CORROSION SCIENCE AND TECHNOLOGY, Vol.4, No.1(2005), pp.29~32

Development of the Activity Type Smart Concrete using the Glass Pipe

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A various structural materials are used in construction projects such as a stone, concrete, steel materials. Between of them, concrete are used widely. The compressive strength of concrete is high, and its maintenance and management is comparatively easy. The R.C Building will be superannuated as time passes. This program is generated by propagation of cracks. In order to manage such cracks, time and efforts, expense, etc. are required. In this study, glass sensors were embedding in a model beam and column and leakage of fluorescence and adhesive material was investigated. Further, currents in glass pipe were observed to find the leakage of liquid in glass pipes. Progressive cracks generated by cause the fracture of glass pipes. Therefore, the liquid become to flow and electric current stops, and the cracked part of the member can be found easily. Moreover, the adhesive delays progressive cracking system that responds in air, and the life of a structure can be made to extend.

The purpose of this research is to develop of low price sensors that can perform of self-diagnosis in addition to ability of concrete repair concrete to damage.

Keywords *: crack, glass pipe, repair, concrete, sensor*

1. Introduction

Performance degradation of concrete structures is generally caused by deteriorations, such as surface collapse, pop-out, crack, and so on. It may result in serious defects of concrete structures. Thus it is very important to detect and repair defects of concrete structures within a proper time to assure the structural safety. However, defects due to deteriorations are usually difficult to find by visual inspections. A sensor, which is proposed by this study, may give early indications of the degradation of concrete structures and show locations of damages.

The action of a real structure has a difference with the mathematical model (FEM) for a structure. Therefore, cracks cannot be predicted correctly, because it is generated according to the factor that can affect the building. Because of concrete is not an isotropic brittle material like glass, a generated physical crack process differs from this (like Glass, Ceramic) and the internal fracture crack has a different propagative length. Because glass is destroyed early more compared with concrete, we can put the simple glass of pipe at the inside of concrete and it can be used be an internal substance of a crack. A crack can be detected by the sense of human such as smell vision or etc according to an internal substance.

Therefore, in this study, the length of a crack, an angle, and a depth were observed with the eye using a glass pipe sensor. Moreover, a mathematical analysis model is used. The laying underground position of a glass pipe sensor can be predicted, and it can be purchased in the process of the construction.

Therefore, in this research arranged the relation of concrete and a glass pipe sensor, application of an internal substance and prediction of a sensor purchase position, and result of experiment. And the repair sensor that can do development of the sensor that can detect crack generating by external force and can predict repair time, and it is developed. It is primary search for the developing of the smart concrete that can do.

2. Experimental

2.1 The method and procedure of research

The one direction sensor about bending of crack was manufactured in the primary experiment of this study.

Bending specimen was comparison of containing specimen the glass pipe, and which is not a glass pipe sensor by failure of brittle. It is inquired value of experiment

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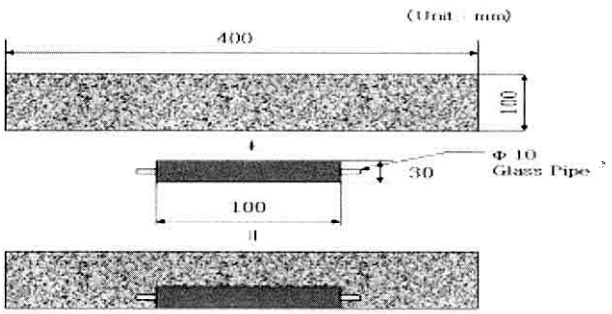

Fig. 1. One direction sensor and Specimen.

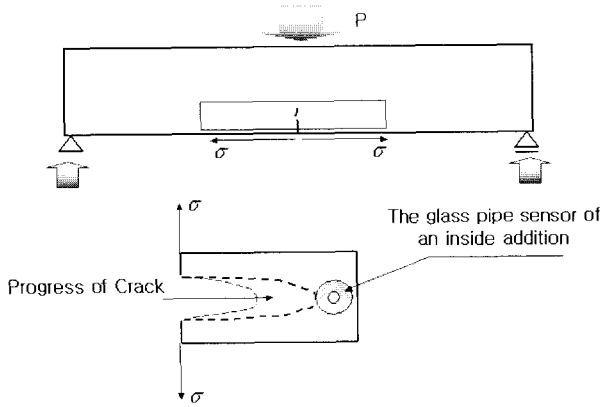

Fig. 2. The conceptual picture of research

through the 2-dimensional analysis using a wide using Finite Element Method Program, Midas.

