



ANALYSIS BREAKWATER TYPE CUBE OF THE TRANSMISSION COEFFICIENT (K_T), REFLECTION COEFFICIENT (K_R), AND DISSIPATION COEFFICIENT (K_D)

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ABSTRACT

Breakwater is a structure made parallel to the shore line and placed at certain distance from the coastline. The structure has function to protect the coast from the attack waves. The division of the energy waves reflected, destroyed, and passed on depends on the characteristics of the wave coming, shapes and dimensions of the breakwater. To find out the value of the transmission coefficient (K_T), reflection coefficient (K_R), and dissipation coefficient (K_D) that occurs in breakwater type cube, and the influence wide the top breakwater (B) then carried out experiments at Hydraulic Laboratory, Faculty of Engineering, Tadulako University. Scale models used were 1: 30 with five variations wide the top breakwater and five frequency variation with two conditions of surface water. The results showed that the model of the breakwater that obtain the value of transmission coefficient (K_T) and reflection coefficient (K_R) smallest, largest dissipation coefficient (K_D) is a model five submerged condition with the interval value of K_T 0,333-0,366, interval value of K_R 0,111-0,213, interval value of K_D 0, 443-0, 556, merged condition with the interval value of K_T 0,083-0,220, interval value of K_R 0,171-0,333, interval value of K_D 0, 500-0, 671 with a wide of the top breakwater 10 cm. The parameters that affect the transmission, reflection, and wave dissipation in breakwater were wide the top breakwater (B), high waves coming (H_i), wave length (L), and the depth of the water.

Keywords: breakwater type cube, wide the top breakwater (B), transmission coefficient (K_T), reflection coefficient (K_R), dissipation coefficient (K_D).

INTRODUCTION

Nowadays the utilization of coastal areas for human activity is growing very rapidly. The more intensive the utilization of coastal areas for human activity such as central government, residential, industrial, port, aquaculture / fisheries, tourism, and the natural factors such as wave, tides and currents can result the new problems such as erosion and sedimentation the coast (Triatmodjo, 1999).

Characteristics of the waves a crucial role with the structure that is in coastal areas of the beach and sea are wave energy. The larger of wave energy, damaged power getting bigger (Paotonan dan Yuwono, 2011). Wave that propagates on a structure surge reducer some energy will be reflected (reflection), some transmitted (transmission), and partly destroyed (dissipation) through the breaking of waves. The Division of the magnitude of the reflected wave energy, transmitted, and destroyed depending on the characteristics of the wave coming, structure type of wave absorber, and geometric of wave absorber.

The magnitude of the wave energy destroyed is the magnitude of the wave energy comes reduced wave energy are transmitted and reflected. The parameters of the wave energy is destroyed usually expressed in the form of dissipation coefficient (K_D) as well as transmitted and reflected waves are manifested in the form of transmission coefficient (K_T) and coefficient of reflection (K_R) (Horikawa, 1978).

The purpose of this research is to know the magnitude of the transmission coefficient value (K_T), the reflection coefficient (K_R) and the dissipation coefficient

(K_D) on the breakwater type cube on the conditions of submerged and merged and to know the influence wide the structure of breakwater against the transmission coefficient (K_T), the reflection coefficient (K_R), and dissipation coefficient (K_D).

LITERATURE REVIEW

Wave that propagates through a barrier, most of the wave energy will be destroyed through the process of friction, turbulence and wave breaking, and the remainder will be reflected (*reflection*), destroyed (*dissipation*), and transmitted (*transmission*) depending on the characteristics of the incoming wave (period, wave height and wave length), the type of shore protection (smooth or rough surface) and the dimensions and geometry of protection (slope, elevation, and the width of obstruction) and the local environmental conditions (depth of the water and the basic contours of the coast) (CERC, 1984).

Wave Transmission Coefficient (K_T)

According to CERC (1984), Paotonan dan Yuwono (2011), that the wave transmission coefficient (K_T) can be determined by using the following equation:

$$K_T = \frac{H_T}{H_i} = \sqrt{\frac{E_T}{E_i}}$$

$$H_i = \frac{H_{\max} + H_{\min}}{2}$$

$$H_T = \frac{(H_{\max})_T + (H_{\min})_T}{2}$$



Where:

$$K_{T0} = C \left(1 - \frac{F}{R}\right), \text{ for merged breakwater} \quad (1)$$

- K_T = Wave transmission coefficient
- H_T = Transmission wave height
- H_i = Height wave coming
- E_T = Transmission wave energy
- E_i = Wave energy coming

$$K_{T0} = C \left(1 - \frac{F}{R}\right) - C' \left(1 - \frac{F}{R}\right)^2, \text{ for submerged breakwater} \quad (2)$$

With;

$$\begin{aligned} \frac{F}{R} &< 0, C' = 0, 24 \\ C &= 0, 51 - 0,11 \frac{B}{h} \end{aligned} \quad (3)$$

Soding (1971) do research the influence of breakwater against the wave transmission in Rubble Mound Breakwater. As for the transmission coefficient equation as follows:

