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Alternative For The Embankment Coastal Protection In Bantaeng Regency

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Abstract: *Bantaeng Regency is an area directly conterminous to the high seas with wave currents and energy which has the potential to damage the embankments, and it has coastal road. Abrasion caused by damage to embankments and road infrastructure, design of road embankment construction is planned in general and does not take into account the environmental burden so that it can threaten the safety of road users and the people who live in the vicinity. This research identified and analyzed the damage to coastal road embankments, the effects of abrasion factors and alternative solutions to the construction of road embankments. This research can be used as a reference in determining alternatives to road embankment protection along coastal areas prone to abrasion.*

This research uses a quantitative qualitative approach and AHP method that is carried out by stages, observations on coastal roads affected by abrasion to determine the condition of road embankment damage, analyze marine environmental loads as factors causing damage to road embankment construction, and analyze alternative coastal protection buildings as a solution handling road dam damage.

The results of the analysis showed that abrasion was the cause of damage to road construction due to scouring on embankments and sub grade. The alternative is to select the building of embankment protection on coastal roads that is very relevant is the revetment.

Keywords: *Wave energy, abrasion, embankment construction, coastal protection*

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I. Introduction

Law Number 1 of 2014 concerning the management of coastal areas and small islands, coastal areas are transfer areas between terrestrial and marine ecosystems that are affected by changes in land and sea. The interaction between the sea and the land and the absence of a beach border affect the road conditions along the coast. The construction design of the road embankments that are built is relatively the same as the design of the road embankment in general which does not take into account the burden on the marine environment so that it is likely to be damaged due to very large coastal abrasion. The coastal road section is shown in Figure 1.

