Proceedings of Ninth World Conference on Earthquake Engineering
August 2-9, 1988, Tokyo-Kyoto, JAPAN (Vol.II)

3-4-8

MECHANISM OF RAYLEIGH TYPE SURFACE WAVE IN SEDIMENTARY PLAIN

Isao TORIUMI[1] and Teruo SEGAWA[2]

[1]Department of General Construction Engineering, Fukui University,
Bunkyo, Fukui, Japan
[2]Takenaka Komuten Co.,Ltd.,
Higashi-ku, Osaka, Japan

SUMMARY

Sedimentary plain surrounded with rock mountains is like to a basin filled with water. Tapping the basin edge makes a water ring which starts from edge to center. This wave is surface wave in sedimentary plain.

In this paper, the mechanism of this wave is analyzed. And it is concluded that this surface wave is TSUNAMI in sedimentary plain according to the similarity of uniform arrangement from surface to bottom.

SEPARATION OF SECOND WAVE

At sunset of '73.11.25, we got a record at the observation station near the center of OSAKA plain (Fig.1). This wave is composed clearly of two waves. At the rock site near the OSAKA plain, there is no second wave. So this second wave exists only in plain.

The first is main shock which starts from the rock bottom of plain and reaches to the ground surface with S wave multi-reflections. So it contains a large quantity of high frequency components. About 20 sec. later, the second wave appears which loses high frequency components, however its amplitude of acceleration is in high level. By the array observation, it is clarified that this second wave is surface wave which starts from the surrounded rock mountain site and is transmitted to inner area of plain at a velocity of 600 m/s.

We give it a nickname "ATOYURÉ".

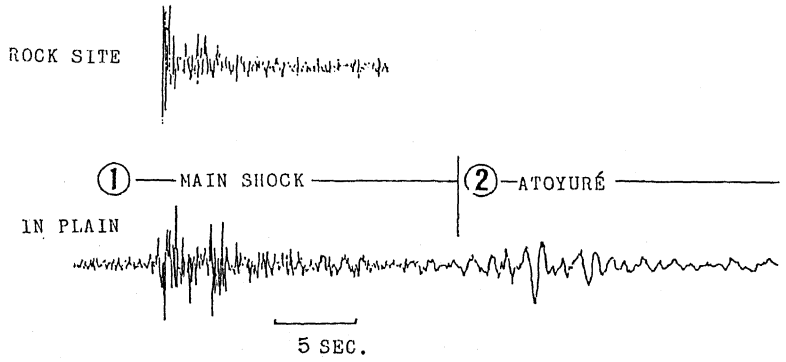

Fig.1 Wave Records in Two Site (Horizontal Acceleration)

RAYLEIGH WAVE IN HALF INFINITE MEDIUM

To consider this ATOYURÉ wave, numerical method of displacement potential is applied. One sin vertical input (20τ) excits at a point of free surface.

Fig.2 shows displacement distribution at 100τ step. P wave spreads in concentric circle, and S wave follows it. Near the free surface Rayleigh wave is generated.

Fig.3 shows the close up of distribution of displacement and potential near the Rayleigh wave at 40τ step.

In this potential distribution, S wave potentials are prominent. Near the surface, there are P potentials which are excited by S potentials using free surface condition.

In all, this distribution of potential is like to a fish.