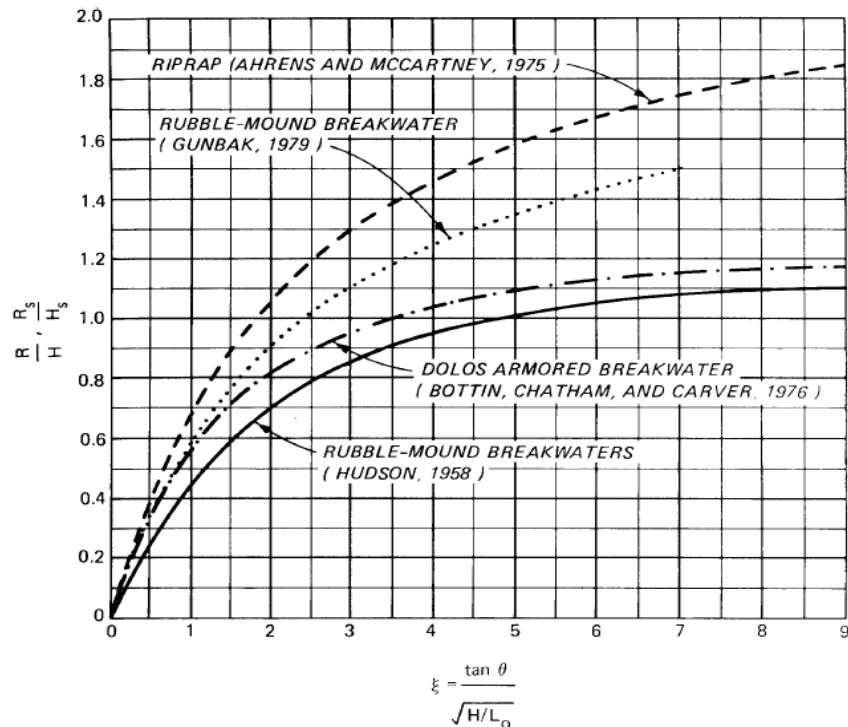


Figure-1. Determination R/H value on breakwater
(Shore Protection Manual Volume 2, 1984).

For comparison analysis of transmission coefficient (K_T) then Van der Meer and Angremond in CEM part II chapter 7 (2006) provides an alternative for determining the transmission coefficient (K_T) waves by using the graph of F/H_i to the value of K_T as in Figure-2 below:

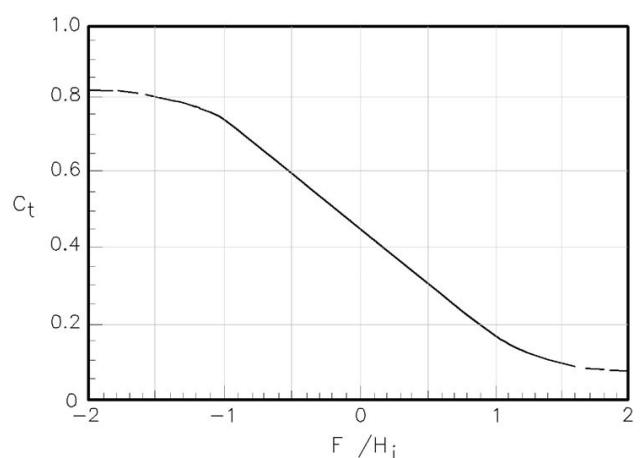


Figure-2. Determination the value of transmission coefficient (CEM, 2006).



Wave Reflection Coefficient (K_R)

Reflection wave occurs when a wave coming or hit an obstacle that is then reflected in partly or entirely. The ability of a breakwater can be known through the reflection coefficient. The reflection coefficient is the ratio between the reflection wave height (H_R) and the height wave coming (H_i).

If a wave of the objects that blocking the speed of the wave, then certainly those waves have what is called reflection and transmission. Similarly, on the waves of the shore protection structures. Simply wave reflection can be interpreted as large waves that bounced by the protective structure compared with a value of the incoming wave.

So that, when formulated into mathematical form, the reflection coefficient becomes:

$$K_R = \frac{H_R}{H_i} \quad (4)$$

$$H_R = \frac{H_{\max} - H_{\min}}{2} \quad (5)$$

Where:

- K_R = Wave reflection coefficient
 H_i = Height wave coming
 H_R = Reflection wave height

In analyzing the reflection wave inflicted due to the dampers, there are several variables was observed that the water depth (h), height wave coming (H_i), wave period (T), and reflection wave height (H_R). The scheme wave reflection is presented in Figure-3.

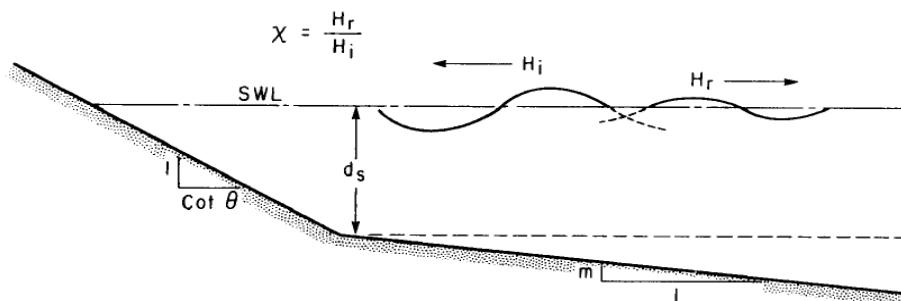


Figure-3. The scheme of wave reflection (Shore Protection Manual Volume 2, 1984).