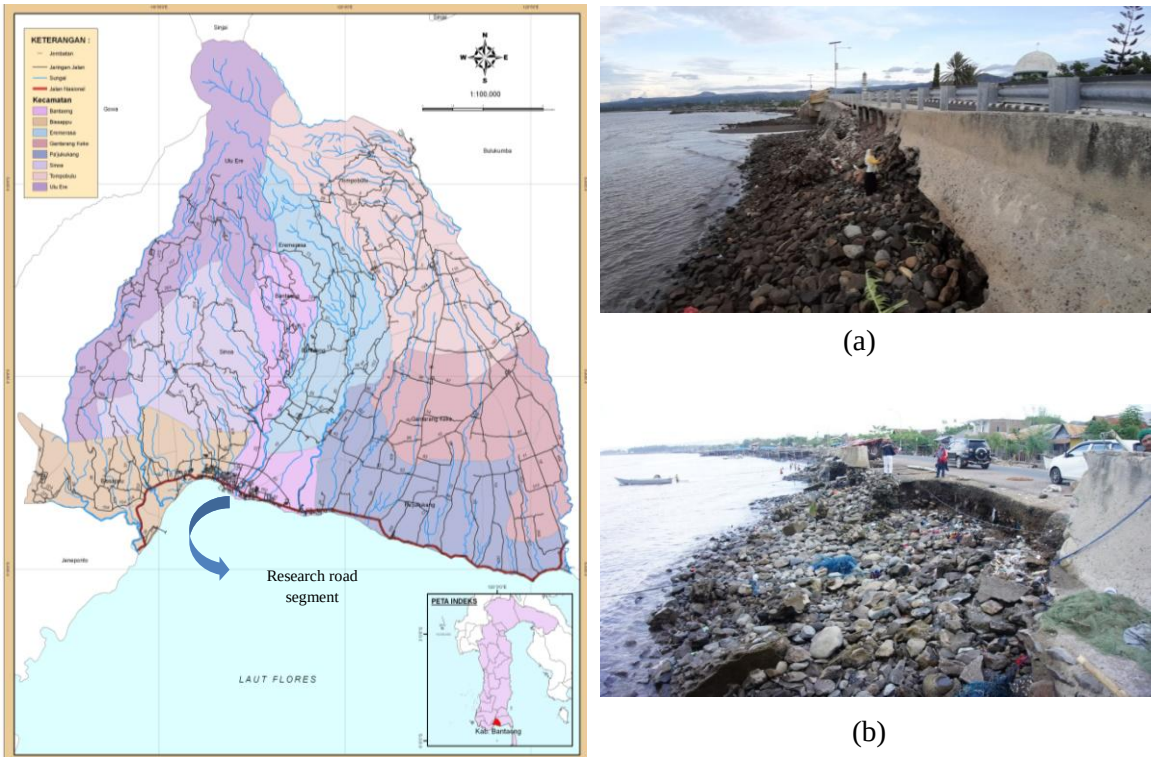

Figure 1. Location of coastal road, a. Damage conditions for road embankments in Pallantikang Village, b. Damage condition of the road embankment in Tappanjeng Village

Abrasion resulted in the road embankment and the shoulder of the road collapsing, thus disrupting the activity, accessibility and mobility of the community. If it is not handled, the damage will be more severe and can cause the road to be cut off, in terms of the economy the impact on maintenance costs is increasing because the construction of coastal protective construction is very expensive.

The objectives expected in this research are: 1) Identifying and analyzing road damage due to abrasion; 2) Analyzing the factors that cause abrasion; 3) Selection of alternative building protective coastal road embankments. The benefits of this research as a consideration in road maintenance along coastal areas prone to abrasion, science development and can be used as reference material for researchers who wish to continue this research.

Theoretical basis

Road is a land transportation infrastructure in any form, covering all parts of the road including complementary buildings and equipment intended for traffic (Jinca, 2011). Scour is one of the phenomena that often occurs in road infrastructure in coastal areas that are exposed to wave energy, currents or even a combination of both. This has been realized as one of the causes of failure in the road structure. The local scouring process is caused by an increase in the transport capacity of the base material mass which is initially located on the structure of the road (Dalrino, 2011).

There are 3 components that have a direct influence on the coastal abrasion process, namely: Waves caused by wind blows, tides caused by the attraction of celestial bodies, and patterns of ocean currents due to the influence of circulation patterns of wind direction and speed (Shuhendry, 2004).

The resulting ocean wave energy is kinetic energy. Kinetic energy Ocean waves can be calculated by the following equation (Triatmodjo, 1999):

$$E_k = \frac{\rho g H^2 L}{16} \quad (1)$$

The length and speed of ocean waves are influenced by the period of arrival of the wave. The wave arrival period can be calculated using a formula (Nielsen, 1986), i.e.:

$$T = 3{,}55\sqrt{H} \quad (2)$$

The length and speed of the waves are based on equations (Ross, 1980), as follows:

$$\lambda = 5{,}12T^2 \quad (3)$$

$$V = \frac{\lambda}{T} \quad (4)$$

Where:
E_k: Wave kinetic energy (Joule)
ρ: Meeting mass of liquid (sea water = 1025 kg/m^3)
g: Gravity acceleration (9.81 m/s^2)
H: Wave height (m)
λ = L: Wavelength (m)
T: Wave period (second)

Sea tides are a phenomenon of periodic ups and downs of sea level that occur throughout the hemisphere due to the tidal generation force which mainly originates from the sun and moon (Douglas, 2001).

Surface ocean currents are movements of water masses caused by winds that blow on the sea surface at depths of less than 200 m which move from one place of high air pressure to another that is very low air pressure and occurs in the entire ocean in the world (Gross, 1990).

Beach buildings that are commonly used to protect the coast against wave and current damage (Dundu, 2013) as follows:

1. *Groin*
Groin is a coastal safety structure that is constructed indented relatively perpendicular to the direction of the coast. Groynes are carried out with the aim of holding longshore sediment transport

2. Sea wall
Sea wall is a beach security building that is made parallel to the coast and usually has a relatively upright or curved wall that functions as a protector or anchoring/resisting the strength of the waves.

3. *Revetment*
Revetments are buildings that are made to maintain the stability of cliffs or slopes caused by waves or currents. The slope reinforcement function is to protect a coastal slope or slope surface as a whole has a role to increase the stability of the coastal groove or the shoulder of a protected embankment (Junarsa, 2004).