It used the Acrylonitrile as one type repair system. The types of two-repair system have process of addition polymerization. Acrylonitrile is changes to a high polymer substance out of air by removal of water or alcohol. Therefore, it used as the type of one repair system. A Cement paste was applied to the inside of glass pipe sensor.

2.2 Position determination of a sensor

In this study, the experiment of diagnostic solution is used to as a method, which is about failure of bending and failure of shear easily. Therefore, the action of the glass pipe is detected differently to concrete behavior. The primary experiment is about the comparison of the initial stress in the entire specimen. The Finite Element Method Program was used in order to determine the sensor position.

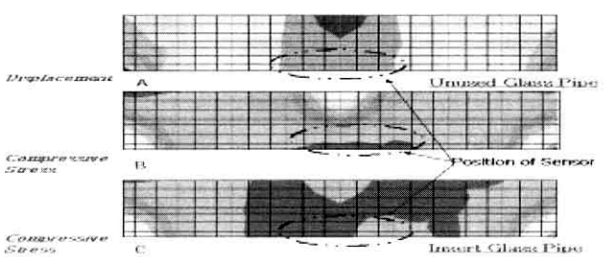

Fig. 3. Determined the sensor position

3. Results and discussion

3.1 Bending test of plain concrete specimen in the primary experiment.

Figs. 4 illustrate the relationship of the load-displacement on the flexural test. In the case of the plain concrete occurred the displacement of concrete at 95 % grade. In which destruction of a sensor was occurred simultaneously. However, the decline of total proof the stress did not occurred when sensor was inserted. Figs. 5 illustrate that the plain concrete specimen was compared with the experimented by the primary examination through the 2-dimensional analysis using Midas.

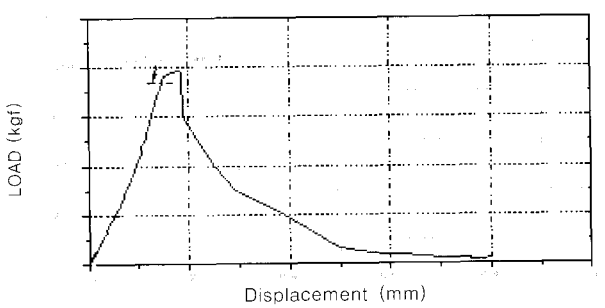

Fig. 4. Relationship of the load-displacement

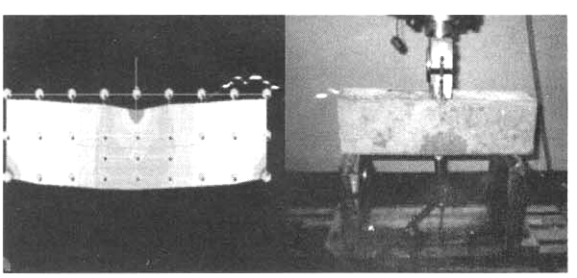

Fig. 5. Analysis of Midas and Experiment

Glass pipe of material properties were applied to the central part of 10x10x40 specimen. Actual load used the coefficient in the experiment. Figs. 6 illustrate an analysis result.

