study, we try to derive a correction forms that can predict precisely the wind induced waves using for design of offshore and coastal structures by proper analysis of model test and experiment forms.

Figure 1.2 is the global map of tropical cyclones which displays the strongest storms for the major storm regions Western and Eastern North Pacific, North Indian, South Indian and South Pacific, Caribbean/Gulf of Mexico and open North Atlantic. In this way, strong winds have been generated in many parts of the world and the damage caused by the winds has been frequent.

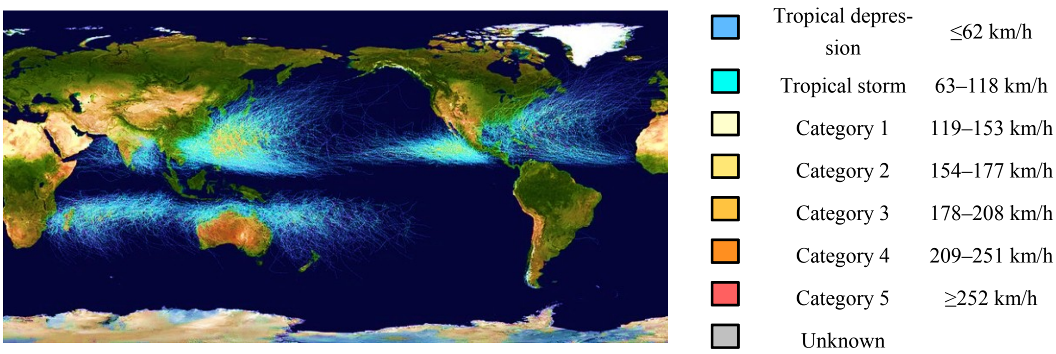

Fig 1.2 Global Tropical Cyclone Tracks

The cyclone as shown in the above figure has a large impact on the offshore and coastal structure, so this study is indispensable. In the study, we modified and revisited the other experiment forms based on Nobuhiro Matsunaga model test results. As the results, the Jonswap spectral forms(Carter, 1982) with the smallest deviation, and other experiment forms had large deviations.

Also in this study, the results of the model test of Nobuhiro Matsunaga (1996) have been compared with the revisited experiment forms. Conventional experiment forms has been revised and revisited and the results were within limit of deviation such as 15% of wind induced wave height and peak period.

2. Interpretation Theory of Wave due to Wind Effect

Below it is a description of the various conventional experiment forms for wind induced wave prediction currently in use.

2.1 JONSWAP Spectral Forms (Carter, 1982)

Carter (1982) developed parametric equations based on Jonswap spectral forms that the spectral forms predicts parametrically the integral wave parameters. These parameters are then used to define the spectrum, using the Jonswap shape. This spectrum is frequently used to describe waves in a growing phase. Jonswap Spectrum forms was considered fetch length and wind duration as shown in Table 2.1.

Table 2.1 Parametric Equations Derived from the JONSWAP Spectral Forms

	Is Duration $\geq 1.167\frac{F^{0.7}}{U^{0.4}}$			
	Yes(Fetch-Limited)		No(Duration-Limited)	
	$F < 2.32U^2$		$D < 2.01U$	
Parameter	Yes (Growing Sea)	No (Fully Developed)	Yes (Growing Sea)	No (Fully Developed)
H_S	$0.0163U\sqrt{F}$	$0.0248U^2$	$0.0146U^{9/7}D^{5/7}$	$0.0248U^2$
T_P	$0.566U^{0.4}F^{0.3}$	$0.728U$	$0.540U^{4/7}D^{3/7}$	$0.728U$
T_Z	$0.439U^{0.4}F^{0.3}$	$0.566U$	$0.419U^{4/7}D^{3/7}$	$0.566U$

Note 1) The Duration(D) is in hours, and the fetch(F) in kilometers. All other values are standard S.I. units.

These equations recognize three main conditions: a fetch limited sea, a duration limited sea and a fully developed sea. The equations are summarized in Table 2.1 which estimates the significant wave height (H_S), peak wave period (T_P) and crest wave period (T_Z) using these relationships.

The Unit of Wind Speed in m/s, Duration of wind in hours, Fetch length in km and otherwise in S.I Unit.

