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The submerged breakwater as prototype of coastal protection in Gili Trawangan, Lombok, Indonesia

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Abstract

Gili Trawangan is a small island in North Lombok Indonesia which is famous with its beauty of white beach and coral reefs. In the last decade, the north beach of Gili Trawangan suffers erosion. The erosion is almost along ±650 m beach and retreat as far as ±50 m landward. The coastal protection plan is needed due to the importance of Gili Trawangan economic value in tourism business. Survey and field investigation was performed to analyze the mechanism of erosion. The utilization of submerged breakwater was proposed for coastal protection because the aesthetic and environmental consideration of Gili Trawangan as tourism place. The Reefball and Concrete Beam were designed as coastal protection model to overcome the erosion problem.

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Keywords: submerged breakwater; coastal erosion; Reefball; Gili Trawangan

1. Introduction

The Gili Trawangan is one of three small islands in Gili Matra Archipelago. It is located on North West of Lombok Island, West Nusatenggara, Indonesia. The Gili Trawangan has natural excursion, which is famous worldwide, i.e. the white beach and the coral reef with sea creature inside it. The tourism activity in Gili Trawangan

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had started in 1980’s and there are ±350,000 of local and foreign tourist has visited Gili Trawangan in 2012. However, the tourism growth has exceeded the environmental capability of Gili Trawangan.

In the last decade, the beach of Gili Trawangan suffers hard erosion in some part of island. The north beach has eroded along ±650 m due to high waves. The erosion has cut the public road, broken the private embankment, made over wash and flooded the low land of backshore.

The erosion problem in Gili Trawangan needs immediate treatment to reduce the impact to Gili Trawangan people. First, the erosion cause factors need be identified and become the planning base in the handling of beach erosion. This paper will present the beach erosion problem and the application of submerged breakwater model to overcome the problem in Gili Trawangan.

2. Methodology

The position of Gili Matra Archipelago has coordinate between 116^0 0.0’ ~ 116^0 5.5’ E and between 8^0 20.0’ ~ 8^0 22.0’ S. The location is in Gili Indah Village, Pemenang Sub District, North Lombok District, West Nusa Tenggara Province, Indonesia. The position is at north gate of Lombok Straits (between Bali Island and Lombok Island), which connects the Bali Sea on the north and Indian Ocean on the south. Therefore, the Gili Matra Archipelago get strong influence from both water body such as waves and tide current.

As mentioned before, the Gili Matra Archipelago consist of three small island, i.e. Gili Trawangan, Gili Meno and Gili Air. Gili Trawangan is the biggest island, i.e. almost two times of other island. The island of Gili Trawangan stretchs from north to south with the area of ±3,480,182 m^2 and the perimeter of ±7,035 m. The topographic of Gili Trawangan is relatively flat on the north and going up to the south with ±70 m of hill.

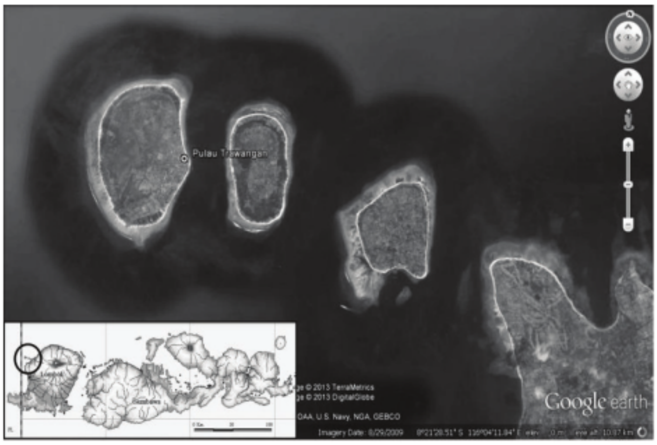

Fig. 1. The location of Gili Trawangan.

2.1. Shoreline Change Identification

The shoreline change can be identified from two sources. First, it is based on information from local resident. The information is collected and recorded from interview with local resident who knows the shoreline change in their place. The visiting event was also performed on the location to measure and record the change based on information from local resident by using the measure band, GPS and digital camera.

Second, the shoreline change is identified by performing comparison between the old and new shoreline data. The shoreline data can be collected directly from the field survey by using auto level, theodolite, or GPS equipment. The data also can be collected indirectly by utilizing the topographic map, aerial photograph or satellite image. The identification results are time, location and shoreline change magnitude, which can become the preliminary data for problem solving plan.

