CHARACTERIZATION OF TSUNAMI WAVE USING TEXTURE & STRUCTURE OF SEDIMENTS FROM SOUTH WESTERN COAST OF SRI LANKA

*De Silva R.H.S.I., Jeyram.P., Perera R.S.L., Thananchayan A., Wickramanayake N.U., *Rathnayake N.P., Premasiri H.M.R., Abesinghe A.M.K.B. , Puswewela U.G.*

Department of Earth Resources Engineering, University of Moratuwa, Moratuwa
**Corresponding Author email: nalin@earth.mrt.ac.lk.*

ABSTRACT

This research focuses on characterization of Tsunami waves by using tsunami sediments, as the only reliable source of information which a Tsunami leaves after strike are sediments. The sediments contain information about Tsunami waves which can be extracted by analyzing. The study focuses on evaluating wave height, flow velocity and wave energy by examining of the thickness, grain size distribution, sediment structures and texture of tsunami deposits. These findings can be used for the prediction of Tsunami threats and in the formulation of precautionary measurements.

KEY WORDS
Characterization, Tsunami, Wave, Sediments.

INTRODUCTION

With the massive wave which affected many countries in the Indian Ocean, caused by the mega Tsunami generated in last December 2004, concern and awareness of the people in the world was increased regarding this phenomenon. It killed a large number of human beings and destroyed enormous amount of property causing a huge economic downturn of affected countries. The cause of this disaster is not controllable by the human beings, and thus the only alternative people have is to take precautionary actions to minimize the loss which may be caused by future Tsunamis. For this it is important to examine the past Tsunami records to identify the existing vulnerabilities and to develop suitable precautionary programs. Records of post-Tsunami researches give a great support in this examining process. Since this was the only striking experience for Sri Lanka in the known history we face a lack of written records.

In the study, an attempt was made to gather information about the Tsunami sediments, by examining the thickness, grain size distribution and sediment structures of tsunami deposits. It may be possible to evaluate the height and flow velocity of the wave. Tsunami sediments may also contain markers that illustrate different sources (deep sea, terrestrial, estuarine, etc.) of sediments. These records may constitute important evidence to understand a particular region which may be at risk from a tsunami. By studying sediments from recent tsunami deposits in Sri Lanka, it may be possible to identify and interpret tsunami sediments in a much better way in the geologic record throughout the world.

Also Researches have identified paleo tsunamis in the geological record. However, since a major tsunami has not been recorded for years prior to the Indian Ocean Tsunami of 26th Dec. 2004, it is essential to study the present tsunami deposits in Sri Lanka as a database to understand about tsunamis

METHODOLOGY

Areas from south western coast of Sri Lanka, which were severely affected by the Tsunami, were selected for the study, along with other places where undisturbed tsunami sediments and other parameters such as topography appeared prominent. Instruments were used for sample collection and measurements (Surveying instrument for leveling, GPS instrument for positioning, and Brunton for angle measurement). First tsunami sediments were identified by visual examination following a standard procedure, and then sediments were collected from pits as layers where collected where from pits as layers where tsunami sand. Sediment thickness, run up, inundation distance, erosion features, location descriptions etc. were also studied and recorded with respect to locations. Then the grain size distributions of the collected samples were analyzed at the lab by using the standard set of sieves. Next, results from sieve analysis and location analysis were computerized and the variation of particle size distribution was identified, especially indexes such as mean grain size, sorting index, and skewness. These indexes are defined in table 1.

Table1: Indices used in the research

Index	Definition
Mean Grain Size	(Φ10+ Φ20+ Φ30+ Φ40+ Φ50+ Φ60+ Φ70+ Φ80+ Φ90)/9
Sorting Index	(Φ84-Φ16)/4+ (Φ95-Φ5)/6.6
Skewness	(Φ16+Φ84-2*Φ50)/2(Φ84-Φ16) + (Φ5+Φ95-2*Φ50)/2(Φ95-Φ5)

RESULTS

In a particular location, we selected sample points and information was gathered for each sample as shown in the table 2. Table 2 shows the location description for the 1st sample collected from the Payagala survey line and the figure 1 shows the particle size distribution of the first sample

Location	Sample point	GPS Coordinates	Offset	Wave height	Layer	Sediment Thickness	Initial weight
Payagala	1	002-72-323 E; 001-20-782N	12ft	16.4ft	1	3cm	19.94g

