Solitary Wave Induced in a Water Surface Wave Field

Shigehisa Nakamura
Kyoto University, Japan

Abstract— A problem on solitary wave induced in a water surface wave field, is introduced for obtaining an analytical solution in a manner of mathematics. By this time, it was recorded offshore at the case of the tsunamis generated by the earthquake in 2011 March 11 in the northwest Pacific. Adding to the above, a hydraulic experiment had been confirmed a couple of solitary waves induced in a field of water surface wave field artificially generated in a basin. Then, a problem is raised to solve in a manner of analytical mathematics for the solitary wave in a water surface wave field under the given conditions.

1. INTRODUCTION

This work concerns a certain problem on solitary wave in the water surface wave induced in a water field. This problem could be raised to solve in a manner of applied mathematics for physical science.

By this time, it was recorded offshore at the case of the tsunamis generated by the earthquake on 2011 March 11 in the northwest Pacific by a ocean wave recorder settled on the sea floor for monitoring the ocean water in order to realize the specific property of the ocean water surface waves which have been destructive for the super-tankers' navigation by chance. One of the professors had shown strongly interested in the record of a strange water surface wave at the earthquake under sea. Seismologists had pay a little attention to tsunamis energy in relation to any seismic mechanism.

Adding to the above, a hydraulic experiment had been confirmed a couple of solitary waves induced in a field of water surface wave field artificially generated in a basin.

Now, the problem should be raised to solve in a manner of analytical mathematics for the solitary waves in a water surface wave field under the given condition.

Some part of mechanism for inducing the solitary waves noted above could be realized after obtaining a solution reduced in a mathematical manner in brief.

2. SOLITARY WAVE

As for "solitary wave", it can be seen what is the basic for seeing "solitary wave", for example, in the publication by Lamb [1].

In the first edition of "Hydro-Dynamics" written by Lamb [1] must had included the papers presented by McCowan in 1894 [2] and by Korteweg and de-Vries in 1895 [3].

In the waves noted just above in this section, almost all of what are the essential and specific properties of the interested waves named as "solitary waves."

This solitary wave advancing on a straight line in a canal apriori assumed.

The water in the canal is assumed to be isotropic and homogeneous.

Lamb [1] in 1879 started his publication to describe about the water as an idealized fluid for a linearized water motions.

A sinusoidal water surface wave was considered to be a small-amplitude wave first so that the problem was a linear problem.

Nevertheless, the wave discussed by McCowan [2] and Korteweg de-Vries [3] was not any one of the linear waves.

In this case, it was considered only "solitary wave" under a water depth was constant and a width of the canal was uniform.

Lamb [1] had noted about a decay of "solitary wave" though the viscosity was out of his consideration, though he noted about viscosity of fluid in the other chapter later separately.

3. TSUNAMI WAVE OBSERVED IN OCEAN

The author has to note that a strange case of the water surface variations observed offshore at the earthquake undersea on 2011 March 11 in the northwest Pacific.

In fact, the strange wave was surely generated and propagating in the ocean. The body force to the water at the earthquake must force to be in motion of the water column rom the surface to the bottom.

The leading wave of tsunamis generated by the earthquake had a sharp spike.

The observed data of the tsunami waves was obtained at only one station settled offshore at that time so that no information was seen about any three-dimensional motion of the water surface patterns.

The sharp spike at the head of the leading tsunami waves forced the seismological scientists' wondering at its dynamical understanding because they had not any bit of proper understanding of water motions at the earthquake even after the seismic event was happened offshore. Then, seismologists had tended to adjust the seismic parameters for finding any reasonable understanding of the processes on the water surface undulations.

4. SOLITARY WAVE IN HYDRAULIC EXPERIMENT

Nakamura [4] had ever found "solitary wave" induced in the cyclic water surface wave field.

4.1. Monitoring Water Surface Waves

He used a water basin in an arbitrary scaling to see long water wave transform process in the basin after generating a forced cyclic water surface waves.

What was point to see was box-shape block with a slits.

A barrier with a centered slit was arranged to block the incident water waves, so that his intension was to see the wave crest line should be orthogonally cross the barrier.

The barrier width was limited by the wall on both sides of the barrier ends to form a couple of rectangular corners.

