Analysis of Individual Accident Scenarios for Dry Storage System

Hyungyu Roh [a*], Eun-ho Lee [a], Chiwoong Ra [a], Junghyun Kim [a], No-Cheol Park [a*]
[a]*Department of Mechanical Engineering, Yonsei University, Republic of Korea*
[*]*Corresponding author: pnch@yonsei.ac.kr*

1. Introduction

Due to the increasing saturation of wet storage facilities for Spent Nuclear Fuel(SNF) within nuclear power plants, the need for independent storage facilities outside the power plant is increasing as an intermediate disposal step for long-term storage until final disposal. For this reason, dry storage system is being widely developed around the world. Spent Nuclear Fuel(SNF) is transported using dry storage system and must demonstrate safety in the event of an accident scenario during transportation[1], [2]. In particular, for canisters, which are metal containers used to load and seal spent nuclear fuel, it is necessary to minimize damage in the event of a falling accident.

2. FE Analysis and Results

In this paper, a finite element model of a dry storage system was constructed as show in Fig. 1, and the response of the structure to impact during a falling situation in transportation accident scenarios was analyzed.

2.1 Dry Storage System Model

Dry storage system is composed of internal components including fuel, a canister, a cask, and a impact limiter. Detailed modeling was performed for structures that are expected to have a significant impact on the dynamic characteristics and response to impact loads for each component.

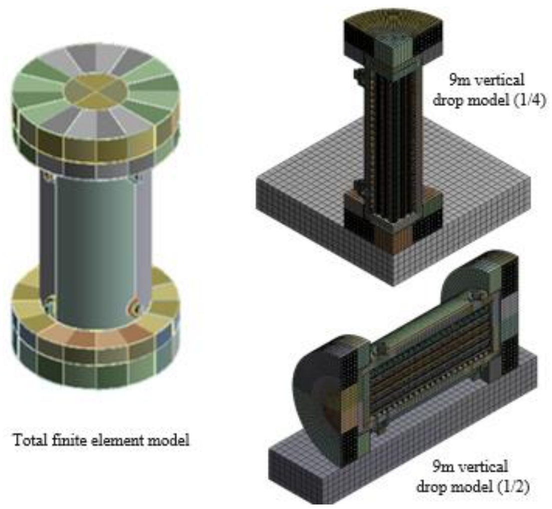

Fig. 1 FE model for dry storage system

2.2 Material Properties

The material properties of the dry storage system was used as a basis for the mechanical properties, and an analysis model was constructed by inputting the material properties for each component of the cask, canister, and impact limiter. For the wood material used in the impact limiter, the Stress-Strain curve was input based on actual test results and applied to the analysis[3].

Table I: Material by Dry Storage System Part

Component	Material
Cask	SA-350 GR. LF3
	SA-182 GR. F6NM
	SA-240 TP.304
	NS-4-FR
Canister	SA-240 TP. 316L
	SA-240 TP. 304
Impact Limiter	Balsa Wood
	Red Wood

2.3 Finite Element Analysis

Based on the established analytical model, finite element analysis was conducted for accident scenarios of a dry storage system. The accident scenarios include a 9 m vertical free fall, a 9 m horizontal free fall, a 9 m oblique free fall and a 1 m vertical and horizontal penetrating fall. After analyzing each scenario, a Stress-based evaluation was conducted to evaluate the safety of the dry storage system in the event of a fall accident. The analysis results for each accident scenario by component of the dry storage system are shown in Fig.2 below.

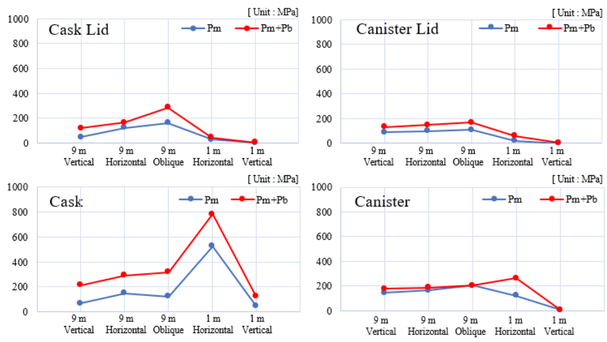

Fig. 2 Stress intensity evaluation for each part

According to the analysis results, it was confirmed that the accident scenarios of a 1 m horizontal penetrating fall and a 9 m oblique fall would cause the most significant damage to the dry storage system.

3. Conclusions

The response of the dry storage system was analyzed by conducting stress-based evaluation through non-linear impact analysis for various accident scenarios. The obtained results will be used to develop structural improvements and assess cumulative damage that may occur for the dry storage system in the future.

4. Acknowledgements

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