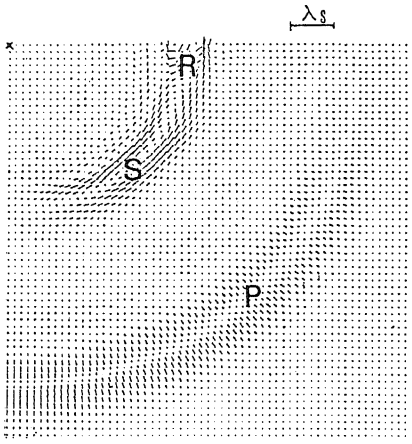

Fig.2 Simulation of Rayleigh Wave

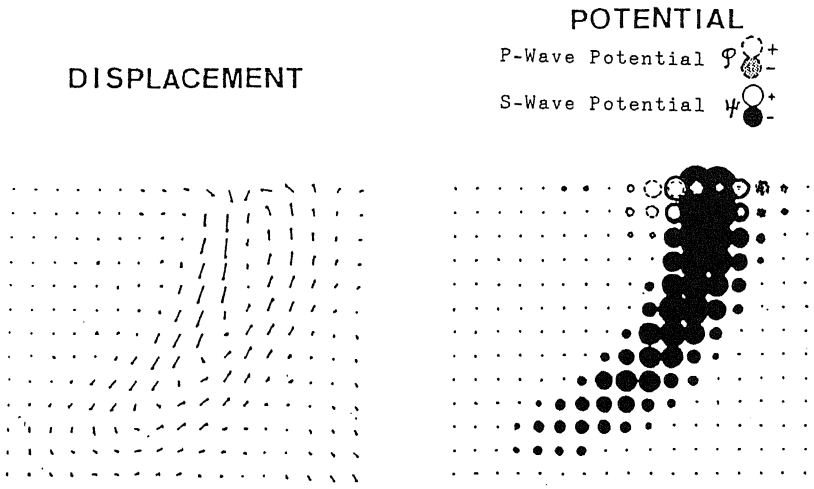

Fig.3 Close Up of Distribution of Displacement and Potential of Rayleigh Wave

This fish moves to right in enlarging.

"If fish's tail hits the rock bottom of the plain", this is the present problem of ATOYURÉ wave.

RAYLEIGH TYPE SURFACE WAVE IN SEDIEMNTARY PLAIN

If fish's tail hits the rock bottom, S wave potentials arranged in a concentric circle reflect at the line of bed rock succesively with respective angles (Fig.4). Reflected potentials are composed of P and S wave potentials. However, the main group is S wave potential.

At 40τ step, vortex like distribution of displacement is seen in this group position.

At 50τ step, this reflected S potential group forms a line vertically. And potentials in position of Rayleigh wave diminish its energy, and the reflected

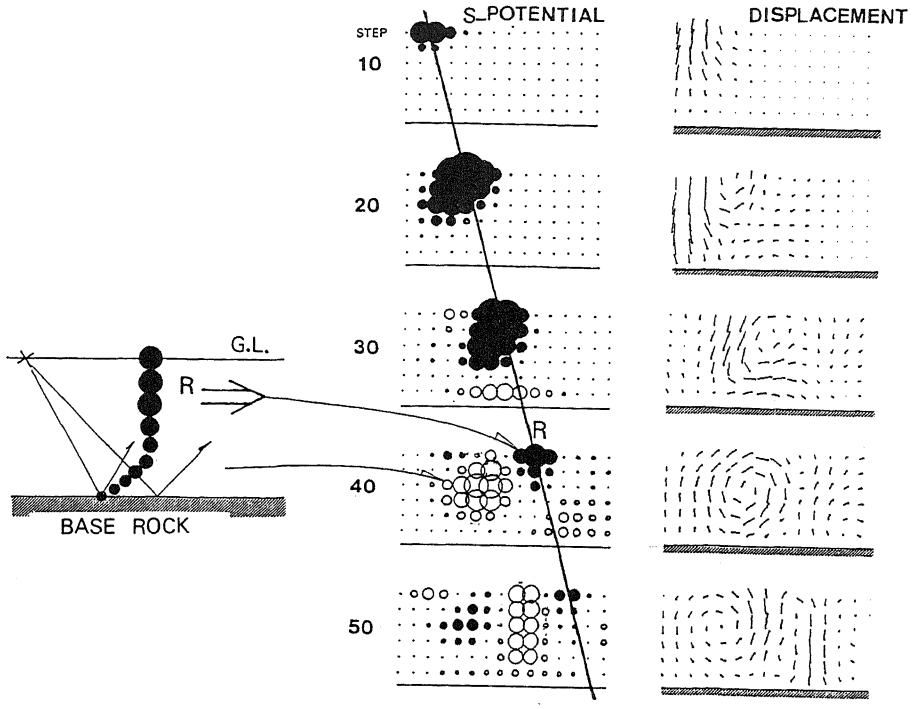

Fig.4 The behavior of Reflected S wave

S wave potential grow up. Vortex like displacement moves to right exchanging its form, and upward and downward displacements in both sides of this reflected S wave potential group make remarkable progress.

At this time step, the behavior becomes to be quite different from the one of Rayleigh wave in half infinite medium.

This variation is the main key point of ATOYURE wave.

In Fig.5, both distributions of P and S wave potentials are shown. P wave potentials which are distributed before and behind this S group do not show vigorous behavior in displacement.