2.2 Simplified Donelan and JONSWAP forms Wilson (1965)

Wilson (1965) developed parametric equations based on full Donelan and Jonswap spectrum forms approach to the simplified approach using equations (2.1), (2.2), (2.3) shown below.

$$H_s = 0.00178U\sqrt{F}\sqrt{g} \tag{2.1}$$

Where, H. is the significant wave height in meters, U is the design wind speed in meters per second, F is the fetch length in meters, g is the acceleration due to gravity (9.81m/s^2), and the wave period can be derived using:

$$T_p = 0.07118F^{0.3}U^{0.4} \tag{2.2}$$

The relationship between T_P and T_z is given as:

$$T_z = 0.82T_p \tag{2.3}$$

Above forms are not considered boundary limitation of fetch and wind duration of which forms were small fetch and wind duration such as lake or river.

2.3 The Donelan Spectral Forms (Donelan, 1980)

Donelan(1980) published a Donelan spectral forms which was Similarity theory applied to the forecasting of wave heights, periods and directions. The forms were based on extensive measurements carried out in Lake Ontario, Canada, in which the full wave energy, frequency and direction spectra were obtained as shown in equations (2.4), (2.5), (2.6).

$$T_p(1.85g^{0.77}U^{-0.54}) = F^{0.23} \tag{2.4}$$

$$H_s = 0.00366g^{-0.62}U^{1.24}F^{0.38} \tag{2.5}$$

$$T_z = 0.871F^{0.23}/(1.85g^{0.77}U^{-0.54}) \tag{2.6}$$

Where, H. is the significant wave height in metres, U is the design wind speed in metres per second, F is the fetch length in metres and g is gravity acceleration (9.81m /s^2).

Above forms are not considered boundary limitation of fetch and wind duration of which forms were small fetch and wind duration such as lake or river.

2.4 Revised Revised SPM Forms Based On Data of Schafer Lake (In 2005, 2007, And 2008)

This revised forms are based on data in Schafer Lake 2005, 2007, and 2008. Only the Shore Protection Manual (SPM, 1984) method will be modified for use in small reservoirs were obtained as shown in equations (2.7), (2.8) and (2.9).

$$H_{m0} = \left(\frac{U_A^2}{g}\right) 0.0025 (gF/U_A^2)^{0.44} \quad (2.7)$$

$$T_P = \left(\frac{U}{g}\right) 0.4147 (gF/U_A^2)^{0.28} \quad (2.8)$$

$$U_A = 0.71 U_{10}^{1.23} \quad (2.9)$$

Minimum duration for the waves to be fetch-limited, the minimum duration, D_{min} is shown in equation (2.10)

$$D_{min}(\mathrm{hr}) = [\left(\frac{U_A}{g}\right) 108.2 \left(\frac{gF}{U_A^2}\right)^{0.28}]/3600 \quad (2.10)$$

Where, F= Fetch Length (m), U_A = Calculate wind stress factor(m/s)

In order to assume that the wave generation is boundary fetch limited, the wind must maintain a velocity for a sufficient time period. Since the wave train travels at group wave speed, the minimum duration for the waves to be fetch-limited can be approximated by integrating equation (2.8) over the fetch, which yields.

2.5 The SPM Forms (CERC 1977, U.S. Army, 1984)

In this method, significant wave height (H_S) and peak period (T_P) which is the period at the peak of the wave energy density spectrum are associated with the wind speed, duration, and fetch length as shown in equation (2.11) and (2.12).

$$\left(H_s, T_p\right) = f(U_A, F, \mathrm{D}) \quad (2.11)$$

Where, U_A is the wind stress factor (m/s) which is defined as:

$$U_A = 0.71 U_{10}^{1.23} \quad (2.12)$$

In the fetch limited case, for the hindcast of waves from wind, SPM forms suggested a parametric model expressed as equation (2.13), (2.14), (2.15)

$$\frac{gH_s}{U_A^2} = 0.0016 \left(\frac{gF}{U_A^2}\right)^{0.5} \quad (2.13)$$

$$\frac{gT_p}{U_A^2} = 0.286 \left(\frac{gF}{U_A^2}\right)^{1/3} \quad (2.14)$$

$$\frac{gD_{min}}{U_A} = 68.80\left(\frac{gF}{U_A^2}\right)^{2/3} \tag{2.15}$$

Minimum duration for the waves to be fetch-limited, the minimum duration, D_{min} is shown in equation (2.16)

$$D_{min}(\text{hr}) = [\left(\frac{U_A}{g}\right)68.80\left(\frac{gF}{U_A^2}\right)^{2/3}]/3600 \tag{2.16}$$

Where, D_{min} is minimum wind duration (s) and F is fetch length (m) which was computed as the effective fetch length suggests to make use of the forms for the boundary fetch limited case. Duration of wind to be replace D_{min} by D in equation (2.16).