For comparison analysis of reflection coefficient (K_R) then in the Shore Protection Manual Volume 2 (1984) provide an alternative to determine the coefficients

reflection (K_R) waves by using the graph of ζ with K_R value as shown in Figure-4.

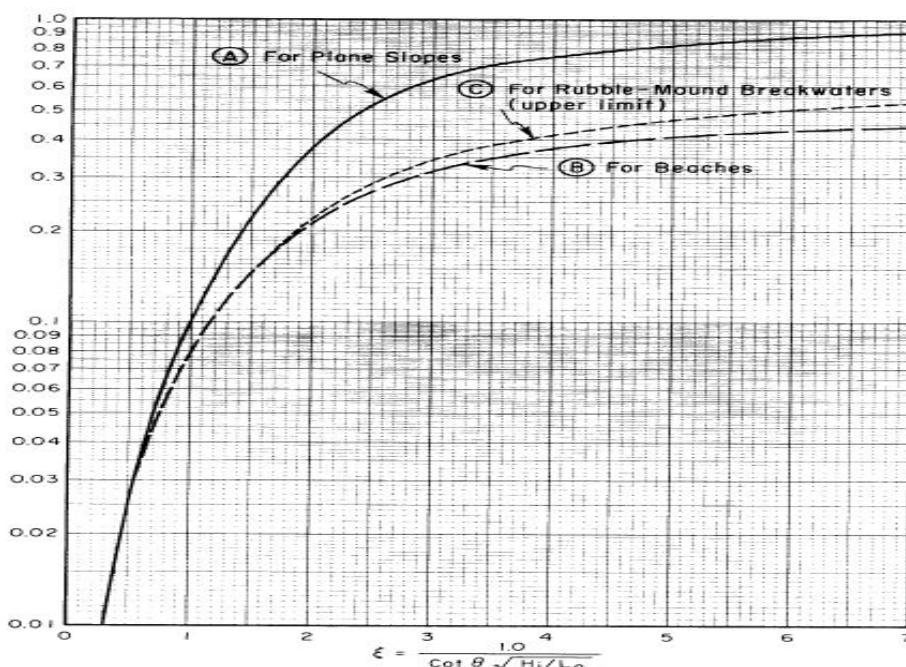


Figure-4. Wave reflection coefficient for slopes, beaches and rubble mound as a function of the surf similarity parameter ζ . (Shore Protection Manual Volume 2, 1984).



Wave Dissipation Coefficient (K_D)

According to Horikawa (1978) that the magnitude of the wave energy that destroyed (dissipation) is the magnitude of the incident wave energy is reduced energy transmitted and reflected waves. The larger the dissipation coefficient (K_D), means the structure is more effective in absorbing the wave. When formulated in mathematical form, the reflection coefficient becomes:

$$K_D = 1 - K_R - K_T \quad (6)$$

MATERIALS AND METHODS

This research was conducted in the Hydro laboratory of Civil Engineering, Tadulako University.

Table-1. Model scale.

Variable	Scale
Width scale	30
Width the top scale	30
High scale	30
Cube scale	30

Design model breakwater made of materials in form of cube.

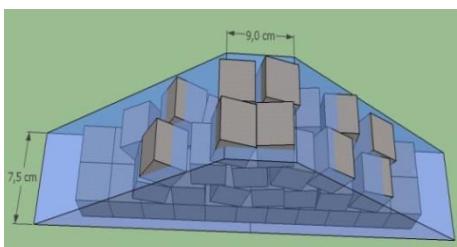


Figure-5. Five model breakwater.

From this research, used five model breakwater with the following dimensions:

- Model I: Width the top 6 cm, High 11,2 cm, Wide 7,5 cm, and Slope 1 :1,5
- Model II: Width the top 7 cm, High 11,2 cm, Wide 7,5 cm, and Slope 1 :1,5
- Model III: Width the top 8 cm, High 11,2 cm, Wide 7,5 cm, and Slope 1 :1,5
- Model IV: Width the top 9 cm, High 11,2 cm, Wide 7,5 cm, and Slope 1 :1,5
- Model V: Width the top 10 cm, High 11,2 cm, Wide 7,5 cm, and Slope 1 :1,5

RESULTS AND DISCUSSIONS

The calculation result of height wave coming (H_i), reflection wave height (H_R), transmission wave height (H_T), transmission coefficient (K_T), reflection coefficient (K_R), and dissipation coefficient (K_D) are presented in Table-2 and Table-3.

Table-2. The calculation result of K_T , K_R , K_D on model I (submerged).