3.2 One type repair system experiment

Fig. 7 illustrates two-type repair system of epoxy, a

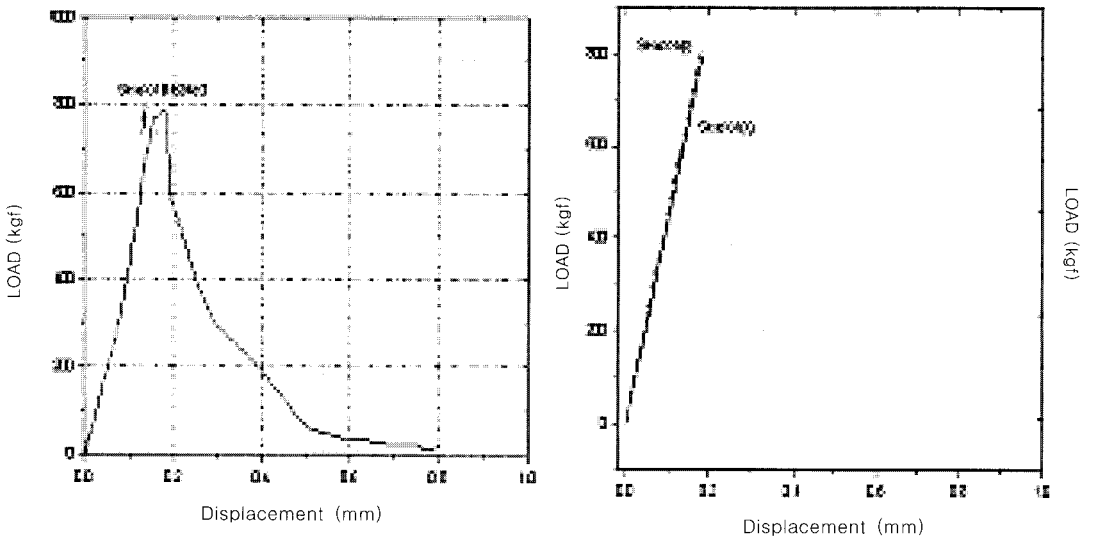

Fig. 6. Experiment and analysis result

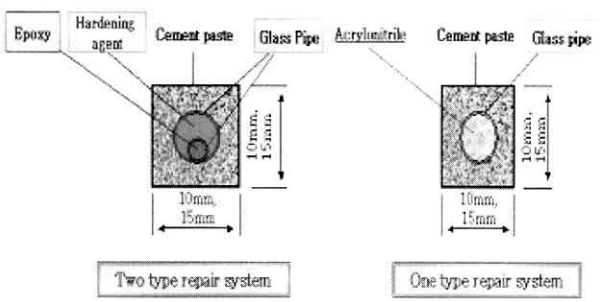

Fig. 7. Design of repair system

hardening agent and one type repair system of acrylonitrile.

Acrylonitrile became polymerization through out the Polyacrylonitrle. Polyacrylonitrile is the substances that become the function of a repair system. Bending test is on a par with a primary experiment. Fig. 8 illustrate that internal force was restored partially. However, it was concluded that it is difficult to prevent a crack but it is possible to delay its process.

3.3 Using Cement Paste repair system in the third experiment

A glass pipe is used, while cement past to the diameter 10mm glass pipe and putting water into 4mm glass pipes.

In the experiment using the glass pipe with the repair function adapting cement mortar, when an apparent glass pipe was previously damaged by the crack, strength improvement did not occur. When an internal glass pipe was destroyed previously, it appeared with internal cement being hardened and demonstrating strength improvement by effect of fulfill.

