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ESTIMATION OF VERTICAL STRUCTURE OF DISPERSION COEFFICIENTS OFF WOLSONG

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ABSTRACT

Water movements at nine different layers were observed from July 31 to August 2, 1976 at station H, which has water depth 42 meters and 3km far from the coast of Wolsong, and dispersion coefficients were computed from these current data, then relative magnitudes of dispersion coefficients were calculated at each layers.

Relative magnitudes of dispersion coefficients based on the surface value are 62% at 5m layer, 24% at 10m layer, 20% at 15m and 20m layers, 17% at 25m layer, 21% at 30m layer, 28% at 35m layer and 15% at bottom layer, respectively.

INTRODUCTION

We understand that the coastal process is very complex phenomena, and many variables vary with time and space. However coastal zone is getting important for human living. Waste water is discharged to coastal zone and dispersed into sea water. Understanding coastal water movement and dispersion process is one of prime importance for treatment of waste water. Estimation of dispersion coefficients at different layers may give some answers to preserve natural environment of coastal zone for designing waste water structure.

Dispersion coefficients computed from current data obtained by Aanderaa Recording Current Meter (RCM-4) were studied by Hahn (1978), however, he discussed them at current meter mooring depth only. That site located at 0.5 km off the coast of Wolsong has water depth of 10 meters, current mooring depth 5 meters.

DATA AND METHOD

At station H (35° 42′ 41″ N, 129° 30′ 55″ E) which has water depth 42m and 3 km far from the coast of Wolsong, south eastern coastal area of Korea, water movements at 9 different layers (every 5m layers from the surface) were observed by Toho Dentan Direct Reading Current Meter (CM-2) with data interval an hour from July 31 to August 2, 1976 at anchored survey ship. During current measuring period, sea was very calm, wave height less than 0.5m and wind speed less than 3m/sec, so wind effect was not considered to compute dispersion coefficients. Current data were used to compute dispersion coefficients discribed by Ahn and Smith (1972), and Hahn (1978). Relative magnitudes of dispersion coefficients based on the surface value were calculated at each layer.

RESULTS

A. Water Movement

Water moved to NNE direction during the observed period at all layers. Progressive vector diagrams show this clearly. Scalar mean speed at the surface (0.5m layer) was 65.1cm/sec, that of intermediate layer (20m) 28.0cm/sec and that of bottom layer (40m) 19.1cm/sec.

Table 1. Current data at studied area (July 31-August 2, 1976)

Layer	Component	Mean (cm/sec)	Max. (cm/sec)	Variance
0.5m (surface)	E	16.73	59.5	237.8
	N	61.47	121.8	625.1
5m	E	9.87	46.3	135.5
	N	44.65	109.9	437.9
10m	E	5.41	42.4	139.2
	N	32.60	69.9	406.8
15m	E	4.70	20.5	49.2
	N	27.51	69.9	377.8
20m	E	5.31	17.6	26.7
	N	25.93	64.9	276.7
25m	E	5.56	33.5	82.8
	N	23.69	47.9	203.7
30m	E	5.60	41.9	127.9
	N	22.66	56.5	314.9
35m	E	5.48	32.3	97.5
	N	20.65	62.4	417.5
40m (bottom)	E	4.25	19.5	55.7
	N	14.74	46.1	199.3

Vector mean speeds at the surface, intermediate and bottom layers were 63.7cm/sec, 26.5cm/sec and 15.3cm/sec, respectively.

Oceanic current was stronger than tidal current at station H. Oceanic current speeds were 55.8cm/sec, 24.2cm/sec and 12.9cm/sec at the surface, intermediate, and bottom layers, respectively. East and north components of current at each layers are shown in Table 1. North component of current speed was 4.5 times stronger than that of east component.

Boundary zone between tidal current dominant area and oceanic current dominant area was not clearly defined during the current measuring period, however, vertical structure of water movement at 15h 30m, July 31, 1976 (Fig. 1) may suggest boundary zone about 2～2.5 km from the coast. Experiences from monthly oceanographic survey for a year in this coastal area support this idea.

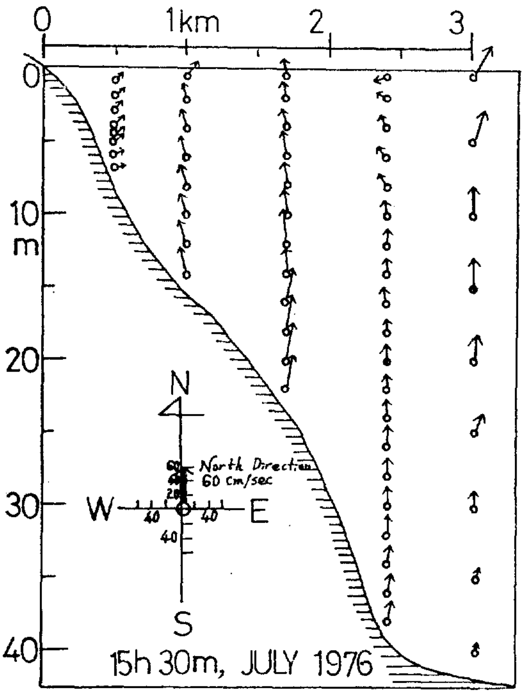

Fig. 1. Vertical structure of water movement off Wolsong at 15h 30m, July 31, 1976.