2.2. Submerged Breakwater

Generally, the breakwater is constructed with its crest is always on top of sea water level to gain the maximum reduction of wave energy. However, the breakwater also can be designed with its crest is below the sea water level, which is called the submerged breakwater. The crest of submerged breakwater can be below, parallel or slightly on top of Mean Sea Level (MSL). The submerged breakwater reduces the wave energy in some fraction and transmitted the rest of energy through overtopping above its crest (Pilarczyk[5]). The submerged breakwater profile can be seen in Fig. 2. The submerged breakwater is also called the reef breakwater because has some same characteristics with the coral reef in coastal waters.

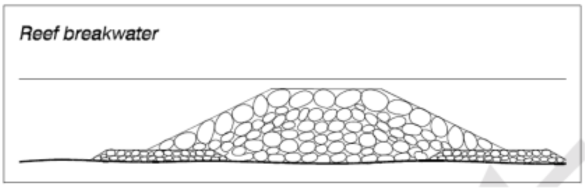

Fig. 2. The submerged breakwater profile (USACE[7]).

The performance of submerged breakwater in reducing the wave energy had been examined by many researchers such as Dick and Brebner[4], Dattatri et.al.[3], Ahrens[1], d'Angremond et.al.[2], Seabrook and Hall[6]. Many of them had performed the physical model in laboratory and tried to formulate the empirical equation of wave transmission coefficient. The wave transmission coefficient (C_t) is the ratio between transmission wave height (H_t) and incoming wave height (H_i). In general, the results of research show that the magnitude of wave transmission is depend on: 1) wave characteristics (i.e. height and period); 2) structure crest width; 3) gap between water surface and structure crest; and 4) structure porosity.

van de Meer and d'Angremond[8] formulated the calculation of transmission wave height as:

$$C_t = \left(0.031\frac{H_s}{D_{n50}} - 0.24\right)\frac{R_c}{D_{n50}} + b \qquad (1)$$

with:

- H_t = wave transmission coefficient
- Hs = incoming significant wave height
- Dn50 = mean diameter of armour block
- Rc = distance between water level and structure crest
- b = structure width

3. Results and Discussion

3.1. The Shoreline Change of Gili Trawangan

Based on local people information and field survey, the biggest shoreline change in Gili Trawangan is on the north side as can be seen in Fig. 3. Fig. 3 (a) shows the condition on March 11th, 2013 that the revetment was be built in front of private hotel. Then, the revetment was totally broken on September 9th, 2013 (Fig. 3 (b)) due to high waves. Fig. 3 (c) shows the sand beach with public road on the right side of that hotel. The local people state that the position of public road is far away behind the position in 10 years ago. This condition shows that the shoreline in this location suffer erosion.

The impacts of erosion in this location are:

- The destruction of public road makes the travelers have difficulty for walking or biking in this location as can be seen in Fig. 4. The new road was made through inside the island without beach view.
- The private land and property is threatened broken because the erosion has reached their border. The material loss will be faced by the owner due to their broken property or the reducing of tourist who stay in their hotel.

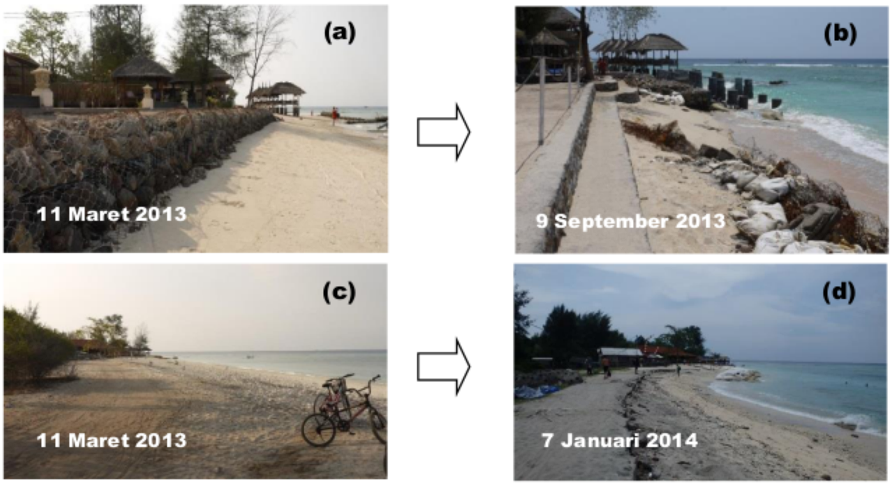

Fig. 3. The biggest erosion on north of Gili Trawangan

Fig. 4. The one impact of beach erosion.