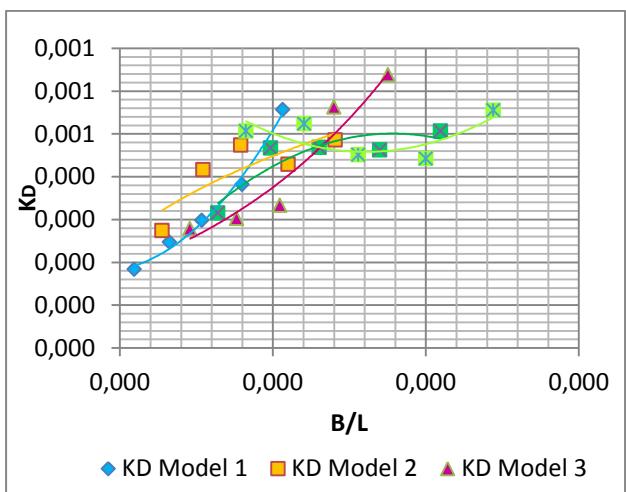
Type model	Ba (m)	L (m)	B/L	H_i (m)	H_R (m)	H_T (m)	K_R	K_T	K_D
Model I	1,8	82,258	0,022	0,900	0,300	0,435	0,333	0,483	0,183
	1,8	68,000	0,026	1,215	0,435	0,480	0,358	0,395	0,247
	1,8	58,621	0,031	1,410	0,450	0,540	0,319	0,383	0,298
	1,8	50,000	0,036	1,650	0,390	0,630	0,236	0,382	0,382
	1,8	43,590	0,041	2,370	0,240	0,810	0,101	0,342	0,557

Table-3. The calculation result of K_T , K_R , K_D on model I (merged).

Type model	Ba (m)	L (m)	B/L	H_i (m)	H_R (m)	H_T (m)	K_R	K_T	K_D
Model I	1,8	55,263	0,033	0,630	0,300	0,135	0,476	0,214	0,310
	1,8	45,652	0,039	0,690	0,300	0,120	0,435	0,174	0,391
	1,8	38,889	0,046	0,705	0,285	0,135	0,404	0,191	0,404
	1,8	33,333	0,054	0,795	0,255	0,195	0,321	0,245	0,434
	1,8	29,577	0,061	0,885	0,195	0,315	0,220	0,356	0,424

Comparison of K_T , K_R and K_D

To present the top relations wide breakwater on the perceived value K_D on the conditions of submerged and merged. Based on the results of data processing, obtained the wave length (B/L) and wave dissipation coefficient (K_D). If the dissipation coefficient (K_D) plotted by taking the B/L as variable axes X and Y as variables K_D for each type of model then the generated graph as follows:





top model will be greater the dissipation energy (K_D) that generated model.

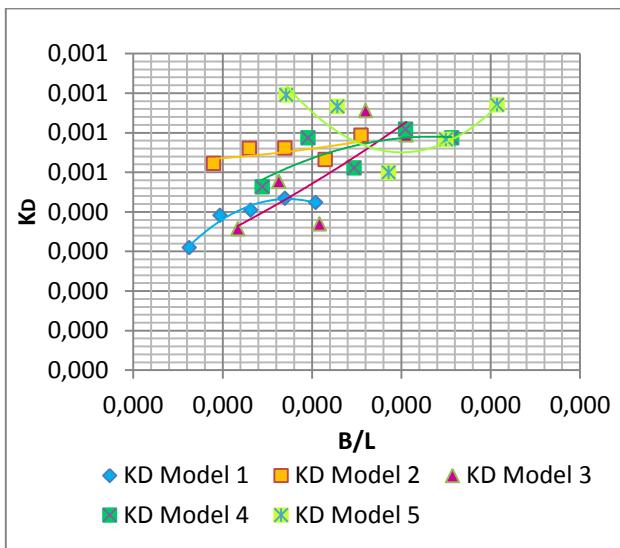


Figure-7. Graph of influence B/L to K_D each variation of width the top model merged condition

Figure-7 shows that the K_D graphs are directly proportional to the value B/L . The value of K_D increase as the width of the model, so in this condition width of the top model will be greater the dissipation energy (K_D) that generated model.

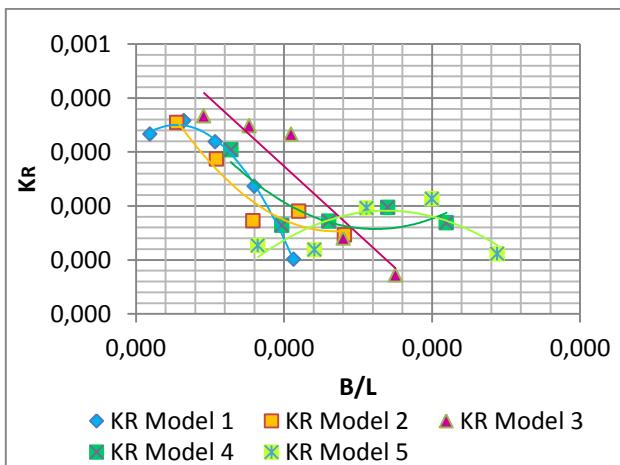


Figure-8. Graph of influence B/L to K_R each variation of width the top model submerged conditions.

Figure-8 dan Figure-9 shows that the graph K_R and K_T is inversely proportional to the value of K_R and K_T value decreases due to the width of the top model bigger, so it can be concluded that the condition of submerged the larger value of B/L and the larger the width of the top of the model the smaller value K_R and K_T are generated models.