The expected incident water wave with a cyclic period was sinusoidal just in front of the wave generator, nevertheless the water wave passed a centered slit for propagating the wave to the barrier just a waves affected to show a Fresnel diffraction at the first slit just in front of the wave generator.

Then, a couple of solitary waves was induced and established at the two corners.

The couple of the solitary waves at the corners moves to maintain each wave form.

Each one of the solitary waves moves between the corner in front of the barrier.

The two solitary waves meet at the center to pass without any wave form change.

Nakamura [4] had tried to confirm whether the couple of the induced waves could be taken as a kind of "solitary wave". Then, he had confirmed the two waves were under some conditions for fitting to McCowan's limit for the solitary wave (refer to [4]).

These two waves moving simply in a cyclic motion along the barrier.

Then, the barrier acted a part of the canal for the solitary wave (for example, [3]).

The energy loss of the couple of the solitary waves was supported by the part of the incident wave energy, even though the decay must be mainly caused energy dissipation after the viscous effect of the water and by the friction on the boundaries as the floor and as the barrier face. Height of the solitary waves decayed out when the incident wave was cut.

The solitary wave in the cyclic waves generated in the water basin was quite similar to the wave form observed at the earthquake noted above section.

It is pity that there was no information to the conditions around the wave gauge settled on the sea floor at the earthquake. Hence, it is hard here to take the observed leading wave with a spike as a solitary wave in a water surface wave field though its wave form pattern is quite similar to that of the couple of the solitary waves induced in a hydraulic base for water surface waves in the field of hydraulics.

4.2. Instrumentation

The above solitary wave in the water surface waves in the basin was monitored by an electric and electronic signal transfer system with a mechanical actuator which transfer a designed input function of the signal for generating a water wave in the basin through a metallic pipe in a form of a corresponding oil-pressure signal to force and drive a plunger.

4.3. Plunger

The plunger is designed to float in the water basin. Any size and shape could be for a designer's choice, though Nakamura [4] had designed a box-type float made by steel members. It was 7 meters wide, 2 meters long and 0.5 meter high. In order to a stable response to the actuator's forcing oil-pressure under the actuator fixed a cantilever frame work system in a truss structure following the manner in structural engineering standard.

4.4. Actuator

The actuator's forcing along its vertical axis transfer its designed forcing to the floating plunger tied to the actuator.

The final target of this system was to generate the expected design water wave in the basin after a transferred output forcing of the oil-pressure controlled by the actuator as they had done for their operations in the field of mechanical engineering.

What was important to drive the system successfully at a water wave generation in the basin, was the expected response of the plunger to be well following to the signal of the output function in a stable manner in motion.

4.5. Input Function

The most important part for designing this system was to design the input function for transfer the signal to the actuator generate the expected water waves in the basin.

4.6. Feedback

It is usual to control any output signal when an input function is designed. Nevertheless, in Nakamura's case [4], the time lag of the signal was very long so that its delay caused an disagreeable response of water motion in the basin in the early stage of his experiment. Then, the writer had to adjustment of the input function design at first on the bases of the mathematical and dynamical consideration in the fields of engineering technologies. The properly adjusted output function was completed in a finalized form on a disc of the transparent plate made by plastic after his skilled minor adjustment technique.

As for the input function, it was determined with consideration of a lubrication effect of the oil for the actuator and of a viscous effect of a water for experiment in the basin after some minor adjustments for energy balance maintaining during the experiment.

5. SOLITARY WAVE IN A WATER WAVE FIELD

Now, it is necessary to clearly describe what problem should be raised.

The spike in the leading wave of the tsunamis in the ocean and a couple of the solitary waves induced in a water surface wave field in a water basin are governed by the equation of motion for the theory in hydrodynamics.

Then, a problem to be raised could be described as that a solitary wave or a couple of the solitary waves should have a solution in a form of an applied mathematics under a certain boundary condition.

When the solution is obtained, it is clarified what mechanism is contributive for the induced solitary wave or waves.

6. CONCLUSIONS

A problem is raised for realizing a solitary wave or a couple of the solitary waves could be obtained in a form of a solution in a manner of applied mathematics.

Then, what is mechanism of inducing the solitary wave or a couple of the solitary waves in the water surface wave field.

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