4. Breakwater
Breakwater is a building made parallel to the coast built as a form of coastal protection against abrasion by destroying wave energy before it reaches the coast so that deposits occur behind the building.

5. Sea embankments
The sea embankment is a coastal safety structure built along the coast with the aim of protecting low coastal plains from inundation caused by high tides, waves and storms (Minister of Public Works Circular Number 07/SE/M/2010 concerning implementation of Guidelines for Construction of Coastal Safety Buildings)

Basic methods of decision making can use the Analytical Hierarchy Process (AHP) and become a method that is able to solve problems in decision making, basically the AHP method breaks down a complex and unstructured situation into its component parts which are then parts it is organized into a hierarchical arrangement, gives numerical values to subjective considerations of the relative importance of each variable, and synthesizes these considerations to determine which variables have the highest priority and act to influence the results (Saaty, 1993). The Analytical Hierarchy Process (AHP) data was obtained with a questionnaire with a value scale, eigen Vector determined after the normalization test and data consistency test (Akbar, 2017).

II. Research Methoods

This research was conducted using quantitative qualitative approaches and Analytical Hierarchy Process (AHP) methods. The data used are secondary data sourced from the relevant institutions/agencies. Primary data is obtained by observation and direct measurements in the field and distributing questionnaires with a sample of respondents consisting of experts from academic, planner, executor and public elements. This research was carried out by stages, observations on coastal roads affected by abrasion to determine the condition of road embankment damage, analyze the sea environment load as factors causing damage to road embankment construction, and analyze alternative coastal protection buildings as a solution to handling damage to road embankments.

III. Results And Discussion

Road Damage Conditions

Scour that occurs on the foundation of the embankment causes seawater to arrive at the construction of the road shoulder which consists of compacted landfill material. The material is very susceptible to the danger of damage caused by scouring so that if not handled it will cause road traffic lines to collapse as well so that it can endanger road users. Damage to coastal roads is presented in Figure 1.

Factors that affect abrasion

1. Wave energy

The wave energy that occurs in Bantaeng waters is shown in Figure 2

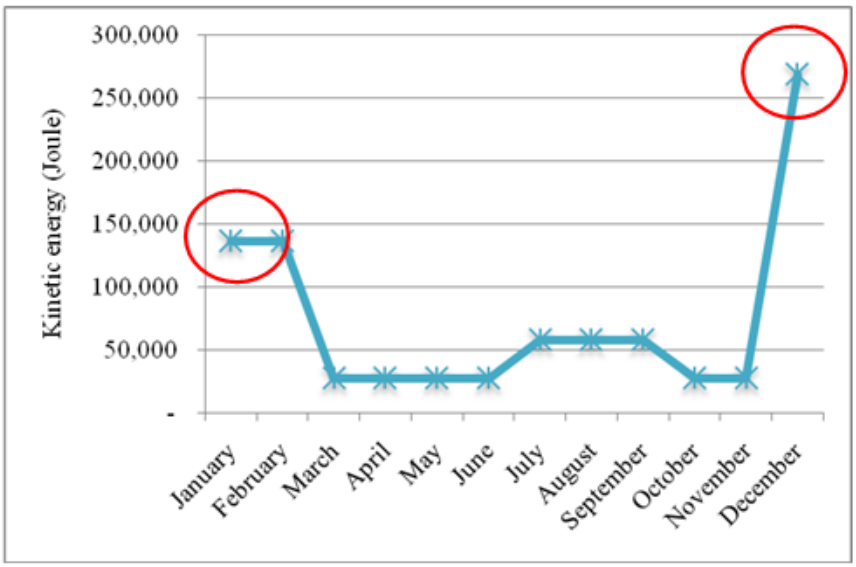

Figure 2. Wave energy in Bantaeng waters

January, February and December have relatively large wave energy because in these months high waves occur.

2. Tidal conditions

The water level at the highest tide ranges from 0.875 meters and the water level at the lowest tide ranges from -1.0 meters from the average surface (Baharuddin, 2016).

3. Speed of ocean currents

The average flow velocity in Bantaeng waters in 2018 ranges from 0.08 m/s in June to 0.48 m/s which occurred in August as in Figure 3.