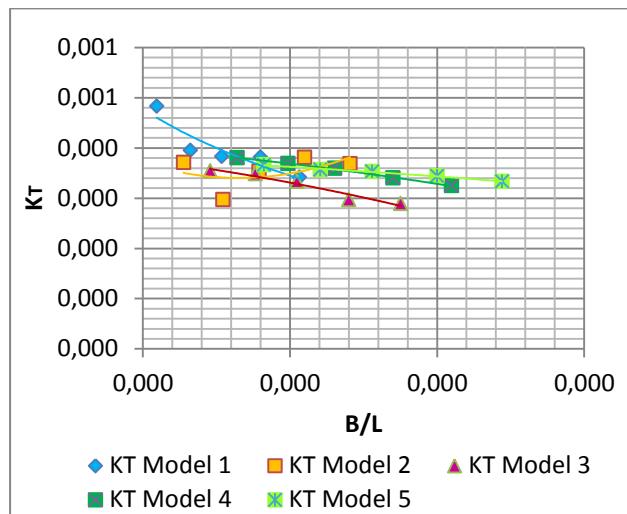


Figure-9. Graph of influence B/L to K_T each variation of width the top model submerged conditions.

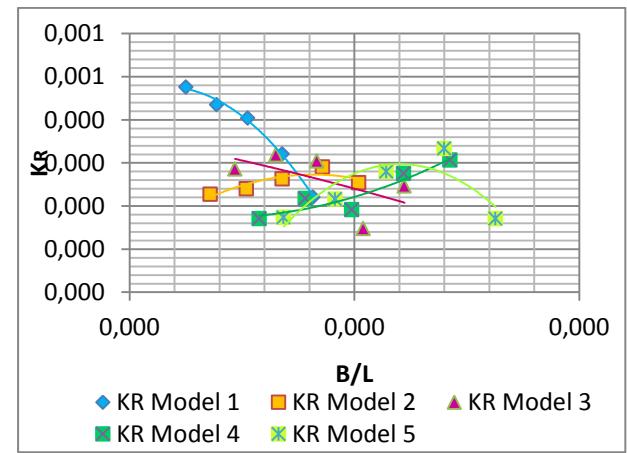


Figure-10. Graph of influence B/L to K_R each variation of width the top model merged condition.

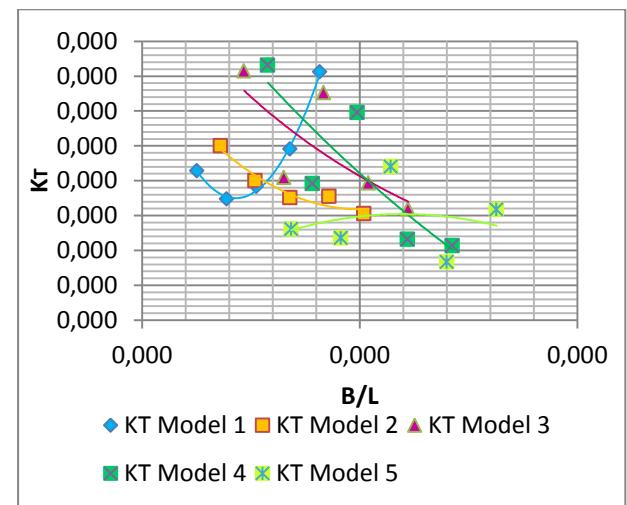


Figure-11. Graph of influence B/L to K_T each variation of width the top model merged condition.



Figure-10 and Figure-11 shows that the graph K_R and K_T is inversely proportional to the value of K_R and K_T value decreases due to the width of the top model bigger, so it can be concluded that the condition of merged the larger value of B/L and the larger the width of the top of

the model the smaller value K_R and K_T are generated models.

Comparison of experimental result with theoretical conditions of submerged and merged are presented in Table-4 and Table-5.

Table-4. Comparison of K_T , K_R , and K_D experimental and theoretical value (submerged).

