The primary conversion efficiency of a "Backward Bent Duct Buoy" (BBDB) wave energy converter is measured in two and three dimensional tank experiments. The effect of duct extension on the primary conversion efficiency is investigated by attaching 15cm and 45cm ducts to the normal model. The experimental result shows that the duct extensions reduce the primary conversion efficiency because they reduce the pitching motion of the BBDB.

Key Words: Backward Bent Duct Buoy, wave energy, primary conversion

2. MODEL EXPERIMENT

Fig2 shows the dimensions of the model, which was made from an aluminum frame and an acrylic board. The model was 0.85m long and 0.78m wide, and had a 0.35m draft. To maintain the buoy’s level in the water, 37.5kg of ballast was loaded into the buoyancy module. Two ultrasonic sensors are installed in the air chamber to measure the water level. A pressure sensor was also installed in the air chamber. The sampling interval was 20Hz.

The motion of the model was measured with image processing, using images taken at a sampling interval of 10Hz. The motion of a marker was converted to the motion around the center of gravity.
To investigate the effect of the body shape, the duct was extended by 15cm and 45cm. The duct extensions were attached to the normal body (Fig.3).

The primary conversion efficiency is investigated in two- and three-dimensional tank experiments. Table 1 shows the geometry of the tanks. The model was moored in the center of the tanks, and the incident waves, with amplitudes of 2.5-3.0 cm, were made using a wave maker.

### Table 1 Tank geometry

<table>
<thead>
<tr>
<th></th>
<th>Length</th>
<th>Width</th>
<th>Water Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saga</td>
<td>18.0 m</td>
<td>0.8 m</td>
<td>1.0 m</td>
</tr>
<tr>
<td>Kyushu</td>
<td>65.0 m</td>
<td>5.0 m</td>
<td>7.0 m</td>
</tr>
</tbody>
</table>

The primary conversion efficiency is defined as

\[
\eta = \frac{E_{\text{out}}}{E_{\text{in}}}
\]

where \( E_{\text{in}} \) is the energy flux of the incident wave and \( E_{\text{out}} \) is the energy flux of the air. \( E_{\text{in}} \) is defined as

\[
E_{\text{in}} = \frac{1}{2} \rho g \zeta_i^2 C_g B
\]

\[
E_{\text{out}} = \frac{S}{T} \int_0^T p(t) \frac{\partial}{\partial t} \left( \frac{\eta_1(t) + \eta_2(t)}{2} \right) dt
\]

where
- \( \rho \) density of water
- \( g \) gravity
- \( \zeta_i \) amplitude of the incident wave
- \( C_g \) group velocity
- \( B \) BBDB width
- \( S \) area of the air chamber
- \( T \) period of incident wave
- \( p(t) \) pressure in the air chamber
- \( \eta_1(t), \eta_2(t) \) water level in the air chamber
3. RESULTS

Fig. 4 shows the incident wave amplitude, internal water level, pressure and conversion efficiency. The horizontal axis is defined as the incident wave length ($\lambda$) / body length (L). Extending the duct reduces the pressure and, as a result, the primary conversion efficiency is also reduced.

Fig. 5 shows the amplitude of motion. The amplitude is non-dimensionalized, using the incident wave amplitude. This figure shows a large pitching motion is required to achieve a high efficiency.

4. CONCLUSION

The effect of duct extension on the primary conversion efficiency of a BBDB was investigated in two- and three-dimensional tank experiments. The results show that the duct extension reduces the primary conversion efficiency because it reduces the pitching motion of the BBDB.
REFERENCES