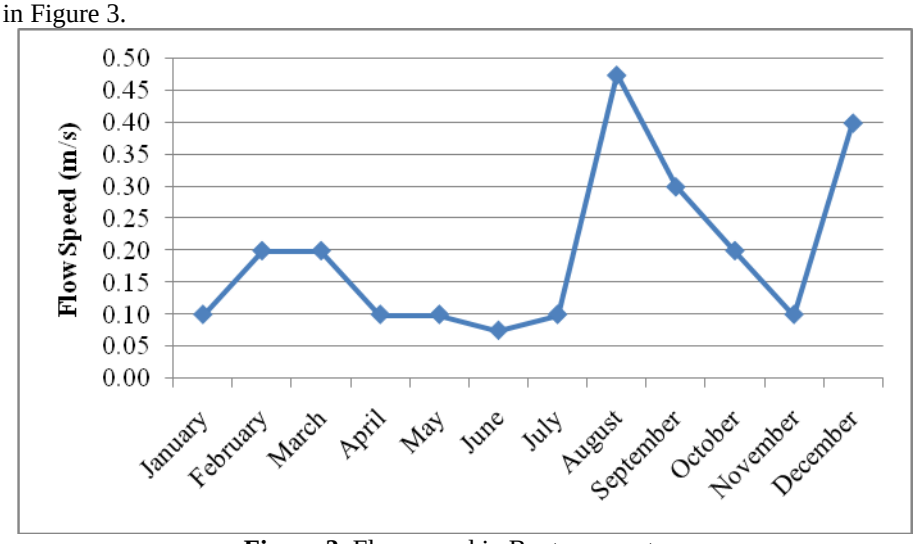

Figure 3. Flow speed in Bantaeng waters

Alternative protection for embankments on coastal roads

The data used in selecting alternative embankment protection uses a hierarchical questionnaire as in Appendix 1. Alternative priorities for coastal road embankment protection based on accumulated eigen vector are presented in Figure 4.

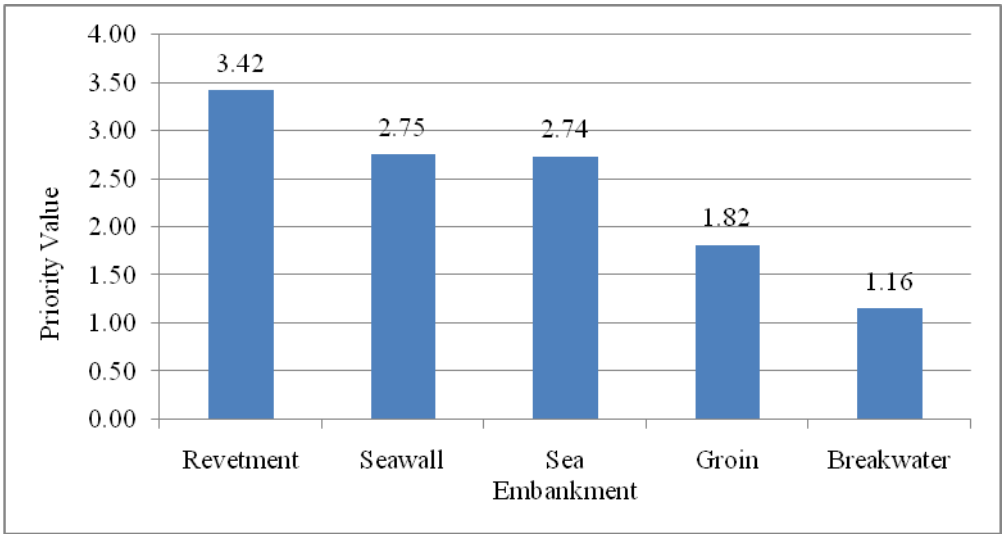

Figure 4. Sequence of alternative priority for road embankment protection

The selection of coastal protection buildings using the AHP method obtained clarity that the alternative protective embankments according to the economic, social and environmental aspects are Revetment; the results of the analysis of economic aspects can be seen in Table 1.