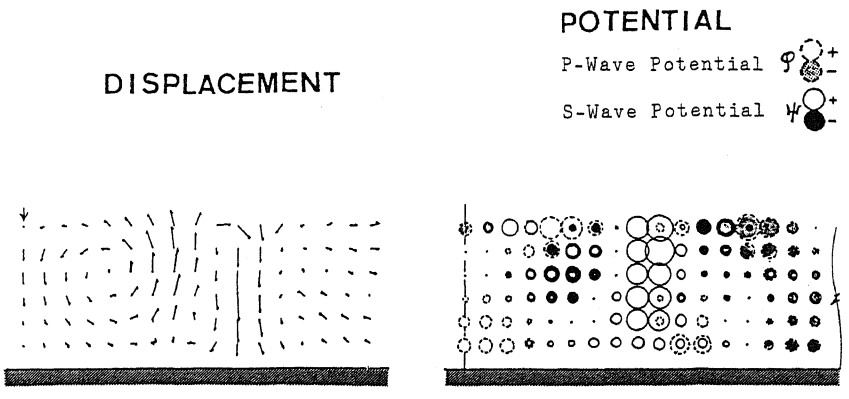

Fig.5 Both P and S Potential Distributions in Sedimentary Plain at 50 Step

ENERGY TRANSMISSION TO NEXT GROUP

As a result pursuing the behavior of this reflected S wave group in progress of time, the fact of energy transmission is cleared.

Fig.6 shows its mechanism generally.

At first, after the establishment of reflected S wave group, that group moves at a velocity of S wave. This vortex like group has a anti-clockwise sign.

Then at the behind of this vortex, another vortex which has a clockwise sign appears.

In progress of time, this second vortex grows up. And the first vortex diminishes step by step, at last disappears.

So the second vortex becomes the top vortex. The same phenomenon occurs one after other.

This phenomenon is explained as under that many players of rugby in sport run with the same speed spreading in line. The ball is passed to next player for backward a little. So the speed of ball to forward is less than the speed of players. This is the reason that the ATOYURÉ wave velocity is less than S wave velocity.

Throw to backward is prescribed by rule. In this phenomenon, this rule is shear force. It is like to hydrodynamics, in it this rule is viscosity.

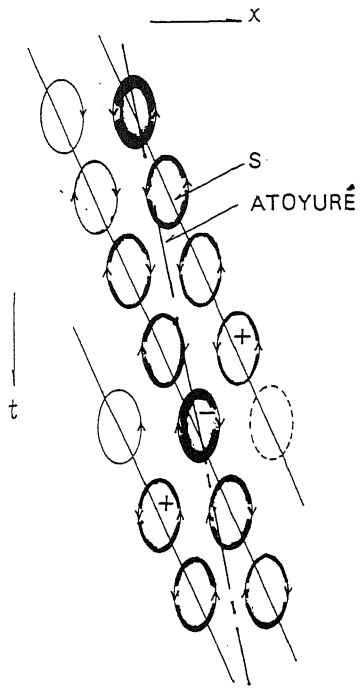

Fig.6 Transmission to Next Group

S wave is shear wave. Rayleigh wave is modified S wave using the free surface condition.

After the occurrence of ATOYURÉ vortex, its velocity is controlled by the consistency of shearing force.

Uniform motion from the surface to bottom is like to TSUNAMI in hydrodynamics. TSUNAMI is long wave in ocean.

ATOYURÉ is TSUNAMI in sedimentary plain.

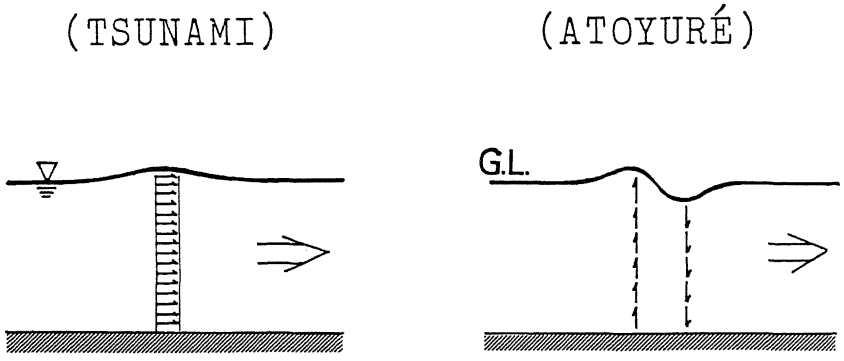

Fig.7 TSUNAMI and ATOYURÉ

REFERENCE

1. I.Toriumi,S.Ohba and N.Murai, "Earthquake Motion Characteristics of OSAKA Plain", 8 th WCEE (1984).