Assessment of workability is critical for the offshore wind energy farm construction in terms of safety, punctuality and feasibility. Workability is defined as the ratio of weather window to the whole time. Weather window is regarded as the period that wind and wave conditions are within construction criteria. In Japan, Ishihara et al.\(^1\) assessed workability by using wind and wave simulations, but the validation problems existed since there was no measurement data in offshore and no construction experience. And there was not enough discussion about the complex terrain and typhoon effect on wind and wave simulations.

Meanwhile, prediction accuracy has improved in the recent studies. For wave simulation, Fukushima, Yamaguchi and Ishihara\(^2\) clarified the effect of complex terrain, land use and sea surface temperature on its predictions. For wave simulation, Tanemoto and Ishihara\(^3\) predicted wave and wind by using wave prediction models and combined wind fields. Also, the first offshore wind farms Choshi and Kitakyusyu wind farms were built up in 2012 as demonstration projects, which provided wind and wave measurement data in offshore and actual construction method in Japan.

**Wind and wave conditions** were used to understand the workability of construction and the conditions for working. The model used was WRF Ver. 3.4.1\(^4\) that was applied combined wind field of mesoscale and typhoon model proposed by Tanemoto and Ishihara. The model used to predict wave condition is based on WAVEWATCH III. The model was used to predict wave conditions for four domains. For the boundary condition, NCEP-FNL was used in domain 1 and predicted wind speed by WRF was used in domain 2 – 4. The model used for wave prediction is validated with data from Ocean.co.jp and measurement data from kajima.co.jp.

Seasonal occurrence frequency of wave and wind was presented in Fig.5. Occurrence times of wind speed less than 10 m/s were 20 – 25 days per a month through four seasons, which had less impact on weather window for the construction. Those of significant wave height less than 1.0 m were below 15 days per a month in spring and autumn, but around 15 days in winter and 20 days in summer. Those of significant wave period less than 8 sec were around 15 – 20 days per a month, which were not so variable as wave height. Predictions underestimated the occurrence time in low wave height and short wave period. Then, the bias for each bin was evaluated and modeled as linear equation. The modified predictions with proposed correction formula improved the prediction accuracy.

Assessment of workability by using wind and wave simulations. Construction method and construction criteria were investigated at the two construction sites by interview and summarized in Table1. Also, the actual workability at Choshi site were assessed as summarized in Table2. Workability predicted by observations and measurements were assessed. The prediction accuracy was good as Fig.6 shows.

**Validation of simulation for wave and wind**

### Table 2 Workability at Choshi site

<table>
<thead>
<tr>
<th>Bottom preparation</th>
<th>Workability</th>
<th>Workability</th>
</tr>
</thead>
<tbody>
<tr>
<td>2/23 – 4/6</td>
<td>15.9%</td>
<td>80%</td>
</tr>
<tr>
<td>6/12 – 7/10</td>
<td>27.6%</td>
<td>83%</td>
</tr>
<tr>
<td>9/9 – 10/25</td>
<td>63.8%</td>
<td>84%</td>
</tr>
</tbody>
</table>

### Table 3 Workability at Kitakyusyu site

<table>
<thead>
<tr>
<th>Month</th>
<th>Bottom preparation</th>
<th>Workability</th>
<th>Workability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring</td>
<td>2/23 – 4/6</td>
<td>15.9%</td>
<td>63%</td>
</tr>
<tr>
<td>Summer</td>
<td>6/12 – 7/10</td>
<td>27.6%</td>
<td>72%</td>
</tr>
<tr>
<td>Autumn</td>
<td>9/9 – 10/25</td>
<td>63.8%</td>
<td>68%</td>
</tr>
</tbody>
</table>

**Wind speed**

- Significant wave height and significant wave period were validated with observations. The following figure shows the comparison between predictions and observations in July and that in January.

**Wave height and wave period**

- Seasonal occurrence frequency of wind and wave in Fig.5
- Occurrence times of wind speed less than 10 m/s were 20 – 25 days per a month through four seasons, which had less impact on weather window for the construction.
- Those of significant wave height less than 1.0 m were below 15 days per a month in spring and autumn, but around 15 days in winter and 20 days in summer.
- Those of significant wave period less than 8 sec were around 15 – 20 days per a month, which were not so variable as wave height.
- Predictions underestimated the occurrence time in low wave height and short wave period. Then, the bias for each bin was evaluated and modeled as linear equation. The modified predictions with proposed correction formula improved the prediction accuracy.

**Introduction**

Wind and wave simulations were performed at Choshi Offshore wind farm in the period from 2013. 12 to 2014. 12 to get the timeseries of wind speed, wave height and wave period.

**Wind simulation**

- WRF Ver.3.4.1\(^4\) was used.
- The model runs were performed for four domains. For the boundary condition, NCEP-FNL was used in domain 1 and predicted wind speed by WRF was used in domain 2 – 4.
- Combined wind field of mesoscale and typhoon model proposed by Tanemoto and Ishihara were applied.

**Wave simulation**

- Wave Watch III (WWS) Ver.3.14\(^5\) was applied.
- The model runs were performed for four domains. For the boundary condition, NCEP-FNL was used in domain 1 and predicted wind speed by WRF was used in domain 2 – 4.

**Wave conditions at Choshi and Kitakyusyu**

Fig.3 shows occurrence frequency of significant wave height and significant wave period at Choshi and Kitakyusyu.

- Seasonal occurrence frequency of significant wave height and significant wave period were validated with observations. The following figure shows the comparison between predictions and observations in July and that in January.

**Validation of simulation for wave and wind**

Fig.4 shows actual and predicted workability at Choshi site and Fig.5 shows actual and predicted workability at Kitakyusyu site.

**Conclusions**

In this study, workability was assessed by using the latest wind and wave simulations. Conclusions are summarized as follows.

1. Predicted seasonal, significant wave height and significant wave period reproduced observations well. Annual average of monthly mean errors were 4.3 %, 12.3 % and 7.8 % respectively.

2. Seasonal occurrence frequencies were assessed by predicted and observed wind speed, significant wave height and significant wave period. Occurrence time of wind speed was predicted well, but those of significant wave height and significant wave period were modified with bias correction to improved the prediction accuracy. Annual average of monthly mean error decrease to 9.9 % for wave height and to 2.9 % for wave period.

3. By using the validated construction criteria and the predicted wind and wave time series, workability were predicted well at Choshi offshore wind farm.

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