2.6 The CEM Forms (Kazeminezhad et al., 2005)

The CEM is Coastal Engineering Manual which is published from US Army Corps of Engineers. The Parameter unit of fetch length(F) in meters which was computed as the effective fetch length in this study. In the fetch limited case, the hindcast equations for non-dimensional wave height and period are shown in equation (2.15) and (2.16)

$$\frac{gH_S}{U_*^2} = 4.13\times10^{-2}\sqrt{\left(\frac{gF}{U_*^2}\right)} \tag{2.15}$$

$$\frac{gT_p}{U_*} = 0.651\left(\frac{gF}{U_*^2}\right)^{\frac{1}{3}} \tag{2.16}$$

Where, U* is the friction velocity (m/s) estimated as shown in equation (2.17).

$$U_* = U_{10}(C_D)^{0.5} \tag{2.17}$$

Where, C_D is the drag coefficient which is defined as shown in equation (2.18)

$$C_D = 0.001(1.1 + 0.035U_{10}) \tag{2.18}$$

Minimum duration for the waves to be fetch-limited, the minimum duration, D_{min} is shown in equation (2.19)

$$D_{min}(\text{hr}) = 77.23\left(\frac{F^{0.67}}{U^{0.34}g^{0.33}}\right)/\ 3600 \tag{2.19}$$

In this equation, t is the wind duration (s). The equivalent fetch length estimated from this equation(2.19) must then be substituted into equations (2.15), (2.16), (2.17) and (2.18) to obtain estimates of wave height and wave peak periods.

2.7 **SMB Forms(Sverdrup Munk and Bretschneider 1947,1954, 1970)**

SMB form was developed by Sverdrup and Munk (1947) and improved by Bretschneider (1952). The SMB method combines a simple energy growth concept with empirical calibrations using field data. The wind of speed (U) blowing over fetch (F in meters) will produce the H_S and T_S values according to following equation:

$$\text{X} = \text{Ln}\left(\frac{gF}{U^2}\right) \tag{2.20}$$

Minimum duration for the waves to be boundary fetch limited, the minimum duration, D_{min} is shown in equation (2.21)

$$D_{min}(hr) = 0.00183Exp\left(\sqrt{0.0161X^2 - 0.3692X + 2.2024} + 0.8798X\right) \quad (2.21)$$

$$\frac{gH_s}{u^2} = 0.283tanh\left[0.0125\left(\frac{gF}{u^2}\right)^{0.42}\right] \quad (2.22)$$

$$\frac{gT_s}{u} = 0.283tanh\left[0.0125\left(\frac{gF}{u^2}\right)^{0.42}\right] \quad (2.23)$$

2.8 Revised Wilson forms wilson(1965) revisited by Goda(2003)

In this forms, the minimum duration for the full growth at a given boundary fetch length is approximately calculated by equation (2.24).

$$D_{min}(hr) = (U/g)0.001194(gF/U^2)^{0.73} \quad (2.24)$$

Where, U is the wind speed at 10 m above the sea surface (m/s), D_{min} is in hour, and F is in meter which was computed as the effective fetch length in this study. In the fetch limited condition, the significant wave height (H_S) and period (T_S) are expressed as equation (2.25), (2.26).

$$T_s = 8.61\frac{U_{10}}{g}\left[1 - \left[1 + 0.08\left(\frac{gF}{U_{10}^2}\right)^{1/3}\right]^{-5}\right](s) \quad (2.25)$$

$$H_s = 0.30\frac{U_{10}^2}{g}\left[1 - \left[1 + 0.04\left(\frac{gF}{U_{10}^2}\right)^{0.5}\right]^{-2}\right](m) \quad (2.26)$$

The relationship between T_s and T_p is given as: $T_p = 0.9523T_s$ in seconds, Hs is significant wave height in m.

