

## Structural Safety Diagnoses and Repair Designs for HANARO's peripheral Buildings

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### 1. Introduction

Structural safety diagnoses and repair designs for peripheral buildings around the HANARO reactor building have been done.[1,2] The peripheral buildings consist of the irradiated material examination facility (IMEF), radioisotope production facility (RIPF), post irradiation examination facility (PIEF) and underground box culvert (UBC). These building structures have been here for over 15 years. Unlike usual buildings, these include a radiation control area and there are complex inner paths, radiation test equipments, hot cells, pool and some special utilities in these buildings. Considering the importance of these buildings, it is required to manage the buildings more safely and actively. We intend to extend the structural service life and improve structural safety to the utmost after making the repair plans and evaluating the structural integrity.

### 2. Structural Safety Diagnoses

HANARO's peripheral buildings - the IMEF, RIPF, PIEF and UBC were checked out through the exterior inspection and the precise examination and even structural integrity evaluation when it was necessary. We grasped the deterioration records thoroughly and also put the check-up data in document and drawing.

The main external inspection includes the group crack of masonry mortar, the crack over the allowable width, the concrete exfoliation, the exposure of reinforced bar, the status of the paint film, etc. The precise examination contained the crack depth measurement of the concrete structure, the nondestructive strength measurement, the investigation of reinforced bar, the neutralization, salt contents, the differential settlement, the paint film thickness measurement of the steel structure. The design classification category and construction year for the peripheral buildings are shown in Table 1. Where, the safety classification, NA is the structure related to the safety.

Table 1 Design Classification and Category

	Safety C	Seismic C	Quality C	Construction Y
IMEF	NA	I	Q	1995
RIPF	NA	II	T	1995
PIEF	NA	I	T	1985
UBC	NON	NON	S	1995

#### 2.1 Irradiated Material Examination Facility (IMEF)

Many deterioration phenomena have been found through an exterior inspection and precise examination. There were the wall finish crack, the exposure of reinforced bar, the paint exfoliation, the damage of bottom joint part, the finish mortar damage at the roof in the exterior of buildings. In the interior of the building, on the other hand, the shear direction and vertical crack generated at concrete wall were found in the controlled area and the masonry crack, the vertical crack of the shear wall were found in the non-controlled area. But any damage by the excessive external force and the differential settlement were not found.

The result of the crack depth measurement showed that the depth of the cracks in some sections were deeper more than the thickness of the coating of reinforcing bar. We need to repair them properly for effective structural maintenance and good durability because they are a cause of the decrease of durability. It is important that after repairing the only group crack parts of the roof we waterproof on the whole roof area. And for the outer wall of a structure, it is desirable that we repaint the whole outer wall for a fine view after repairing the deterioration phenomena such as cracks, the exposure of reinforced bar and the concrete exfoliation.

#### 2.2 Radioisotope Production Facility (RIPF)

For the exterior of the building, the wall finish crack, the exposure of reinforced bar, the paint exfoliation, the deterioration of external drain pipe, the masonry mortar, the excitation etc were found. For the interior of the building, the aslant direction and vertical crack of the concrete wall, etc. were found in some sections of the controlled area and the masonry crack was found in the non-controlled area. The shear and the bending crack of 0.2~0.5mm width was found on the girder and the beam in the some sections. The result of the structural integrity check-up showed that the building has a good integrity at the cross section. Also these will not affect on the structural safety. The result of the crack depth measurement showed that the depth of the cracks in some sections were deeper than the thickness of the coating of the reinforcing bar. We need to repair them properly for an effective structural maintenance and a good durability because they are a cause of the decrease of the durability. And for the outer wall of the building,

it is desirable that we repaint the whole outer wall for a fine view after repairing the deterioration phenomena such as cracks, the exposure of reinforced bar, etc.

### *2.3 Post Irradiation Examination Facility (PIEF)*

This building is the oldest one among all the HANARO peripheral buildings. The main deterioration phenomena are the following. In the exterior of the building, finish cracks, the excitation, the paint exfoliation, the efflorescence, the corrosion of the drain pipe and the other utilities (air conditioning angle, inspection ladder, plate), the crack and damage of the roof waterproofing layer were found. For the interior of the building, the small crack and secession of concrete shear wall, the paint exfoliation were found in the basement of the controlled area and the masonry crack of wall was found in the non-controlled area. We judge that the concrete secession of the internal wall was not caused by an external force but by defective materials and it was not as serious as it had good structural integrity. But we need to repair them properly for effective structural maintenance and good durability. The damaged parts on the bottom of the roof layer have to be waterproofed. And for the outer wall of the building, it is desirable that we repaint the whole outer wall for a fine view after repairing the deterioration findings.

### *2.4 Underground Box Culvert (UBC)*

The main deterioration phenomena are the vertical crack of the wall, the leakage of water and the efflorescence, the exposure of reinforced bar, the concrete exfoliation, the corrosion of the pipe support structure and the steel plate, the leakage of the joint parts and damage. There were not any damages by excessive external forces or differential settlements. Water was leaking from connection joints in some sections during examination period. Cracks more than 0.2mm on the structure were caused mostly by shrinkage. We judge that it was not as serious as it had good structural integrity. The result of the crack depth measurement showed that the depth of the cracks in some sections were deeper than the thickness of the coating of the reinforcing bar. We need to repair them properly for effective structural maintenance and good durability because they are a cause of the decrease of durability. It is required to execute the rust-proofing treatment and repaint the whole corrosion parts on the pipe support structure and the steel plate to improve durability. The efflorescence and exposure of the reinforced bar on some concrete sections will be repaired. And it is desirable that the corrosion parts on the steel cover, inspection ladder, ventilation fan be repainted for good serviceability.

## **3. Repair Design**

We have the following to repair: the crack of a concrete structure over 0.2mm, the masonry crack over 0.3mm, the clearance of the building connection part, the efflorescence, the exfoliation, the exposure of reinforced bar, the separation of materials, the damage of the roof floor, deterioration of the drain pipe, the crack of painting and the excitation part. To repair each deterioration phenomenon, we're going to use injection method for the crack of a concrete structure over 0.2mm, filling method for the masonry crack over 0.3mm, the surface treatment method for the efflorescence parts, the cross section-recovery method for the separation of materials, the exfoliation parts, the recovery method after rust-proofing for the exposure parts of reinforced bar, the waterproofing method for the damage parts of the roofs. For the painting crack of the steel surface and the painting excitation, we're going to process with the painting repair method of the steel surface and then repaint them. We will apply ARC waterproofing method especially for the waterproofing of the joints in underground box culvert.

## **4. Conclusions**

The exterior inspection and the precise examination for each building showed that it was mostly in good condition, within a tolerance limit. In the structural safety evaluation, every building had an estimated cross section force strong enough to hold up the buildings. Based on all the results of the exterior inspection, the precise examination and structural analysis, even though there were partial damages such as cracks over 0.2mm, a leakage of water, efflorescence and exposure of a reinforced bar, they maintain good structural integrity. But to extend the durability and the structural service life of each building, it is required to conduct repair works based on the repair design according to the structural safety diagnosis and to have continuous interests for their maintenance.

## **REFERENCES**

- [1] Jeong-Soo Ryu, Technical Specification for Structural Safety Inspection and Diagnosis, Repair Design of Buildings around HANARO, HAN-SE-DD-SP-08-002, May, 2008.
- [2] KAERI and Shinhwa Eng., Final Report for Structural Safety Diagnoses and Repair Designs for HANARO Peripheral Buildings (IMEF, PIEF, RIFP, UBC), Oct., 2008.