History of ATD development

On March 11, 2011, Japanese people experienced East Japan Earthquake and its accompanied catastrophic tsunami, and they felt that human is very weak against such catastrophic natural hazards. We thought that we would like to invent any system to prevent/minimize tsunami hazards even only by little, in order to help human to keep the life under such hazards. ATL considered the following 3 points are essential in the development:

(1) If the anti-tsunami system is functioned by machinery/person, they might fail to function properly by such as power loss or the person might have a danger for making the system to work properly (such as closing of opening in breakwater), so the system should be automatically functioned without using machinery/electric/personal action.

(2) In order to prevent the system from being so big like concrete sea wall of more than 10m height and disturbing the sight and daily life of people, the system should be kept in compact condition during normal time and be acted as breakwater by moving and/or expanding when tsunami comes.

(3) Because he anticipated tsunami height will become so large, the system should be economical.

After deep research, ATL found the lumber's buoyancy/strength/economic are just fit to the system considering the above 3 points and invented Anti-Tsunami Door system. In it, reinforced lumber unit (2~3m height x 5m width x 20~30cm thickness) is used as main structure, which is installed as laid down on ground near sea coast. The one width side of unit is hinged with ground, and the opposite side is open and will stand up in the flooded water when tsunami comes. The standing position will be supported mechanically and ATD will function as breakwater. This unit is made of wood, so it is economic and environmental friendly. And this utilizes the buoyancy of wood for functioning the breakwater system automatically without using machinery/ electricity/ human action. Therefore this system is matching with the original 3 essential points. Because ATD is of unit structure, ATD can be used for the protection of long sea coast line by sequential installation of multiple units. And because ATD can be constructed as of multiple panels like folding screen, it could be kept in compact during normal time and could be functioned as tall breakwater during tsunami (e.g., ATD of 3m height x 5 panels folding could be used as 15m height breakwater. The thickness of one panel is 20~30cm, so total thickness of all the 5 panels is only 1~1.5m as laid down on the ground.).

On the other hand, there were 2 technical issues; "Issue1: Can ATD have practical tsunami reduction because ATD is automatic system of unit structure, then it is not water tight?.", and "Issue2: Can ATD (structure and connecting parts) bear the tsunami force because ATD is made of wood? (The wooden structure of only 20-30cm thickness is robust enough against tsunami power?)"

As per Issue1, ATL performed the experiments of ATD model and found that ATD has a reasonable tsunami height reduction effect which is 80~90% of that of solid sea wall of the same height. Because it is considered that the 10~20% reduction of effect acceptable, the ATD could be used as standard breakwater.

As per Issue2, ATL has applied reinforced lumber unit for ATD. It is made by sanding a frame of rectangular lumber by two wooden board, so both wooden materials support each other and improve the overall strength. (The reinforced lumber unit is a more excellent structure for breakwater than we expected. It has open space inside, which can contain flooded water, and its total weight when tsunami comes, becomes heavier and it is expected that the strength becomes more robust. On the other hand, the total buoyancy of the structure is not affected by this. This is because the lumber parts have the buoyancy, and the water inside the unit and outside the unit have the same specific gravity. Additionally the required strength of the unit (as breakwater) in the water (i.e., when the unit has the same water pressure at the tsunami receiving side and opposite side) is only for stopping the water movement (i.e., without applying the water depth pressure difference), so if the unit is supported with the required strength (for the water movement), the unit can be kept at the required position and functioned as breakwater. Because there were some hazards of river flooding when driftwood were stuck in bridge pier, this consideration might be applicable.) In the model experiments, it was confirmed that the structure which is functioned as sea wall in the water, has no damage under the experiment conditions. And the hinged connection between ATD and ground is double ring of wire and has no damage under the experiment conditions. On the other hand, the support of ATD (used to keep ATD be the sea wall condition) is required to be robust enough in order to keep the standing position and location of ATD against all force of wave even in the water. Because the force is so strong, the support were sometimes bended (the support at early stage was not so strong) and/or moved abaft greatly (the weight for the support was not sufficient for the wave force) at the early time of experiments. It is required that the strength of support specially in actual facility shall be designed and applied properly.