II －95 **EOF ANALYSIS OF TOPOGRAPHY CHANGE ON SENDAI COAST**

Tohoku University Student member ○ Hyun Woo KANG
Tohoku University Member Hitoshi TANAKA

1. INTRODUCTION

Beach erosion on Sendai Coast is a big concern in this area at the present. Incident waves from the southeast cause longshore sediment movement to the north, and erosion is continually progressing. Due to this reason, survey has been being carried out twice in a month since 1996 to understand the characteristics of topography change on Sendai Coast. Furthermore, to clearly understand a complex topography change, a complex topography change is divided into spatial fluctuations and temporal fluctuations from survey data using EOF(Empirical Orthogonal Function) method. Furthermore, relationship between each component and wave characteristics is examined. Using these results, topography change on Sendai Coast can be predicted.

2. EOF METHOD

The topography change can be expressed in terms of superposition of eigenfunction as follows:

$$y(x,t)=\sum_{n=1}^{n_x} C_n(t)e_n(x) \quad (1)$$

where $y(x,t)=y'(x,t)-\bar{y}(x)$ ($y'(x,t)$: the survey data, $\bar{y}(x)$: the mean shoreline position), n_x denotes the number of survey station, and $C_n(t)$ and $e_n(x)$ are the temporal and spatial eigen functions, respectively. To obtain eigenfunction, the correlation matrix A is calculated as follows:

$$A=\left[a_{ij}\right]=\frac{1}{n_x n_t}\sum_{t=1}^{n_t} y_{it}y_{jt} \quad (2)$$

where n_t denotes the number of surveyed times. The eigenvalues and eigenfunctons, spatial and temporal function, are obtained by the correlation matrix A .

$$Ae_n=\lambda_n e_n,\ C_n(t)=\sum_{n=1}^{n_x} y(x,t)e_n(x) \quad (3)$$

3. RESULTS OF EOF ANALYSIS

3-1 First Eigenfunction

The contribution of first eigenfunction is 38.7%. Figure 1 shows that the first spatial function, $e_1(x)$, has positive value everywhere along of the coast. Therefore, shoreline change behavior, whether erosion or deposition, is determined by the sign of the first temporal function. Figure 2 shows the first temporal function, $C_1(t)$. When the first temporal function has negative value, the first component becomes negative. It means that erosion occurs everywhere along of the coast. This behavior can express a beach erosion due to high waves. Therefore, the first eigenfunction describes the topography change of shoreline caused by cross-shore sediment transport.

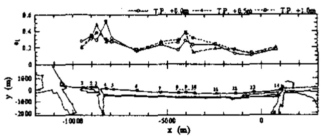


Figure 1 First spatial eigenfunction, $e_1(x)$

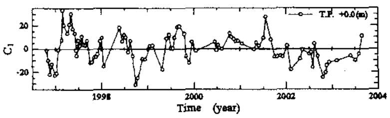


Figure 2 First temporal eigenfunction, $C_1(t)$

3-2 Second Eigenfunction

The second eigenfunction for T.P. +0.0*m* has the contribution ratio of 17.8%. As seen in Fig. 3, the second spatial function, $e_2(x)$, has a similar shape to the rate of change of shoreline, *a*, with an opposite sign. Figure 4 shows the second temporal function, $C_2(t)$. When the second temporal function has a negative value, the second component becomes a positive value in part of where the second spatial function has a negative value on Stations 3, 4, 9, 10 and 11. It means that deposition occurs at these stations. Also, erosion occurs on the other Stations, because the second component has a negative value in part of where second spatial function has a positive value on the other Stations. This behavior can express the phenomenon caused by longshore sediment transport moving from the south to the north. Thus, it is concluded that the second eigenfunction describes a shoreline change due to longshore sediment transport.