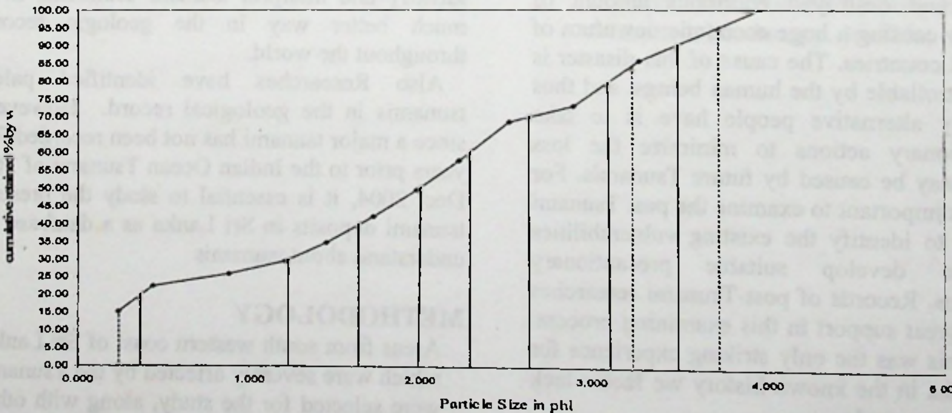

Figure1: Sieve Size (phi) vs. Cumulative Percentage Retained

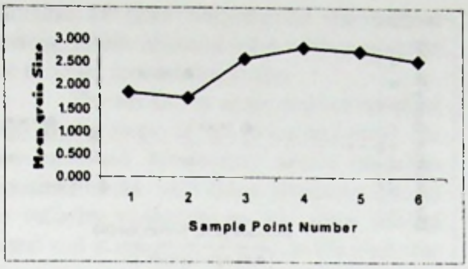

Figure2: Mean Grain Size Variation

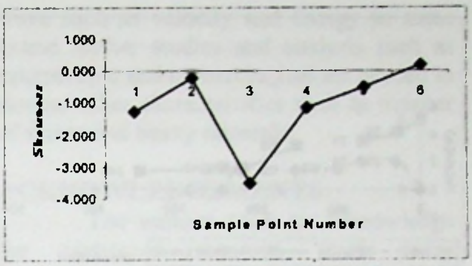

Figure4: Skew ness Variation

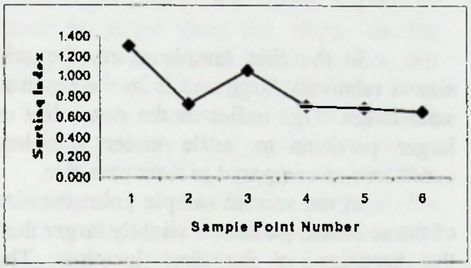

Figure3: Sorting Index Variation

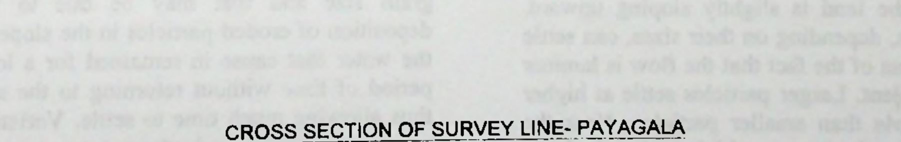

Figure5: Cross Section of Survey Line at Payagala

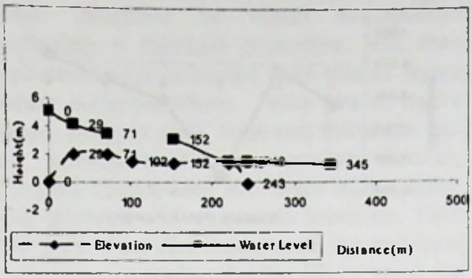

Figure6: Elevation Run up With Distance

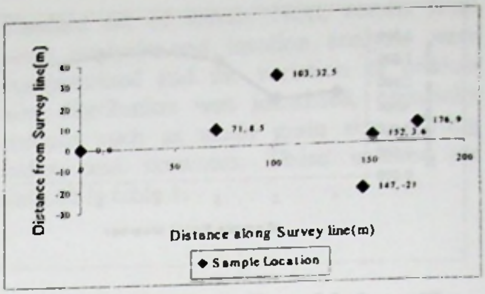

Figure7: Sample Locations at Payagala

DISCUSSION

The location was not a bay or headland. In front of the beach, there was a rock that has acted as a natural barrier to the wave. Nearby there was a canal. There only one sediment layer could be found and no micro layers were visible. But the place had been affected by three waves, and the layer was probably created by all three waves.