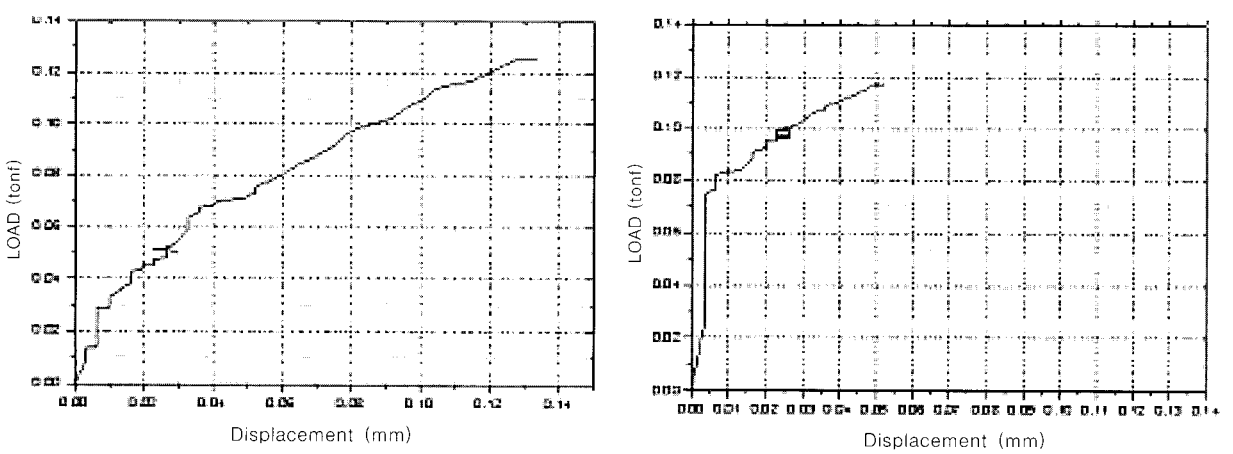

Fig. 8. Repair action before and after in specimen

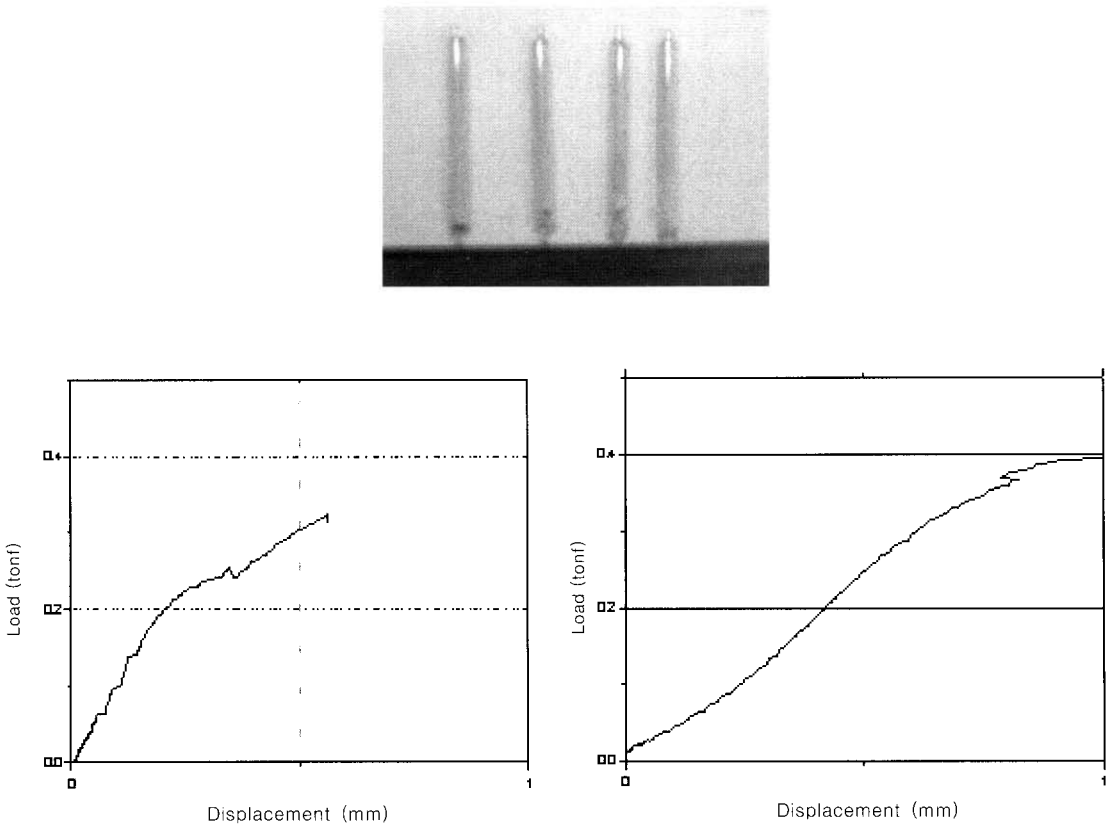

Fig. 9. Repair action before and after in specimen using cement paste repair system

4. Conclusion

In the developing of a concrete that has self-diagnose of damages, the following conclusions were drawn.

(1) When the concrete was inserted in the glass sensors, self-diagnosis could be detected, upon the application of external force at an early crack progress.

(2) By noticing oneself damage, it is considered in order to control progress of a crack as a repair system which can be used for the sensor of oneself repair if acrylonitrile is used together with a shear sensor, although using epoxy was difficult for two type repair system in the case of difficult churning.

(3) The occurrence of the shear crack can be noticed using fluorescence and eradiation substance with the internal solution of a shear sensor.

(4) When an internal glass pipe was destroyed previously, it appeared with internal cement being hardened and demonstrating strength improvement by effect of fulfill.

Acknowledgement

This research is a part of result depended on research cost support with the 2003 Smart Infra-Structure Technology Center and Ministry of Science & Technology.

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