3. Interpretation Theory of Wave due to Model Test

This study use the results of model test performed by Nobuhiro Matsunaga (1996). Experiments were carried out by using a water tank equipped with an inhalation-type wind tunnel. Figure 3.1 and Figure 3.2 show a schematic diagram of the experimental apparatus. The tank was 32 m long, 0.6 m wide and 0.94 m high. A sloping bed was attached to the end of the tank as a beach model. Its gradient was fixed at 1/30. The mean water depth was 0.3m at the horizontal bed section. Wind waves were generated by the shoreward wind. Measurements of the wind velocity, wave height and wind-induced current velocity were made at positions 1 to 5. The distance from the intake of the wind to Position 1 was 11m.

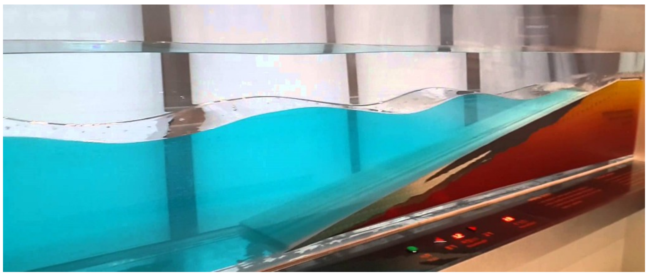

Fig 3.1 Experimental Apparatus

Table 3.1 Experimental Parameters for Model Test of Nobuhiro Matsunaga (1996).

Model Test Result						Model Test Result with Scale-up factor					
Fetch (m)	Water Depth, h(cm)	Um (m/s)	U10 (m/s)	Hs (cm)	Tp (s)	Fetch (Km)	Water Depth, h(cm)	Um (m/s)	U10 (m/s)	Hs (cm)	Tp (s)
11	30		10.9	3.111	0.467	110	30		10.9	196.308	3.884
13	30		10.4	3.437	0.467	130	30		10.4	216.831	3.884
15	25	7.6	10.4	3.719	0.474	150	25	7.6	10.4	234.677	3.943
17	18.4		10.7	4.002	0.493	170	18.4		10.7	252.523	4.101
19	11.9		11.1	4.228	0.483	190	11.9		11.1	266.800	4.017
11	30.4		18.1	6.619	0.585	110	30.4		18.1	417.600	4.866
13	30.2		17.3	7.156	0.595	130	30.2		17.3	451.508	4.949
15	25.2	11.6	19.1	7.495	0.658	150	25.2	11.6	19.1	472.923	5.473
17	18.7		20.6	7.538	0.662	170	18.7		20.6	475.600	5.506
19	12.4		19.1	6.307	0.669	190	12.4		19.1	397.970	5.564
11	29.9		26.4	7.891	0.662	110	29.9		26.4	497.908	5.506
13	30.1		28	9.065	0.714	130	30.1		28	571.970	5.939
15	25.5	15.5	27.3	9.263	0.709	150	25.5	15.5	27.3	584.462	5.897
17	19.3		29.1	8.641	0.746	170	19.3		29.1	545.200	6.205
19	13.4		31.1	6.435	0.775	190	13.4		31.1	406.000	6.446
11	28.5		29	8.556	0.699	110	28.5		29	539.847	5.814
13	30		34.8	9.037	0.719	130	30		34.8	570.185	5.980
15	25.6	18.9	36.9	9.461	0.746	150	25.6	18.9	36.9	596.954	6.205
17	19.6		40.3	8.301	0.787	170	19.6		40.3	523.785	6.546
19	14		45.6	6.802	0.84	190	14		45.6	429.200	6.987
11	27.8		39.4	8.910	0.719	110	27.8		39.4	562.154	5.980
13	28.1		43.3	9.178	0.741	130	28.1		43.3	579.108	6.163
15	24.1	21.8	42.9	9.772	0.794	150	24.1	21.8	42.9	616.585	6.604
17	18.2		45.1	8.146	0.794	170	18.2		45.1	513.970	6.604
19	13.5		45.9	5.926	0.885	190	13.5		45.9	373.877	7.361

The intervals between the adjacent measuring positions were 2.0m. Positions 1 and 2 were in the horizontal bed section and positions 3 to 5 on the sloping bed. The wind velocity was measured by using a propeller-type current meter. In the wave height measurements, two capacitance-type wave gauges were used in order to obtain the phase velocity. They were set 28 cm away. The wave signals were digitized at the intervals of 1/50 s and 16,384 data were sampled. Horizontal and vertical components of the wind-induced currents were obtained by using an electromagnetic current meter. The sampling rate of the velocity signals was 1/20 s and the number of sampled data was 2,048.