Model	No. Data	KR Eksperimen	KR Teoritis	SSE	KT Eksperimen	KT Teoritis	SSE	KD Eksperimen	KD Teoritis	SSE
Model I	1 M1 - B1	0,333	0,550	0,731	0,483	0,060	0,385	0,183	0,400	0,314
	2 M1 - B2	0,358	0,520	0,681	0,395	0,100	0,471	0,247	0,390	0,233
	3 M1 - B3	0,319	0,500	0,764	0,383	0,130	0,486	0,298	0,390	0,193
	4 M1 - B4	0,236	0,480	1,031	0,382	0,120	0,488	0,382	0,430	0,151
	5 M1 - B5	0,101	0,390	2,407	0,342	0,240	0,545	0,557	0,370	0,103
Model II	1 M2 - B1	0,355	0,540	0,624	0,371	0,090	0,422	0,274	0,380	0,252
	2 M2 - B2	0,287	0,510	0,772	0,297	0,140	0,527	0,416	0,350	0,166
	3 M2 - B3	0,172	0,480	1,285	0,353	0,160	0,443	0,474	0,340	0,146
	4 M2 - B4	0,190	0,450	1,163	0,381	0,190	0,411	0,429	0,360	0,161
	5 M2 - B5	0,146	0,390	1,516	0,368	0,260	0,425	0,485	0,360	0,142
Model III	1 M3 - B1	0,367	0,530	0,885	0,354	0,120	0,561	0,278	0,350	0,488
	2 M3 - B2	0,349	0,510	0,931	0,349	0,100	0,570	0,302	0,390	0,450
	3 M3 - B3	0,333	0,500	0,974	0,333	0,150	0,596	0,333	0,350	0,408
	4 M3 - B4	0,141	0,450	2,310	0,297	0,200	0,670	0,563	0,350	0,242
	5 M3 - B5	0,072	0,380	4,493	0,289	0,270	0,687	0,639	0,330	0,213
Model IV	1 M4 - B1	0,304	0,520	0,857	0,380	0,120	0,407	0,315	0,360	0,336
	2 M4 - B2	0,164	0,500	1,591	0,369	0,180	0,419	0,467	0,320	0,227
	3 M4 - B3	0,172	0,470	1,517	0,359	0,200	0,430	0,469	0,330	0,226
	4 M4 - B4	0,197	0,420	1,322	0,340	0,240	0,455	0,463	0,340	0,229
	5 M4 - B5	0,169	0,400	1,544	0,325	0,260	0,476	0,506	0,340	0,209
Model V	1 M5 - B1	0,127	0,530	1,723	0,366	0,070	0,729	0,507	0,380	0,124
	2 M5 - B2	0,119	0,510	1,834	0,357	0,130	0,748	0,524	0,350	0,120
	3 M5 - B3	0,196	0,500	1,114	0,353	0,140	0,756	0,451	0,360	0,139
	4 M5 - B4	0,213	0,450	1,025	0,344	0,190	0,776	0,443	0,330	0,141
	5 M5 - B5	0,111	0,400	1,965	0,333	0,230	0,801	0,556	0,380	0,113

Table-5. Comparison of K_T , K_R , and K_D experimental and theoretical value (merged).

Model	No. Data	KR Eksperimen	KR Teoritis	SSE	KT Eksperimen	KT Teoritis	SSE	KD Eksperimen	KD Teoritis	SSE
Model I	1 M1 - B1	0,476	0,560	0,354	0,214	0,060	0,729	0,310	0,380	0,041
	2 M1 - B2	0,435	0,540	0,388	0,174	0,080	0,898	0,391	0,380	0,032
	3 M1 - B3	0,404	0,570	0,417	0,191	0,070	0,816	0,404	0,360	0,031
	4 M1 - B4	0,321	0,530	0,526	0,245	0,090	0,637	0,434	0,380	0,029
	5 M1 - B5	0,220	0,500	0,766	0,356	0,100	0,439	0,424	0,400	0,030
Model II	1 M2 - B1	0,227	0,560	1,228	0,250	0,085	0,368	0,523	0,355	0,358
	2 M2 - B2	0,240	0,550	1,163	0,200	0,090	0,460	0,560	0,360	0,334
	3 M2 - B3	0,263	0,540	1,060	0,175	0,100	0,525	0,561	0,360	0,333
	4 M2 - B4	0,290	0,520	0,961	0,177	0,120	0,519	0,532	0,360	0,351
	5 M2 - B5	0,254	0,500	1,097	0,153	0,100	0,604	0,593	0,400	0,315
Model III	1 M3 - B1	0,286	0,560	0,926	0,357	0,060	0,431	0,357	0,380	0,310
	2 M3 - B2	0,318	0,540	0,831	0,205	0,085	0,752	0,477	0,375	0,232
	3 M3 - B3	0,304	0,525	0,869	0,326	0,080	0,472	0,370	0,395	0,300
	4 M3 - B4	0,148	0,520	1,793	0,197	0,130	0,782	0,656	0,350	0,169
	5 M3 - B5	0,246	0,480	1,074	0,159	0,120	0,965	0,594	0,400	0,186
Model IV	1 M4 - B1	0,171	0,530	1,708	0,366	0,080	0,307	0,463	0,390	0,387
	2 M4 - B2	0,217	0,520	1,342	0,196	0,090	0,574	0,587	0,390	0,305
	3 M4 - B3	0,191	0,570	1,523	0,298	0,070	0,377	0,511	0,360	0,351
	4 M4 - B4	0,275	0,510	1,059	0,116	0,100	0,969	0,609	0,390	0,295
	5 M4 - B5	0,307	0,490	0,951	0,107	0,180	1,054	0,587	0,330	0,306
Model V	1 M5 - B1	0,174	0,530	1,606	0,130	0,060	0,322	0,696	0,410	0,341
	2 M5 - B2	0,216	0,560	1,295	0,118	0,080	0,357	0,667	0,360	0,356
	3 M5 - B3	0,280	0,510	0,997	0,220	0,080	0,191	0,500	0,410	0,475
	4 M5 - B4	0,333	0,500	0,838	0,083	0,120	0,504	0,583	0,380	0,407
	5 M5 - B5	0,171	0,470	1,636	0,159	0,160	0,265	0,671	0,370	0,354

From the calculation of the value of K_T , K_R , and K_D theoretical experiments occur on top of the transmission coefficient value (K_T), reflection coefficient

(K_R), and dissipation coefficient (K_D). There are some things may be the cause of the difference between the experimental and theoretical results, among others:



- a) Accuracy of measurements in the laboratory facilities are inadequate.
- b) Human error during data retrieval research.

