SEDIMENT TRANSPORT PATHWAYS DETERMINED FROM GRAIN CHARACTERISTICS BASED ON DIGITAL IMAGES

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INTRODUCITON

The direction of sediment transport is one of important factors to manage sandy beaches. McLaren(1985) proposed a model which uses spatial trends in sediment textures such as the mean grain size, the sorting coefficient and the skewness to determine the sediment transport direction. But the MaLaren model has limited application in assessing net sediment transport direction (Masselink1993).In this study the new grain parameter, the roundness of sand grain, was added into the McLaren model and the validity of the model was verified using the field data.

DATA ANALYSIS

Most approaches to grain-size analysis have utilized mechanical sieving, settling through a column of water or laser diffraction. In this study, the sediment textures were determined from digital images of sediment. The digital images of sand particles distributed in a glass chamber were obtained with a commercial scanner. The resolution of the image is approximately 0.032mm/pixel and 500 to 5000 sand particles distribute in the image. The individual particles were extracted from a binarized image with the Otsu method and the perimeter ℓ and the area of sand particle a were measured. Assuming that the shape of the particle is circular, and the value of roundness R was calculated with the following equation (1).

$$d = \sqrt{\frac{4a}{\pi}} \qquad R = \frac{4\pi a}{\ell^2} \quad (1)$$

where d is the diameter d and a the area of a sand particle, and R=1 represents a perfect circle. Figure 1 shows the comparison of cumulative frequency between mechanical sieving and the present method.

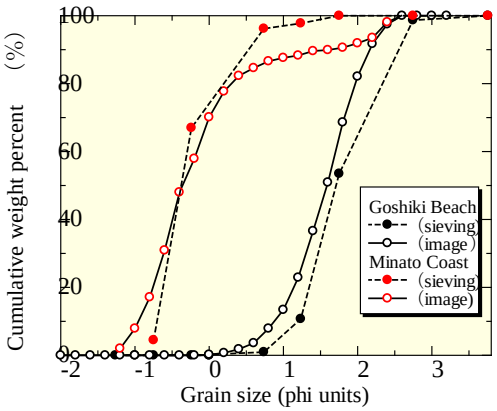

Fig.1 Cumulative frequency

EXPANDED SEDIMENT-TRANSPORT MODEL

The new parameter; the roundness R, was introduced into the model by McLaren. There are two cases associated with net transport defined as Case B and Case C.

Case B: $\sigma_2{}^2 < \sigma_1{}^2, \mu_2 > \mu_1, Sk_2 < Sk_1, R_1 < R_2$

Case C: $\sigma_2{}^2 < \sigma_1{}^2, \mu_2 > \mu_1, Sk_2 < Sk_1, R_1 > R_2$

where σ^2 is the square root of the variance, Sk the skewness and μ the mean diameter.

RESULTS

Figure 2 shows the sample beaches on Awaji Island and table-1 shows the grain size statics

Table-1 Grain size statics

	diameter	sorting	skewness	roundness
1	0.773	0.758	−0.261	0.752
2	0.152	0.814	1.553	0.679
3	0.531	0.871	−0.375	0.696
4	0.631	0.711	−0.527	0.726
5	0.932	0.507	0.86	0.778
6	1.766	0.513	−1.165	0.87
7	0.753	0.619	0.946	0.753
8	1.486	0.385	0.107	0.843
9	1.943	0.458	−1.033	0.872
10	1.521	0.586	−0.849	0.844
11	1.698	0.493	−1.012	0.828
12	1.664	0.484	−0.425	0.866
13	0.779	0.735	0.507	0.751
14	0.508	1.843	−0.391	0.633
15	0.649	0.788	0.533	0.759
16	0.014	0.934	1.467	0.699
17	1.162	0.913	−0.62	0.79

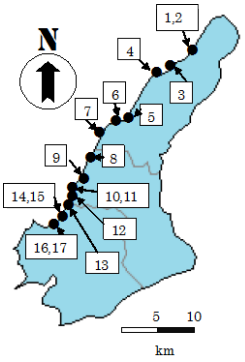

Fig. 2 Study beaches

CONCLUSION

The sediment pathway along the beaches on Awaji Island estimated by the expanded model corresponds to observation data very well. The statistical significant level for estimation of sediment transport pathway increased with introducing the value of roundness.

REFERENCES

McLaren,P. and Bowles,D.(1985): The effects of sediment transport on grain-size distributions: Jour. Sed. Petrology, Vol.55,pp.457-470.