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Selection of subsea surface horizontal displacement monitors in offshore deep-water channel project

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Abstract. This paper studied the performance of subsea ground horizontal displacement monitors based on a 12.5 meters deep offshore channel project in the ChangJiang River. The feather of monitoring instruments were analyzed and compared. A suitable set of instruments were chose according to the feather of deep operation water depth, large flow and no advection period.

Key words: offshore; deep-water channel; automatic monitoring equipment; underwater wireless transmission

1. Introduction

With the rapid development of economy, the water depth becomes much deeper. And the deformation of subsea surface is much harder to be monitored than before. [1] The deep-water channel engineering case also has the characteristics of large operation water depth, large water flow and no advection period. These challenge the real-time monitor practice, especially during the heavy storm period [2].

This paper analyzed the subsea ground horizontal displacement monitors effect based on a 12.5 meters deep offshore channel project in the ChangJiang River. The comparison was proposed and a suitable set of instruments were chose.

2. Comparison among several horizontal displacement monitoring instruments

2.1. Comparison principle

In order to monitoring the horizontal displacement of subsea ground far away from coast during the long construction and servicing period, the instruments should meet the following need.

(1) The monitors should work normally in offshore and deep-water area and can collect data automatically.

(2) The data collected by monitors should have high precision.

(3) The monitors should have long term stability.



(4) The monitors should be suitable for use in harsh environment and have strong anti-construction interference ability.

2.2. Several optional instruments

The monitoring of the horizontal displacement of deep onshore soil was usually carried with burying inclinometers. The monitoring of offshore land horizontal displacement is also proposed with inclinometers, while the head of inclinometers should be above the water surface. Therefore the installation, fixation and protecting of inclinometers are big challenges. The data collection of the sliding inclinometer depends on the manual observation. The fixed inclinometer collects data automatically and can be used in deep-water channel engineering. Three kinds of common fixed inclinometers are shown as followed.

(1) American Geokon instruments

There are two kinds of American Geokon instrument. One is GK-6300, it is shown in Figure 1 and Figure 2. The other one is GK-6150, as shown in Figure 3.



Figure 1. The appearance of GK-6300



Figure 2. The GK-6300 assembled in a inclinometer



Figure 3. The appearance of GK-6150

(2) Canadian instrument

The Canadian instrument for monitoring horizontal displacement is AGI906, and it is shown in Figure 4.



Figure 4. The appearance of AGI906

The measuring range, sensitivity, accuracy, operation temperature cable and sensor parameters of these three instruments were compared. The comparison results are shown in Table 1

Table 1. The comparison of three instruments

Items		GK-6300	GK-6150	AGI906
Range		± 10	± 15	± 12.5
Sensitivity		10 arc second	± 12 arc second	2 arc second
Accuracy		0.1%F.S.R	0.1%F.S.	
Temperature		$-40^{\circ}\text{C} \sim +90^{\circ}\text{C}$	$-40^{\circ}\text{C} \sim +85^{\circ}\text{C}$	$-10^{\circ}\text{C} \sim +50^{\circ}\text{C}$
Sensor	Diameter	32mm(1.25")	32mm(1.25")	38mm(1.5")
	Length	187mm	187mm	208mm
	Weight	0.7 kg	0.7 kg	
	Material	304 stainless steel	304 stainless steel	ABS plastic Delrib Wire blade
Cable		4 conductors	6 conductors	Domestic conductor

The advantages and disadvantages of each instrument were listed in Table 2.

Table 2. Advantages and disadvantages for each instrument

	Gk-6300	Gk-6150	AGI906
Advantages	(1) The output signal is frequency signal, and can be transmitted over long distances by cable. The signal is barely affected by the variation of resistance, temperature. (2) The long term stability is well. (3) The sensor can maintain collection operation with little water penetrating in the instrument.	(1) Most advantages are same with the GK-6300. (2) It has a better compatibility. (3) It can be installed vertically or horizontally.	(1) It has no movable mechanical parts, and therefore there are no drift in monitoring. (2) The sensitivity and reliable is better. (3) Each sensor of AGI906 has a signal regulating circuit, avoiding the interference, alignment error etc. (3) The domestic conductor can be used in monitoring. (4) It can be used in vacuum environment.
Disadvantages	(1) The pendulum block will swing without a break when the ground vibration exceeds a limit. And the swinging of pendulum block would affect the data collection. (2) It can only be installed vertically.		The sensor cannot work with little water penetrating into instrument.

3. Conclusion

The features of GK-6300, Gk-6150 and AGI-906 are proposed and compared. And based on the feature of this deep-water channel engineering, the GK-6150 was chosen to be used in practice.

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