Mean while, the south and west side of Gili Trawangan have different situation with north side. The field survey shows (Fig. 5) that the shoreline change advances in those locations. Moreover, there are over wash phenomenon, i.e. the movement of beach sediment further to the inland due to wave activity. It is signed by the dune height and the spreading of beach sediment further inland until covering the public road. This condition shows:

- The beach sediment always increases in these locations.
- Most of wave activity is in the perpendicular direction with shoreline. It push and transport beach sediment to go further inland.

Supporting the results of field survey, the comparison between old and new shoreline was performed. The data use the topographic map from BIG, which is based on survey in 1995. The newer data use digitations result of satellite image in 2013 from Google Earth website. Both shorelines have same definition, i.e. the border between beach sand and reef base. The data are overlay to see the differences as seen in Fig. 6. The erosion means the new line behind the old line and has red shade. The accretion means the new line in front of old line and has blue shade.

Fig. 5. The condition in south and west side.

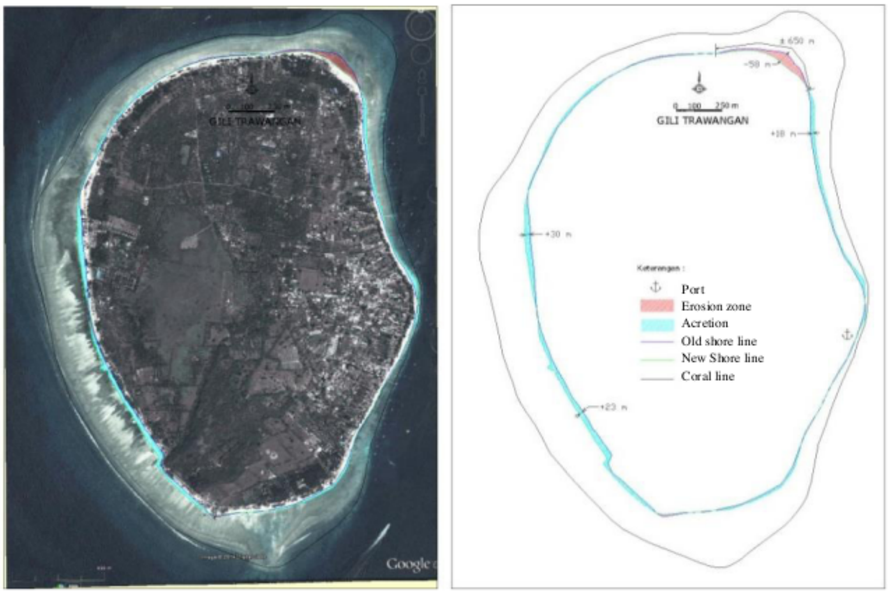

Fig. 6. The comparison of 1995 and 2013's shorelines of Gili Trawangan Island.

The results of comparison shows:

- The biggest erosion is on north side as same as field survey results. The beach was eroded as far as ±58 meter and along ±650 meter beach length.
- The beach on west and south side are advance as far as ±23-30 meter. The high dune and over wash phenomenon are exist in these location based on field survey results.
- The beach on east side is relatively stable. Only the beach on north of port is advance as far as ±18 meter.

3.2. The Design and Construction of Submerged Breakwater

For reducing the erosion in Gili Trawangan, the breakwater is one suitable method to overcome that problem. The breakwater will reduce the wave energy and the beach sediment behind the structure will less moving. However, the breakwater structure, which is appear in nearshore area, will ruin the natural beach view in that area. Therefore, the submerged breakwater is more suitable to overcome the erosion in Gili Trawangan.

The submerged breakwater model was designed and constructed in north of Gili Trawangan. The structure model has 3 meter width and 1 meter height. The model is located on elevation 0 meter at maximum ebb tide. The maximum tidal range in Gili Trawangan is 2 meter according to field measurement. Therefore, the distance between water level and structure crest is 0.2-1 meter during neap and spring tide. The diameter of armour block is same with structure height, i.e. 1 meter. Based on Equation 1, the wave transmission coefficient is about 0.6 as can be seen in Fig. 7.