Table 1. Results of analysis of economic aspects

Criteria	Economy = 0.41			
Sub criteria	Local Material	Ease of implementation	Benefits	Construction Cost
	0.14	0.10	0.58	0.18
Alternative	Local Material	Ease of implementation	Benefit	Construction Cost
Groin	0.11	0.11	0.18	0.10
Sea Embankment	0.35	0.35	0.22	0.26

Revetments are considered more useful for protecting road embankments and relatively lower construction costs compared to sea wall construction and sea embankments. Alternative construction of road embankment protection can be seen in Appendix 2

IV. Conclusion

Damage to coastal roads occurs on the foundation of road embankments causing material collapse due to unstable construction.

Road damage due to abrasion is influenced by the speed of ocean currents, tidal conditions and wave kinetic energy reaching around 300,000 Joules which are affected by the speed of the west wind, especially in December to February.

The construction of the revetment is a suitable alternative choice for the protection of coastal road embankments in Bantaeng Regency.

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Appendix:

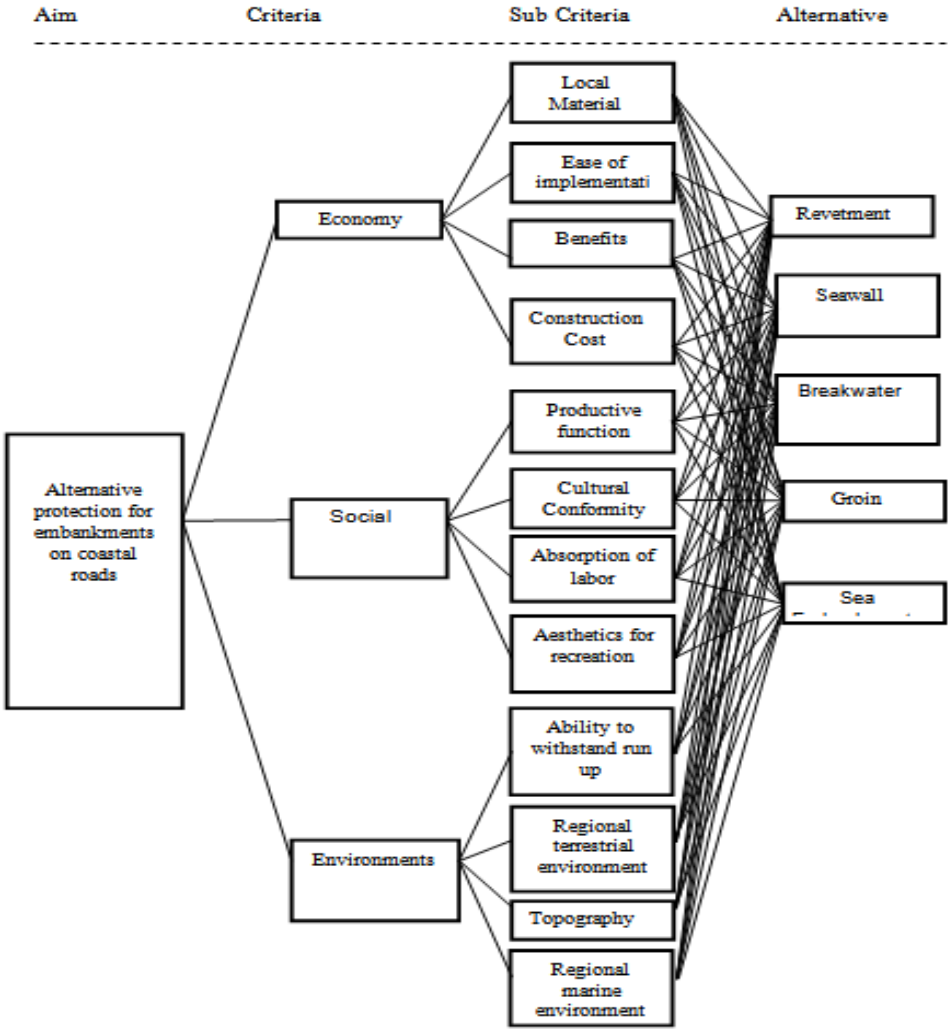

Figure Appendix 1. Alternative hierarchy of coastal road embankment protection

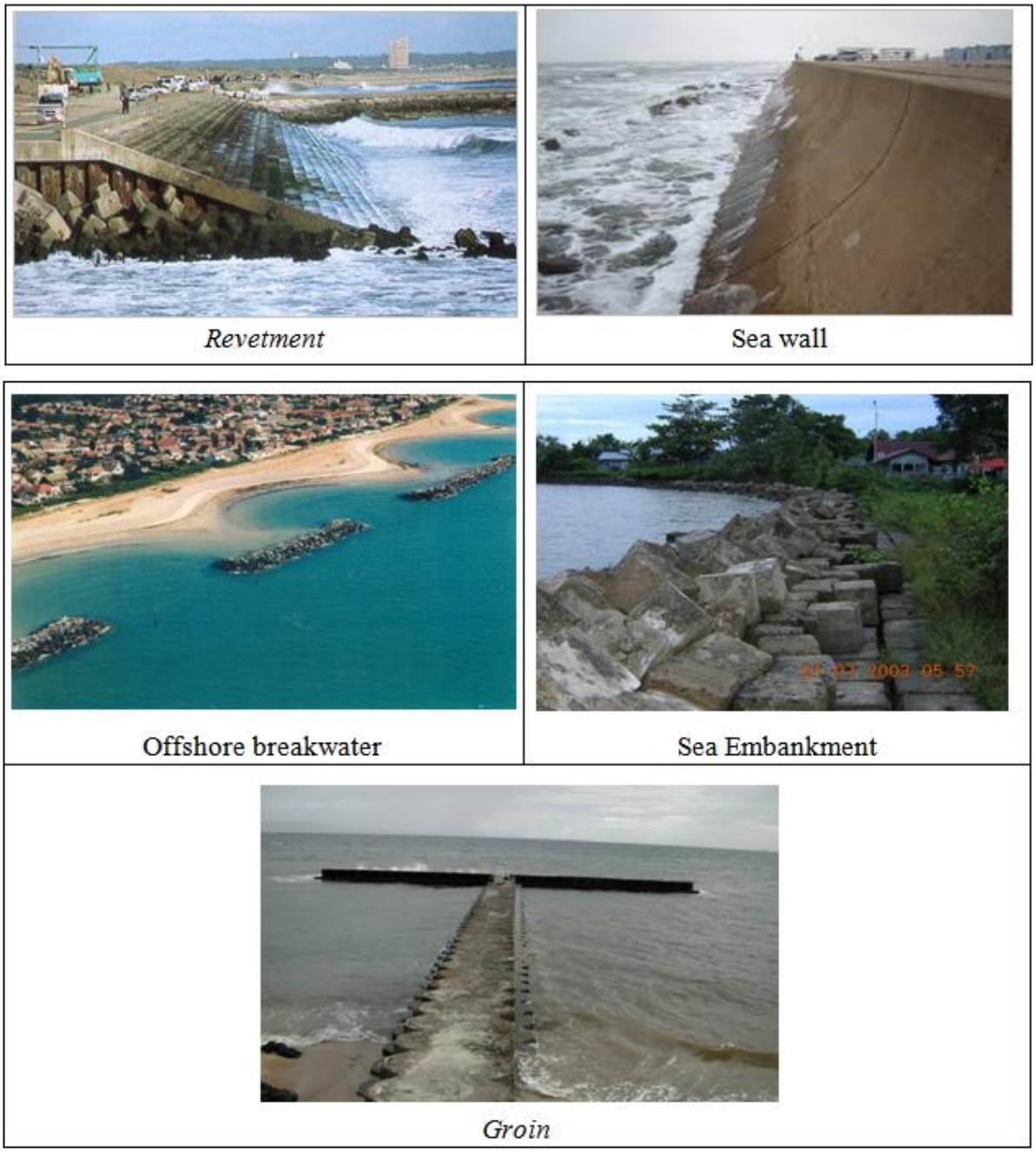

Figure Appendix 2. Protective structures of coastal road embankments

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