Rainfall Infiltration Analysis for the Near-Surface Radioactive Waste Disposal Facility

Jin-Kyu Choi* and Han-Jeong Na
KEPCO E&C, 269, Hyeoksin-ro, Gimcheon-si, Gyeongsangbuk-do, Republic of Korea
*cjk@kepco-enc.com

1. Introduction

The near-surface type of repository is selected to the second phase of LILW disposal facility in Korea. Compared to the silo-type cave disposal facility, which was applied to the first phase of LILW disposal facility, the disposal cover for near-surface disposal facility should be designed to prevent rainfall from infiltrating into the waste package in disposal vaults.

The rainfall infiltration analysis for near-surface disposal facility in Korea is performed using Visual HELP Code (Hydrologic Evaluation of Landfill Performance) which is used to evaluate hydrologic behavior of percolated rainfall through disposal cover.

2. Concept of Disposal Cover Design

The design of disposal cover for near-surface disposal facility is developed based on the internationally proven technology which is applied for various near-surface repositories around the world.

Since the disposal cover consists of several types of layer such as unsaturated soil, water proof barrier and membrane, it prevents rainfall from infiltrating into waste package in disposal vaults. The conceptual section diagram is shown in Fig. 1.

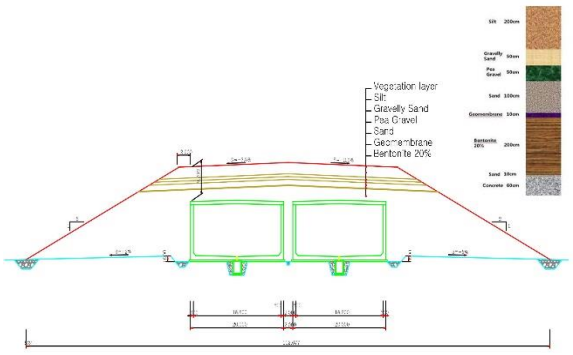

Fig. 1. The conceptual section drawing for near-surface radioactive waste disposal facility.

The performance of disposal cover will be decreased upon the time elapsed, and infiltration rate to waste package will be consequently increased. Since the disposal cover is monitored and repaired, the performance of disposal cover will be completely maintained for 300 years after the closure (institutional period). After institutional period, it is assumed that the disposal cover will be completely degraded and will not be able to prevent rainfall infiltration.

For concrete slab, the performance will be maintained until institutional period. The degradation of concrete slab will start after institutional period.

Table 1. The status of disposal cover and concrete slab

Phase	Period	Disposal cover	Concrete slab
1	Closure ~300 years	Maintain structural integrity	Maintain structural integrity
2	300 years ~ Degradation of concrete	Degraded	On degradation
3	Degradation of concrete ~	Degraded	Degraded

The conceptual model for disposal cover system is classified into Types I and II as follows:

1) Type I (Facility closure ~ 300 years after closure) : 3.5% slope

Table 2. The material and function of disposal cover Type I

Layer	Material	Function
1	Top soil (Silt)	Feeding water for plant or grass, maximizing runoff and evapotranspiration and surface erosion control
2	Soil and Gravel	Moving down infiltration water. Surface erosion control. Prevent penetration of small particles to sand layer
3	Gravel	Control the hydraulic head and prevent penetration of roots or underground animals

4	Soil	Drain infiltration water to planned drainage channel. Prevent the increase of hydraulic head.
5	Geomembrane	Prevent infiltration water
6	Bentonite(20% of sand)	Prevent infiltration water as a Hydraulic barrier
7	Soil	Same as layer 4
8	Concrete Slab	Prevent infiltration water

2) Type II (1,185 years after closure ~) : No slope

Type II has only three layers (layer 1, 7, 8 of Type 1) and no slope. It is assumed that the layers are degraded after institutional period. The concrete slab is also degraded, and related input data are applied after degradation.

3. Rainfall Infiltration Analysis Results

The monthly average climate data during 1981~2010 in Wolsung site where the facility are located is used for this analysis. The Visual HELP creates the weather data for 100 years (maximum) using weather generator in the code.

The analysis results for disposal Types I and II for specific plan are described in Table 3.

Table 3. The annual average rainfall infiltration analysis results

Model Type	Percolation or Leakage (mm/yr)
I (%)	0.01977 (0.0016)
II (%)	435.98 (34.4)

4. Conclusion

Most of rainfall is blocked with evaporation rate and infiltration rate to waste package in disposal vaults is very low for Type I. By contrast, about 35% of rainfall passes through the disposal cover and concrete slab due to change in material characteristics by degradation. As the rainfall infiltration analysis results, the disposal cover which has the function of hydraulic barrier is strongly required to prevent rainfall from infiltrating into waste package for near-surface radioactive waste disposal facility. The analysis results can be utilized to the analysis for potential radiological release from the waste package to the environment or input data for the associated drain system in the facility.

REFERENCES

[1] NCRP/CR-4370, Vol.1, Update of Part 61 Impacts Analysis Methodology, U.S.NRC, 1988.

[2] U.S.DOE/LLW-73T, Prototype License Application Safety Analysis Report Earth-Mounded Concrete Bunker, Ebasco Service.

[3] U.S. New York State LLRW siting Commission, Disposal Method Evaluation Procedures, Rogers & Associates Engineering Corporation and Golder Associates, Inc., 1994.

[4] IAEA, ISAM, the International Programme for Improving Long Term Safety Assessment Methodologies for Near-surface Radioactive Waste Disposal Facilities, 2001.