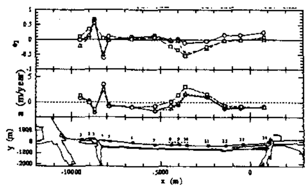


Figure 3 Second spatial eigenfunction, $e_2(x)$

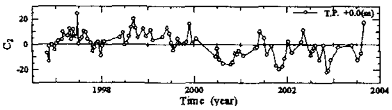


Figure 4 Second temporal eigenfunction, $C_2(t)$

4. PREDITION OF TOPOGRAPHY CHANGE

To reduce the accumulation of error, the relationship between temporal functions and wave characteristics is examined using the first half of the data, from Oct. 1996 to Jun. 1999.

Correlation between the first temporal function and wave characteristics affecting cross-shore sediment transport is investigated. Therefore, relation C_s parameter, the cross-shore beach profile has successfully been classified by Sunamura and Horikawa (1974), and dC_1/dt is considered. It is integrated both equations, for continuity of $C_1(t)$ is low. The relationship between $C_1(t)$ and Cs^* is investigated (Tanaka and Mori, 2001).

$$Cs^* = \int (C_s - C_{s0})\ dt\ (s) \qquad (4)$$

where C_{s0} is Cs parameter corresponding the value of demarcration between erosion and deposition of beach profile. It is estimated through trial and error so that liner relationship between $C_1(t)$ and Cs^* is obtained for the data from Oct. 1996 to Jun. 1999. As shown in Fig. 5 a), C_{s0} =22.8 is found to be most stuitable value. Therefore, the following linear relationship can be obtained.

$$C_1(t) = -0.083\,C_s^* - 25 \qquad (5)$$

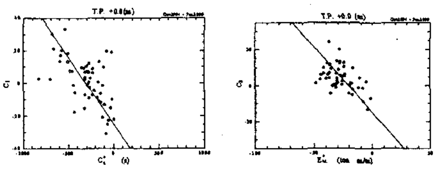
The relationship between the second temporal function and energy flux in longshore direction is investigated hereafter.

The relation between E_{bl}, energy flux in longshore direction at breaking point, and dC_2/dt is considered. As same way as before, it is integrated both equations, for continuity of $C_2(t)$ is low. Relationship between $C_2(t)$ and E_{bl}^*, is examined (Tanaka and Mori, 2001).

$$E_{bl}^* = \int E_{bl}\,dt \quad (ton \cdot m/m) \qquad (6)$$

It is estimated that linear relationship between $C_2(t)$ and E_{bl}^* is obtained from the data spanning Oct. 1996 to Jun. 1999 as shown in Fig. 5 b). The following linear relationship can be obtained.

$$C_2(t) = -0.73\,E_{bl}^* - 15 \qquad (7)$$



a) $C_1(t)\,and\,C_s^*$ b) $C_2(t)\,and\,E_{bl}^*$

Figure 5 Relationship between temporal functions and wave characteristics

Using Eqs. (5) and (7), temporal functions, $C_1(t)$ and $C_2(t)$, are predicted to verify from Jul. 1999 to Jan. 2003. Then, shoreline change is resynthesized according to Eq.1. Figure 6 shows that the surveyed and the calculated shoreline position at Station 7 agreed quite well during the period of calibration. Moreover, these two lines show good agreedment during the period of verification.

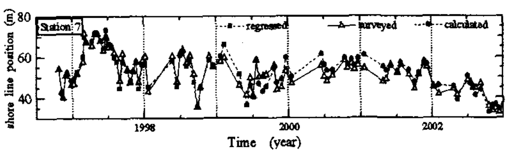


Figure 6 Surveyed and calculated shoreline position

5. CONCLUSIONS

In the present analysis to correlate temporal functions with wave characteristics, the first half of the field data is used for regression process, whereas the second half for verification process. As compared with previous study, more precise prediction can be obtained.

ACKNOWLEDGEMENTS

This research was partially supported by the Ministry of Education, Science, Sports and Culture, Grant-in-Aid for Scientific Research (B), No. 14350262.

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