The relation of width the top (B/L) to the transmission wave height (H_T) of the submerged and merged conditions is presented in Table-6 dan Table-7.

Table-6. Relation value between (B/L) and (H_T) (submerged).

Tipe model	No. Data		Ba (m)	m	d (m)	F (Hz)	T (s)	L (m)	B/L	Ht (m)
Model I	1	M1 - B1	1,8	1,5	5,1	2,5	12,000	82,258	0,022	0,435
	2	M1 - B2	1,8	1,5	5,1	3	10,000	68,000	0,026	0,480
	3	M1 - B3	1,8	1,5	5,1	3,5	8,571	58,621	0,031	0,540
	4	M1 - B4	1,8	1,5	5,1	4	7,500	50,000	0,036	0,630
	5	M1 - B5	1,8	1,5	5,1	4,5	6,667	43,590	0,041	0,810
Model II	1	M2 - B1	2,1	1,5	5,1	2,5	12,000	82,258	0,026	0,345
	2	M2 - B2	2,1	1,5	5,1	3	10,000	68,000	0,031	0,450
	3	M2 - B3	2,1	1,5	5,1	3,5	8,571	58,621	0,036	0,615
	4	M2 - B4	2,1	1,5	5,1	4	7,500	50,000	0,042	0,720
	5	M2 - B5	2,1	1,5	5,1	4,5	6,667	43,590	0,048	0,945
Model III	1	M3 - B1	2,4	1,5	5,1	2,5	12,000	82,258	0,029	0,420
	2	M3 - B2	2,4	1,5	5,1	3	10,000	68,000	0,035	0,450
	3	M3 - B3	2,4	1,5	5,1	3,5	8,571	58,621	0,041	0,510
	4	M3 - B4	2,4	1,5	5,1	4	7,500	50,000	0,048	0,570
	5	M3 - B5	2,4	1,5	5,1	4,5	6,667	43,590	0,055	0,720
Model IV	1	M4 - B1	2,7	1,5	5,1	2,5	12,000	82,258	0,033	0,525
	2	M4 - B2	2,7	1,5	5,1	3	10,000	68,000	0,040	0,675
	3	M4 - B3	2,7	1,5	5,1	3,5	8,571	58,621	0,046	0,690
	4	M4 - B4	2,7	1,5	5,1	4	7,500	50,000	0,054	0,750
	5	M4 - B5	2,7	1,5	5,1	4,5	6,667	43,590	0,062	0,750
Model V	1	M5 - B1	3,0	1,5	5,1	2,5	12,000	82,258	0,036	0,390
	2	M5 - B2	3,0	1,5	5,1	3	10,000	68,000	0,044	0,450
	3	M5 - B3	3,0	1,5	5,1	3,5	8,571	58,621	0,051	0,540
	4	M5 - B4	3,0	1,5	5,1	4	7,500	50,000	0,060	0,630
	5	M5 - B5	3,0	1,5	5,1	4,5	6,667	43,590	0,069	0,720

Table-7. Relation value between (B/L) and (H_T) (merged).

Tipe model	No. Data		Ba (m)	m	d (m)	F (Hz)	T (s)	L (m)	B/L	Ht (m)
Model I	1	M1 - B1	1,8	1,5	2,1	2,5	12,000	55,263	0,033	0,120
	2	M1 - B2	1,8	1,5	2,1	3	10,000	45,652	0,039	0,135
	3	M1 - B3	1,8	1,5	2,1	3,5	8,571	38,889	0,046	0,135
	4	M1 - B4	1,8	1,5	2,1	4	7,500	33,333	0,054	0,195
	5	M1 - B5	1,8	1,5	2,1	4,5	6,667	29,577	0,061	0,315
Model II	1	M2 - B1	2,1	1,5	2,1	2,5	12,000	55,263	0,038	0,165
	2	M2 - B2	2,1	1,5	2,1	3	10,000	45,652	0,046	0,150
	3	M2 - B3	2,1	1,5	2,1	3,5	8,571	38,889	0,054	0,150
	4	M2 - B4	2,1	1,5	2,1	4	7,500	33,333	0,063	0,165
	5	M2 - B5	2,1	1,5	2,1	4,5	6,667	29,577	0,071	0,135
Model III	1	M3 - B1	2,4	1,5	2,1	2,5	12,000	55,263	0,043	0,225
	2	M3 - B2	2,4	1,5	2,1	3	10,000	45,652	0,053	0,135
	3	M3 - B3	2,4	1,5	2,1	3,5	8,571	38,889	0,062	0,225
	4	M3 - B4	2,4	1,5	2,1	4	7,500	33,333	0,072	0,180
	5	M3 - B5	2,4	1,5	2,1	4,5	6,667	29,577	0,081	0,165
Model IV	1	M4 - B1	2,7	1,5	2,1	2,5	12,000	55,263	0,049	0,225
	2	M4 - B2	2,7	1,5	2,1	3	10,000	45,652	0,059	0,135
	3	M4 - B3	2,7	1,5	2,1	3,5	8,571	38,889	0,069	0,210
	4	M4 - B4	2,7	1,5	2,1	4	7,500	33,333	0,081	0,120
	5	M4 - B5	2,7	1,5	2,1	4,5	6,667	29,577	0,091	0,120
Model V	1	M5 - B1	3,0	1,5	2,1	2,5	12,000	55,263	0,054	0,090
	2	M5 - B2	3,0	1,5	2,1	3	10,000	45,652	0,066	0,090
	3	M5 - B3	3,0	1,5	2,1	3,5	8,571	38,889	0,077	0,165
	4	M5 - B4	3,0	1,5	2,1	4	7,500	33,333	0,090	0,075
	5	M5 - B5	3,0	1,5	2,1	4,5	6,667	29,577	0,101	0,195