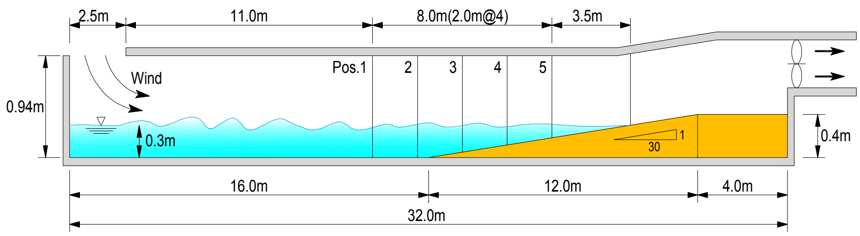

Fig 3.2 Experimental Apparatus

Table 3.1 shows the wind parameters and the wave ones. Five tests in all were carried out by varying the wind velocity. The cross-sectionally averaged wind velocity U_m was varied from 7.60 m/s to 21.8 m/s. F is the fetch and h the mean water depth. The mean wind velocity at a 10m height by U_{10}. H is the mean wave height. The periods of predominant waves are represented by T_P respectively.

In this study, a scale factor was used to replace the test result with the wind waves generated in the actual environment. The Scale-up factor is shown in the following equations (3.1), (3.2). The fetch length of the scale-up model test is 110 km to 190 Km for more accuracies results.

$$\text{Wave Height Scale Factor} = \left(\frac{Applied\ Fetch\ Length(m)}{Test\ Fetch\ Length(m)}\right)^{0.45} = 10{,}000^{0.45} = 63.1 \quad (3.1)$$

$$\text{Wave Peak Period Scale Factor} = \left(\frac{Applied\ Fetch\ Length(m)}{Test\ Fetch\ Length(m)}\right)^{0.23} = 10{,}000^{0.23} = 8.3 \quad (3.2)$$

4. Result and Discussion

The purpose of this study is not only to improve the problems of the conventional experiment forms which calculate wave affected by wind but also to modify an experiment forms for efficient calculation. The conventional forms have been revisited for some problems that the results can be quite different in the value of H_S and T_P depending on which forms they are applied. As shown in Table 4.1, this study modified the factor which was eliminated boundary fetch limit and wind duration time of the Simplified Donelan and Jonswap forms(Wilson 1965), Donelan spectral forms(Donelan 1980), Revised SPM forms(Schafer Lake 2005, 2007, 2008), SPM forms(CERC 1977), the CEM forms(Kazeminezhad et al., 2005), SMB forms(Sverdrup Munk and Bretschneider 1947,1954, 1970), and Revised Wilson forms(Wilson 1965, Goda 2003) based on the Model test results of Nobuhiro Matsunaga (1996) without Jonswap spectral forms(Carter, 1982). This study also proved the efficiency of the experiment forms by comparing the conventional experiment forms and the modified experiment forms with the Nobuhiro Matsunaga model test (1996).

Table 4.1 Revisited Forms (Eliminated the boundary fetch limit and wind duration time)

