DETERMINATION OF OCEAN DATUM USING GPS BUOY OBSERVATION DATA

Jungsoo, Hong [a]*, Kisuk, Back[a], Unyong, Park [a], Dongrak, Lee [b], Sungyeoul, Cha [c]

[a] Dept. of Civil Engineering, Dong-A University, 840 Hadan 2-dong, Saha-gu, Busan 604-714, S. Korea
- ((jungsoo0515, back0897)@hanmail.net, uypark@dau.ac.kr)

[b] Dept. of Civil Engineering, Changshin College,Habsung-2dong, Masan-si, Gyeongsangnamdo, S. Korea
- drlee@csc.ac.kr

[c] Dept. of Civil Engineering, Yangsan College, 922-2, Myeonggok-dong, Yangsan-si, Gyeongsangnamdo, S. Korea
- sycha@yangsan.ac.kr

Commission VIII, WG VIII/6

KEY WORDS: Ocean's vertical datum, GPS buoy, Tidal gauge

ABSTRACT:

The 37% of worldwide population lives in near coastal area have effect on serious damage a sort inundation and tsunami caused by sea level rise. The importance of monitoring sea level rise is evidence. Especially, Korea surrounded by sea on three sides has a complicated tide shape and great tidal range between seashores which is mainly attributable to the geographical features. This situation makes a demand actual surveying data of sea level changes in all seashore to secure ship's navigation, effective coastal development and etc. The application of general land surveying methods is very difficult to use in ocean area due to the complexity of cause and form of mean sea level change and ocean's locality. This study has been tried to escape from the present determination method of ocean's vertical datum using just fixed tidal gauge installed at tide observatory and to apply a self-invented GPS buoy system as an alternative that is able of establishing on sea surface and can monitor physical status and real time change of sea level. Results of this study show that GPS buoy observation technique can play an important role in collecting data of sea level change and determining mean sea level used for the benchmark of levelling on land in the future.

1. ITRODUCTION

In the latest decade, sea level rise caused by the greenhouse effect and a dramatic change of ocean current is leading to increase the scale and frequency of various kinds of disasters all over the world. Therefore, the importance of sea level change monitoring gains a great prominence.

In particular, Korea surrounded by sea on three sides has a complicated tide shape and great tidal range between seashores which is mainly attributable to the geographical features. This situation makes a demand actual surveying data of sea level changes in all seashore to secure ship's navigation, effective coastal development and etc.

In marine surveying, an efficient and systematic surveying technique is necessary to acquire sea level change data, because the correction of water depth regarding tidal height is directly linked to the accuracy of water depth and mean sea level is used for the benchmark of leveling on land. However, the application of general land surveying methods is very difficult to use in ocean area due to the complexity of cause and form of mean sea level change and ocean's locality. In addition, there have been rarely researched on geoids determination integrating geodetic leveling with oceanographic one and ocean datum determination using KDGPS (Kinematic Differential Global Positioning System) as well as.

Therefore, this study has been tried to escape from the present determination method of ocean's vertical datum using just fixed tidal gauge installed at tide observatory and to apply a self-invented GPS buoy system as an alternative that is able of establishing on sea surface and can monitor physical status and real time change of sea level. Besides, the information on physical characteristics including height and frequency of waves collected by bottom pressure sensor are used to correct water level height measured by GPS buoy system.

2. TEST AND ANALYSIS

In this thesis, two different areas; Youngdo and Gadeokdo are optimally selected for the experimental test of GPS buoy system under considering of working conditions and data availability of tidal height by operating both tidal observatories. First of all, GPS control point surveying was conducted to make a fix point that provides the reference position used to be compared with GPS buoy height and to introduce frequency and form of waves from buoy motion.

* Corresponding author: Kisuk, Back(back0897@hanmail.net.)

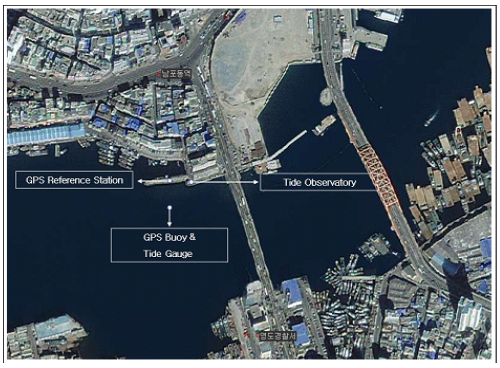

Fig. 1. Youngdo test area and observation location

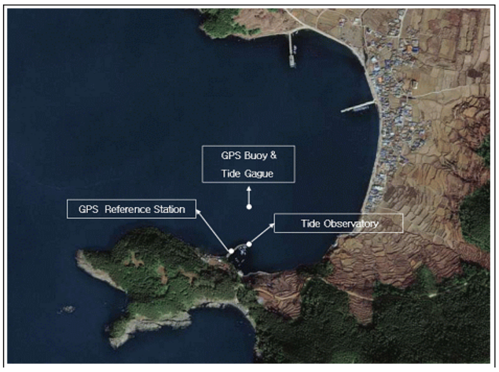

Fig. 2. Gadeokdo test area and observation location

Two fix points in test areas by GPS control surveying are set out at Youngdo and Gadeokdo respectively based on some triangulation points near Youngdo. Afterwards, 3D-coordinates and geoid height were calculated from the 11 surveyed control points near test areas.