Further the maximum run-up was around 3m and the ground shape was some what different than other places as shown in fig6. According to the wave height and geomorphology at the location, it is possible to suggest. The sediment deposition happened due

to the incoming wave, since the possibility of flow back of the wave is very small.

The variation of the mean grain size along the line with the distance at this location is as shown in fig2. That type of behavior is generally expected for a normal bathymetry, where the land is slightly sloping upward. Particles, depending on their sizes, can settle regardless of the fact that the flow is laminar or turbulent. Larger particles settle at higher velocitie4s than smaller particles. Near the sea, the velocities are high and only large particles may settle, while some distance inland, the velocities would

Reduce and consequently smaller particles would settle. This is the expected behavior under normal circumstances.

Once the site bathymetry is different than general bathymetry of the coast line, mean grain size variation has differences as in the graph.

In the first sample point, the grin size is relatively large and is in the medium sand range. This indicates the capability of larger particles to settle under turbulent conditions as compared to finer particles.

In the second sample point the size of the sediment particle is slightly larger than the particles in the first location. The possible reason is the existence of rock as a natural barrier to waves with 2.5m height. Since the wave height is around 3.2m and the barrier is around 2.5m, most of the energy of the wave may be dissipated and hence a sudden fall of velocity can be expected. This may explain the settlement of coarse sand at the second point. Therefore the size of particles deposited has decreased (fine sand range) at point three as the flow changes to turbulent again due to the slope.

Again relatively small particles have deposited in the fourth point with the distance as the wave reduces its velocity. Fifth and sixth points indicate increased grain size and that may be due to the deposition of eroded particles in the slope as the water that cause in remained for a long period of time without returning to the sea, thus allowing much time to settle. Variation of sorting index and skew ness can be decreased according to the location aspects and wave characters.

In the first sample point poorly sorted medium sand exits. Thus a size range exits there, which may be a result of the turbulence of the wave at that point, as the point is very close to the sea.

In the second sample point, moderately sorted sand has sedimented. This may have happened due to the sudden reduction of flow velocity by the natural barriers, which allowed sand with a specific size to settle around that point.

The sorting is again poor at the third point as the slope of the place has mage the flow turbulent. Moderately sorted sand has deposited in the next three locations, due to the velocity reduction as the wave moved inland and stagnation of were at the place for a layer time as it did not return to the sea.

According to the skewness indicates, the first point is in a very negative skewed region, herby the coarse fraction of deposit in larger than the fines. As the velocity and energy is high at the sea, this can be expected. Therefore skewness value has become symmetrical as the wave break had allowed similar sized particle to settle.

At the third point skewne4ss value had dropped dramatically, the slope at this point has increased the velocity and coarse fraction has mainly settled. At the next three points, the coarse fraction has reduced, allowing most fences to settle. The final point has more fines than coarse particles, as water stagnated for a larger period.

CONCLUSION

The effect of tsunami depends on the geomorphology and natural and artificial barriers of a specific area tsunami deposits were analyzed using indicates adopted for this type of sediment study.

Behavior of sedimentation was related to the variation of geomorphology and run up levels. These involved characteristics of the wave such as velocity and energy to some extent further studies and analysis such as microscopic and numerological are needed to discuss other characteristics such as number of waves and heavy minerals.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the assistance received from many individuals in the department of earth resources engineering and materials engineering at the University of Moratuwa, Sri Lanka. As well as in the geological survey and mines bureau, Sri Lanka.

REFERENCES

1) Paul R. Pinet: 2000, Invitation to Oceanography, 91-131, Jones and Bartlett Publishers International, UK.

2) Ananda Gunathilaka: 2005, 'Indian ocean mega tsunami of December 2004 the scientific basis of the catastrophe', J.Natn.Sci.Foundation Sri Lanka 2005 33(2): 69-80

3) Anja Scheffers & Dieter Kelletat: 1994, Bimodal tsunami deposits – a neglected feature in paleo-tsunami research, University of Duisburg-Essen, Germany: 20-70

http://www.geology.er.usgs.gov/eastern/plates.hml - 8.3.2006

http://www.geophys.washington.edu/tsunami/w lcome.html – (8.3.2006