Jonswap spectral forms Same as (Carter, 1982)	Revised SPM forms $H_{m0} = \left(\frac{U_A^{1.341}}{g}\right) \times 0.0059398(\frac{gF}{U_A^2})^{0.44}$ $T_p = \left(\frac{U_A^{0.674}}{g}\right) \times 0.5823632(\frac{gF}{U_A^2})^{0.28}$	SMB forms $H_s = (\frac{U^{1.31}}{g})0.8286806 \times \tanh[0.0125(gF/U^2)^{0.42}]$ $T_P = (\frac{U^{0.536}}{g})5.91144\pi \times \tanh[0.077(gF/U^2)^{0.25}]$
Simplified Donelan / Jonswap forms $H_s = 0.002042372U^{0.569}\sqrt{F}/\sqrt{g}$ $T_p = 0.083608F^{0.3}U^{0.141}$ $T_z = 0.82T_p$	SPM forms $H_s = \left(\frac{U_A^{1.461}}{g}\right) \times 0.0024029(\frac{gF}{U_A^2})$ $T_p = \left(\frac{U_A^{0.781}}{g}\right) \times 0.2606032(\frac{gF}{U_A^2})^{1/3}$ $T_z = 0.7775T_p$	Revised Wilson forms $H_s = \left(\frac{U^{1.287}}{g}\right) \times 0.96816 \times \left\{1 - \left[1 + 0.004\sqrt{(gF/U^2)}\right]^{-2}\right\}$ $T_s = \left(\frac{U^{0.608}}{g}\right) \times 17.8054 \times \{1 - [1 + 0.008(gF/U^2)^{1/3}]^{-5}\}$ $T_p = T_s/1.05$
Donelan spectral forms $H_s = 0.012474g^{-0.62}U^{0.576}F^{0.38}$ $T_p = 1.1877297U^{0.14}F^{0.23}/(g^{0.77})$ $T_z = 0.871T_p$	CEM forms $U^* = U_{10}\sqrt{(0.001(1.1 + 0.035U_{10}))}$ $H_s = \left(\frac{U^{*1.45}}{g}\right) \times 0.0120348\sqrt{(\frac{gF}{U^{*2}})}$ $T_p = \left(\frac{U_*^{0.778}}{g}\right) \times 0.3891678(\frac{gF}{U_*^2})^{1/3}$	

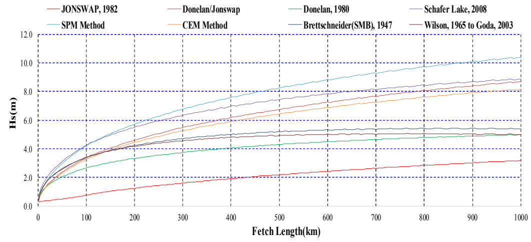

Fig 4.1a Conventional Experiment forms compared Hs Graph

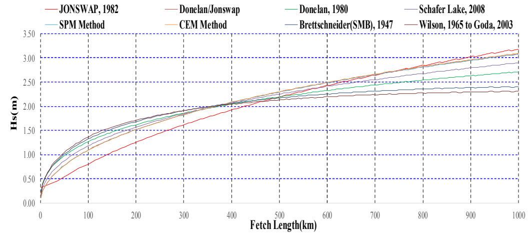

Fig 4.1b Revisited experiment forms compared Hs Graph

Fig 4.1 Comparison Graph of conventional and Revisited for H_S Forms

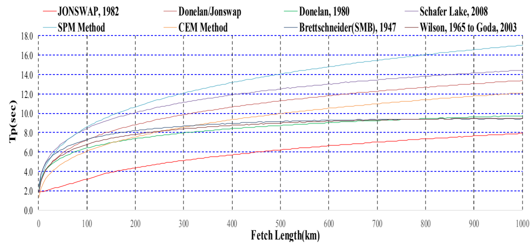

Fig 4.2a Conventional Experiment Forms compared Tp Graph

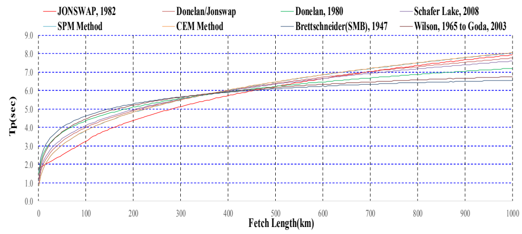

Fig 4.2b Revisited Experiment forms compared Tp Graph

Fig 4.2 Comparison Graph of Conventional and Revisited for T_P Forms

Comparing the results of the conventional experiment forms and the model test, deviation for 74% of the results of H_S and 51% of T_P occurred. Also, when we compared the results using the Revisited experiment forms, the deviation for the results of H_S and T_P were 10.4% and 12.1%, respectively. In the deviation range, the Revisited experiment forms are within the error range of 15%, which is closer to the model test than the conventional experiment forms which is shown in Figure 4.3 and Figure 4.4.