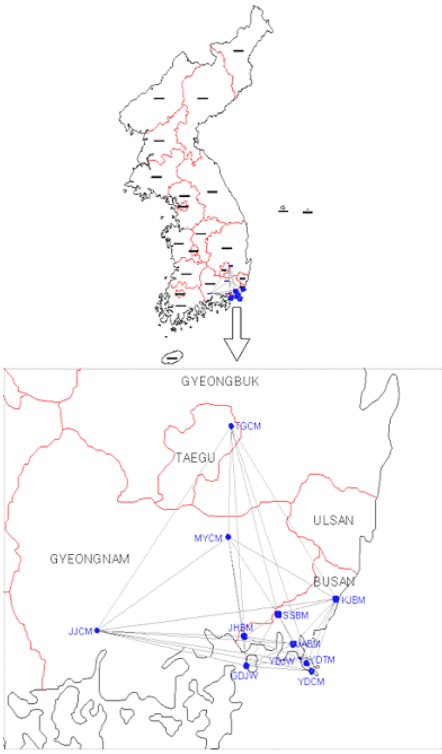

Fig. 3. GPS network

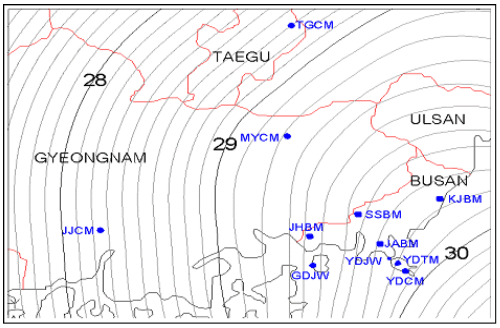

Fig. 4. Geoid height distribution of test area

In order to estimate the accuracy of GPS buoy observation according to baseline length between reference station and GPS buoy, GPS data of two different base stations MYCM and TGCM at a distance of 50km and 90km respectively from test area are processed and analyzed.

Fig. 5. Field test using GPS buoy

The purpose of this test is to check the applicability of the remote DGPS base station for the GPS buoy surveying.

Station		Distance (m)	Local Time	Othometric Height Range
From	To			
YDCM	Youngdo	4,991.38	12 ~ 1	-20.0381cm ± 3mm
			1 ~ 2	-32.7021cm ± 2mm
			2 ~ 3	-38.9181cm ± 3mm
			3 ~ 4	-33.1254cm ± 3mm
MYCM		51,208.37	12 ~ 1	-22.8981cm ± 4mm
			1 ~ 2	-36.2514cm ± 2mm
			2 ~ 3	-41.9856cm ± 4mm
			3 ~ 4	-35.7898cm ± 3mm
TGCM		92,321.96	12 ~ 1	-38.2125cm ± 7mm
			1 ~ 2	-32.1515cm ± 6mm
			2 ~ 3	-43.1859cm ± 4mm
			3 ~ 4	-39.4451cm ± 7mm
YDCM	Gadeokdo	24,083.31	12 ~ 1	-28.2512cm ± 2mm
			1 ~ 2	-52.4546cm ± 3mm
			2 ~ 3	-61.9471cm ± 4mm
			3 ~ 4	-53.8026cm ± 4mm
MYCM		52,189.07	12 ~ 1	-34.2510cm ± 2mm
			1 ~ 2	-54.4748cm ± 3mm
			2 ~ 3	-62.7802cm ± 4mm
			3 ~ 4	-56.5112cm ± 4mm
TGCM		97,874.63	12 ~ 1	-38.4253cm ± 9mm
			1 ~ 2	-60.8415cm ± 8mm
			2 ~ 3	-67.5023cm ± 9mm
			3 ~ 4	-61.4852cm ± 8mm