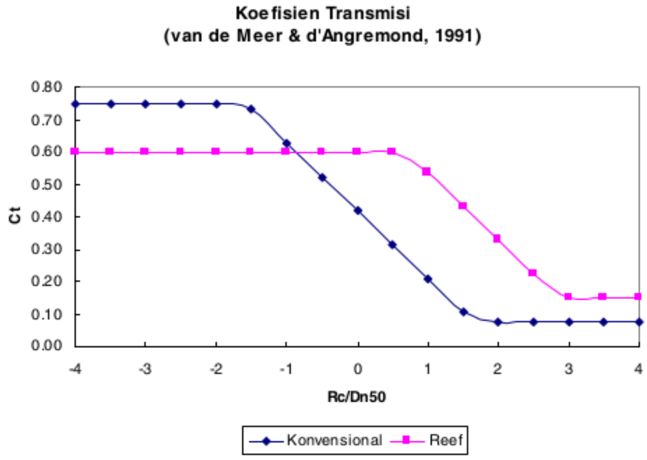

Fig. 7. The graphic of wave transmission coefficient calculation based on Equation 1.

There are two design of armour block for submerged breakwater model in Gili Trawangan, i.e. the Overlapping Concrete Block (OCB) and the Reefball (see Fig. 8). The characteristics of both design are follows:

- Both design have same dimension, i.e. 1×1×1 meter.
- They have hollow space inside the structure to reduce the wave energy through percolation mechanism. It also have function to attract the fish, coral or other sea creature to go inside structure for tourism attraction.
- The OCB design is simple, more easy built and placed, While, the Reefball need special mould in making process and difficult to place in position. Originally, the Reefball is for fish attraction and coral growth media.

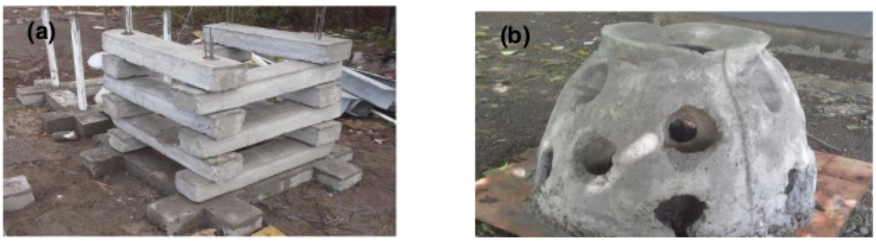

Fig. 8. The armour block of model, a) the OCB, b) the Reefball.

The total of armour block is 136 units. It is consist of 28 units of Reefball and 108 units of OCB. The Reefballs are placed in 2 rows and the OCBs are placed in 3 rows. Therefore, the total dimension of submerged breakwater model in Gili Trawangan is 50 meter length, 3 meter width and 1 meter height. The position of submerged breakwater model in location can be seen in Fig. 9.

Fig. 9. The position of submerged breakwater model.

4. Conclusion

Some conclusions can be formulated as follows:

- The north of Gili Trawangan suffer erosion as much as ±58 meter and along ±650 meter. In opposite, the west and south side have accretion and the shoreline goes advance as much as ±18-30 meter. There are also over wash phenomenon in these sides. The east side is relatively stable.
- The submerged breakwater model has been built with dimension of 50 meter length, 3 meter width and 1 meter height on the north side of Gili Trawangan. The model was constructed from 28 units of Reefball and 108 units of OCB. The model have function to protect the beach and to attract the sea creature for tourism attraction.

Acknowledgements

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References

[1] Ahrens, J.P., 1987, Reef Breakwaters Response to Wave Attack, The 21th International Conference on Coastal Engineering, Spain.
[2] d'Angremond, K., van de Meer, J.W., dan de Jong, R.J.,1996, Wave Transmission at Low Crest Structures, The 25th International Conference on Coastal Engineering, Florida, USA.
[3] Dattari, J., Raman, H., dan Shankar, N.J., 1978, Performance Characteristics of Submerged Breakwater, Proceeding of the 16th International Conference on Coastal Engineering, Hamburg, Germany, pp. 2153-2171.
[4] Dick, T.M., dan Brebner, A., 1968, Solid and Permeable Submerged Breakwaters, Proceeding of the 11th International Conference on Coastal Engineering, London, UK, pp. 1141-1158.
[5] Pilarczyk, K.W., 2003, Design of Low Crested (Submerged) Structures – An Overview, The 6th International Conference on Coastal and Port Engineering in Developing Countries, Colombo, Srilanka.
[6] Seabrook, S., dan Hall, K., 1998, Wave transmission at submerged rubble-mound breakwaters, Proceedings 26th Coastal Engineering Conference, ASCE, 2000- 2013.
[7] USACE, 2000, Coastal Engineering Manual, Vicksburg, USA.
[8] van de Meer, J.W., dan d'Angremond, K.,1991, Wave Transmission at Low Crested Structures, Coastal Structures and Breakwaters, ICE, London, UK, pp.25-42.

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