B. Dispersion Coefficients

North component of dispersion coefficient is stronger than that of east component about 7.4 times on an average. Mean value of north component at the surface is 4.20×10^6 cm^2/sec as shown in Table 2. It decreases rapidly down to 10m layer and then remains nearly constant. They show 62% 24%, 20%, and 15% of the surface value, at 5m, 10m, 20m, and bottom layer, respectively.

Mean value of east component at the surface is 6.16×10^5 cm^2/sec, 14.7% of north component value. It also decreases with depth, 54% of surface value at 5m layer, 26% at 10m layer, and 17% at bottom layer.

In general, dispersion coefficients decrease with depth, 62% of the surface value at 5m layer, 24% at 10m layer, 20% at 15m and 20m layers, 17% at 25m layer, 24% at 30m layer, 28% at 35m layer and 15% at bottom layer (Fig. 2). They show the highest dispersion coefficient at the surface, next highest one at 5m layer and third one at a quarter depth from the bottom. The lowest dispersion coefficient appears at bottom layer and next lowest one at intermediate layer in this area.

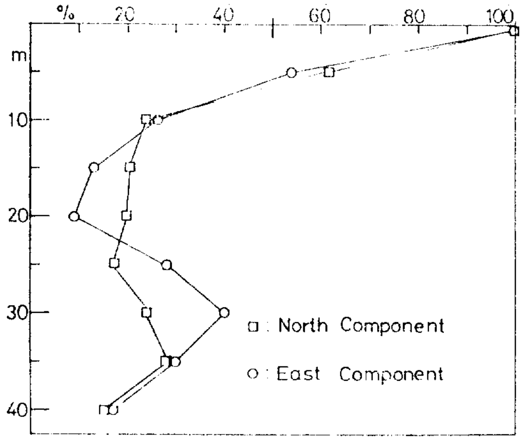

Fig. 2. Relative magnitudes of dispersion coefficient based on the surface value.

DISCUSSION AND CONCLUSION

As the strongest water movement is shown at the surface layer, the highest value of dispersion coefficient appears at the surface. Water movement decreases with depth and dispersion coefficient also decreases with depth in general, and the lowest dispersion coefficient appears

Table 2. Dispersion coefficients computed from current data

Layer	Component	Mean (cm^2/sec)	Min. (cm^2/sec)	Max. (cm^2/sec)
0.5m (surface)	E	6.16×10^5	8.81×10^4	1.93×10^6
	N	4.20×10^6	1.51×10^6	1.11×10^7
5m	E	3.32×10^5	7.89×10^3	1.12×10^6
	N	2.61×10^6	3.44×10^5	4.36×10^6
10m	E	1.58×10^5	2.16×10^3	3.94×10^5
	N	9.93×10^5	2.70×10^5	1.84×10^6
15m	E	8.08×14^4	2.94×10^3	1.97×10^5
	N	8.50×10^5	3.05×10^5	1.95×10^6
20m	E	5.91×10^4	5.37×10^3	1.38×10^5
	N	8.41×10^5	2.25×10^5	1.44×10^6
25m	E	1.74×10^5	1.78×10^4	6.76×10^5
	N	7.15×10^5	4.95×10^5	8.43×10^5
30m	E	2.45×15^5	3.12×10^4	8.72×10^5
	N	9.88×10^5	5.11×10^5	1.73×10^6
35m	E	1.83×15^5	3.72×10^4	4.71×10^5
	N	1.19×10^6	5.67×10^5	1.49×10^6
40m (bottom)	E	1.04×10^5	1.91×10^4	3.38×10^5
	N	6.47×10^5	2.18×10^5	2.05×10^6

bottom layer. However there is slight increasing tendency of dispersion coefficient at a quarter depth from the bottom in this area. This is due to large variance of current speed at this depth.

At a station, 0.5 km off the coast (near shore station), mean current speed is 17.4cm/sec and dispersion coefficient is 1.81×10^{5} cm^{2}/sec. Comparing with this near shore station, they show much higher values of dispersion coefficient at studied area (station H, 3 km off the coast), 23.4 times at the surface, 14.5 times at 5m layer, 5.6 times at 10m layer, 4.7 times at 20m layer, 5.6 times at 30m layer and 3.6 times at bottom layer.

Computing dispersion coefficient from current data may need time series current data more than a month period, however, we were able to gather only a few days current data at this studied area, during the moon's age 4 to 6, so this result may not give real values of dispersion coefficient. In spite of short period of current data, it is very useful information for designing discharge structure in coastal zone if we know relative magnitudes of dispersion coefficient at each layer.

Relative magnitudes of dispersion coefficient based on the surface value is 62% at 5m layer, 24% at 10m layer, 20% at 15m and 20m layers, 17% at 25m layer, 24% at 30m layer, 28% at 35m layer and 15% at bottom layer in this studied area.

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