From the results of the calculation of the value of the transmission wave height (H_T) decreases due to the value of B/L is so large it is shown on the interval value of the H_T on the model V submerged and merged condition, so it can be concluded that the width the top of breakwater then the transmission waves generated getting down, it is because the distance of a longer wave length.

On the conditions of submerged and merged obtained interval value K_T , K_R , and K_D as follows:

Tabel-8. Value K_T , K_R , and K_D (submerged).

Tipe model	Ba (m)	L (m)	B/L	H _i (m)	H _R (m)	H _T (m)	K _R	K _T	K _D
Model I	1,8	82,258	0,022	0,900	0,300	0,435	0,333	0,483	0,183
	1,8	68,000	0,026	1,215	0,435	0,480	0,358	0,395	0,247
	1,8	58,621	0,031	1,410	0,450	0,540	0,319	0,383	0,298
	1,8	50,000	0,036	1,650	0,390	0,630	0,236	0,382	0,382
	1,8	43,590	0,041	2,370	0,240	0,810	0,101	0,342	0,557



Table-9. Value K_T , K_R , and K_D (merged).

Type model	Ba (m)	L (m)	B/L	Hi (m)	Hr (m)	Ht (m)	KR	KT	KD
Model I	1,8	55,263	0,033	0,630	0,300	0,135	0,476	0,214	0,310
	1,8	45,652	0,039	0,690	0,300	0,120	0,435	0,174	0,391
	1,8	38,889	0,046	0,705	0,285	0,135	0,404	0,191	0,404
	1,8	33,333	0,054	0,795	0,255	0,195	0,321	0,245	0,434
	1,8	29,577	0,061	0,885	0,195	0,315	0,220	0,356	0,424

From five top width variation breakwater, which has a transmission coefficient (K_T) and reflection coefficient (K_R) the smallest and the value of the dissipation coefficient (K_D) the largest is the model V with width the top of breakwater 10 cm.

The influence of the width the top of breakwater (B) and the slope (m) constant on condition submerged breakwater and merged breakwater shows the result of wide the top breakwater transmission coefficient (K_T) and reflection coefficient (K_R) is getting smaller, while the value of dissipation coefficient (K_D) increases.

Breakwater effective to reduce the wave energy is a breakwater with a width the top of 10 cm at the merged condition; it is because the longer of distance waves so that the reduction of the resulting wave will be increases.

ACKNOWLEDGEMENTS

It is a pleasure to acknowledge with thanks helpful discussions with Miss Dian Anggreani of the Civil Research Tadulako University of Palu. I am grateful to Dr. Ir. M. Galib Ishak, MS, Research Division, for his constructive comments about the initial version of the manuscript. Thanks are also due to Mrs. Desyanti for the typing work.

REFERENCES

CEM. 2006. Coastal Engineering Manual Part II. US Army Coastal Engineering Research Centre, Washington, USA.

CERC. 1984. Shore Protection Manual. US Army Coastal Engineering Research Centre, Washington, USA.

Horikawa K. 1978. Coastal Engineering. University of Tokyo Press. Tokyo, Japan.

Paotonan C., Yuwono N. 2011. Wave Energy Dissipation on Submerged Structure. Yogyakarta, Indonesia.

Pratikto W.A, Armono H.D, Suntoyo. 1996. Perencanaan Fasilitas Pantai dan Laut. BPFE, Yogyakarta, Indonesia.

Shore Protection Manual. 1984. SPM Volume 2, US Army Coastal Engineering Research Centre, Washington, USA.

Soding H. 1971. Calculation of stresses on ships in a seaway. Schiff Hafen 2, 3, pp. 752-762.

Triatmodjo B. 1999. Teknik Pantai. Beta Offset, Yogyakarta.

Van der Meer, J.W. & I.F.R Daement. 2006. Stability and wave transmission at low Crested Rubble – Mound Structures. Journal of Waterway Port Coastal and Ocean Engineering, pp. 1-19.

Van der Meer J. W. 2006. Conceptual Design of Rubble Mound Breakwaters.