As shown in Figures 4.1a and 4.2a, there is a large deviation between the conventional experiment forms. Therefore, revisited experiment forms based on model test were derived. As a result, revisited experiment forms were derived as shown in Figure 4.1b and 4.2b.

As shown in the above Figure 4.1 and Figure 4.2, the conventional experiment forms show a large deviation error between H_S and T_P for each experiment forms, so it is confusing to decide which experiment forms should be used when calculating the result. However, the Revisited experiment forms can yield more efficient results because the deviation error between the experiment forms are within limit of deviation error.

In Figure 4.3 and Figure 4.4 below, the results of model test of performed by Nobuhiro Matsunaga (1996) and Hs and T_P of conventional and revisited experiment forms are summarized in a graph. In the revisited experiment forms, which is the closest to the mean value among forms model test results more than conventional experiment forms. In this study, the section 3 equations (3.1) and (3.2) scale-up factor is applied to correct the difference according to the scale of the model test and the experiment forms.

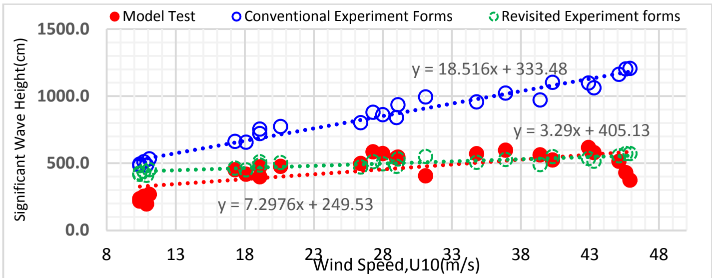

Fig 4.3 Wave Height(Hs) for Test and Theories

The results of the wave height (H_S) comparison in Figure 4.3 are shown deviation between Model test and conventional experiment form and revisited experiment forms. The deviation error between model test and conventional experiment is around 74%, and deviation of revisited experiment forms is around 10.4%. Therefore, the values of the revisited experiment forms were found to be closer to the actual experimental data from the Nobuhiro Matsunaga model test.

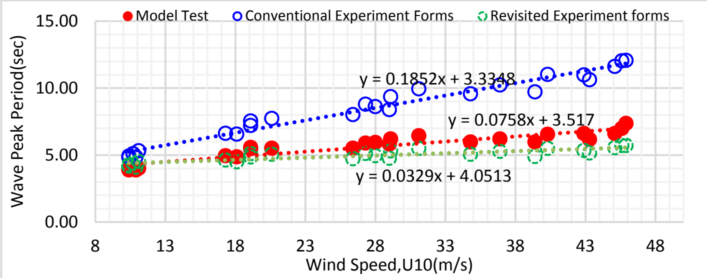

Fig 4.4 Wave Period(T_P) for Test and Theories

The results of the wave peak period (Tp) comparison in Figure 4.4 are shown deviation between Model test and conventional experiment form and revisited experiment forms. The deviation error between model test and conventional experiment is around 51%, and deviation of revisited experiment forms is around 12.1%. Therefore, the values of the revisited experiment forms were found to be closer to the actual experimental data from the Nobuhiro Matsunaga model test.

5. Conclusions

This study presented the differences in the results of several experiment forms such as Jonswap, Donelan, Revised SPM, SPM, CEM, SMB, Wilson and modified them based on the Model test to derive efficient experiment forms that are not overestimated.

In addition, it was compared the Revisited experiment forms with the results of the Model Test performed by Nobuhiro Matsunaga (1996), and verified whether they are more suitable for the actual situation.

Since the newly proposed experiment forms were based on the Model Test, the increase range of the wave height and wave period compared with the wind speed was kept lower than the conventional experiment forms, and it was confirmed that the results were similar to the increase range of the model test.

An engineer working in the area of interest in this study suggests that by using the revisited experiment forms, it is possible to predict efficiently winds induced wave that are within limitation of deviation of 15% when designing coastal structures and calculating wind waves through this study.

Acknowledgement

This paper is partly supported by Bashunddhara Group’s BOGCL Refinery Marine Terminal Project, Contract No. BG-BOGCL-ZENTECH-201709-1113-01, estimation of wave height on Chittagong sea site from deepsea wave for basic design of marine terminal.

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