Table 1. GPS buoy Height range for each baseline

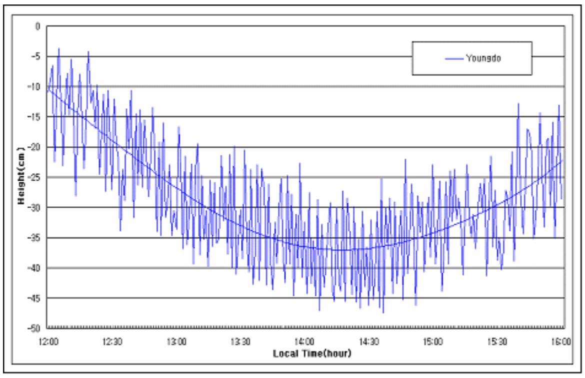

Fig. 6. Tide gauge sea level height in Youngdo

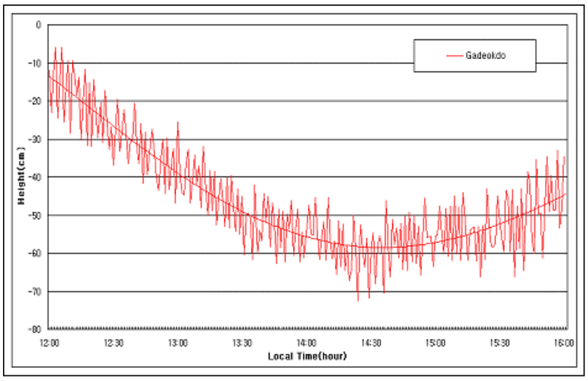

Fig. 7. Tide gauge sea level height in Gadeokdo

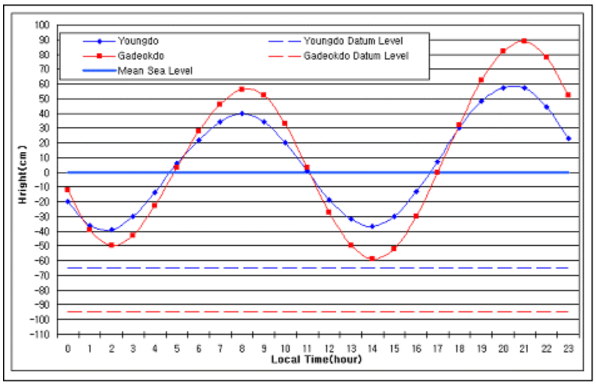

Fig. 8. Tide height variation on 2006/06/25

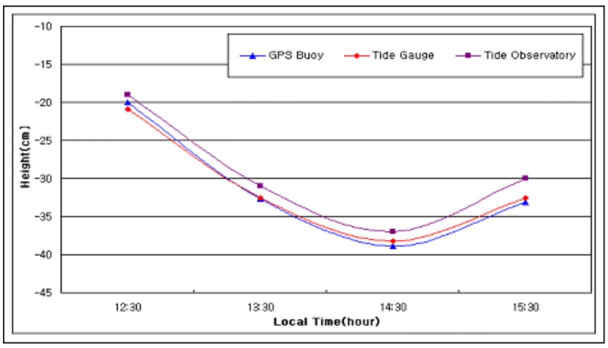

Fig. 9. Orthometric height by tide gauge, tide observatory and GPS buoy in Youngdo fixed YDCM as reference

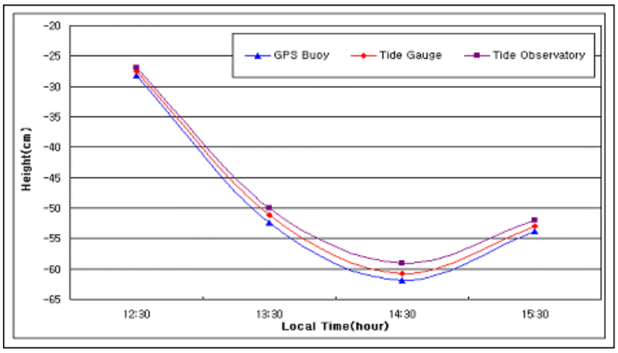

Fig. 10. Orthometric height by tide gauge, tide observatory and GPS buoy in Gadeokdo fixed YDCM as reference

3. CONCLUTION

Results of this study show that GPS buoy observation technique can play an important role in collecting data of sea level change and determining mean sea level used for the benchmark of leveling on land in the future. Furthermore, it is strongly recommended that continuous research on the application of GPS buoy surveying should be required for nationwide coast area.

REFERENCES

References from Journals:

Key. K.M. Parke and G. Born, "Mapping the sea surface using GPS buoy", Marine Geodesy, pp. 67 ~ 79, 1998.

Bisnath, S., D. Dodd, D. Wells, S. Howden, D. Wiesenburg and G. Ston, "Water level recovery with an RTK-GPS equipped buoy", Paper presented at the U. S. Hydro 2003 Conference, pp.23 ~ 27, 2003.

Hein, G.W., H. Landau and H. Blomenhofer, "Measuring sea level changes using GPS in buoy. In Sea Level Changes", America Geophysical Union and International Union of Geodesy and Geophysics, pp. 152 ~ 185, 1992.

Augath, W.,Brouwer, F.,Lang, H.,Van Mierlo, J. "From UELN-95 to EVS 2000 - European Activities for a Continental Vertical Datum", INTERNATIONAL ASSOCIATION OF GEODESY SYMPOSIA, Vol.1 No.118, 2000.

References from Books:

Ming, We., "Water level measurement using kinematic GPS", Geodetic Science and Surveying in the Department of Civil and Environmental Engineering and Geodetic Science, Report 343, 2005.