Enhanced Earthquake-Resistance on the High Level Radioactive Waste Canister

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1. Introduction

In the underground 500m depth, the high level radioactive waste disposition system is made by bored the tunnel in the base rock and putted the high level waste disposal canister that is the surrounding the form with the buffer material as show in Fig.1. According to many statistics, it is the tendency that the earthquake increases in the Korean peninsula every year. Therefore, because the damage which is fatal in the disposal canister can be given in case the earthquake is generated, the method protecting the disposal instrument safely is needed. In this paper, the earthquake-resistance type buffer was developed with the method protecting safely about the earthquake. The main parameter having an effect on the earthquake-resistant performance was analyzed and the earthquake-proof type buffer material was designed. The shear analysis model was developed and the performance of the earthquake-resistance buffer material was evaluated.

Fig. 1 The high level radioactive waste disposal system.

2. Numerical Analysis of the Shear Mdel

The shear rate due to earthquakes with magnitudes greater than 6.5 averages around 0.8m/sec, and the calculated shear displacement is 0.079m[1~2]. Taking this into account, this paper focuses on the fault movement with displacement in the order of 0.1m and shear rates of about 1m/sec.

2.1 Numerical model

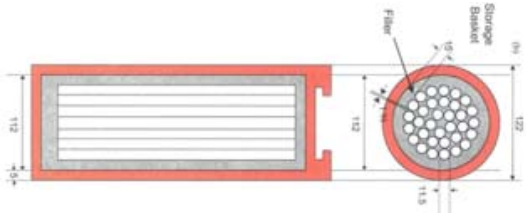
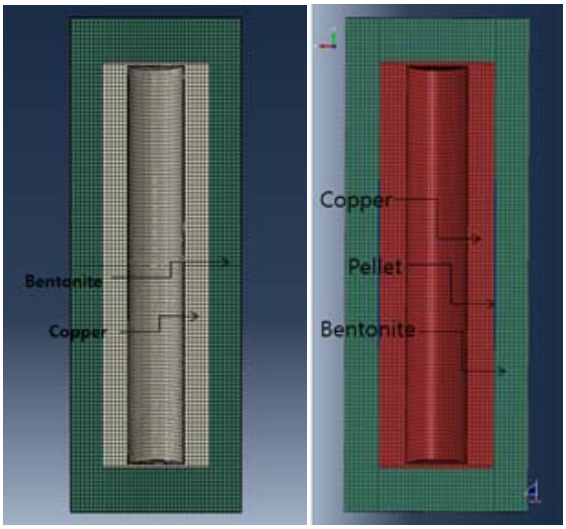


Fig. 2 CANDU disposal canister

A disposal canister can be divided with the ceramic disposal canister, PWR disposal canister and CANDU disposal canister. Because the length is longer than the diameter in the case of CANDU disposal canister, the structurally week CANDU disposal canister was selected to develop the 'earthquake-resistance buffer'.

The reliability of the numerical model is tested by comparison with the available range of experimental results[2]. The 3-dimensional, non-linear, finite element model utilizes the computer code ABAQUS.

Fig.3 shows the numerical model. To improve the earthquake-resistance performance, we designed the buffer by putting the low density buffer between the canister and buffer as shown in Fig.3(b).

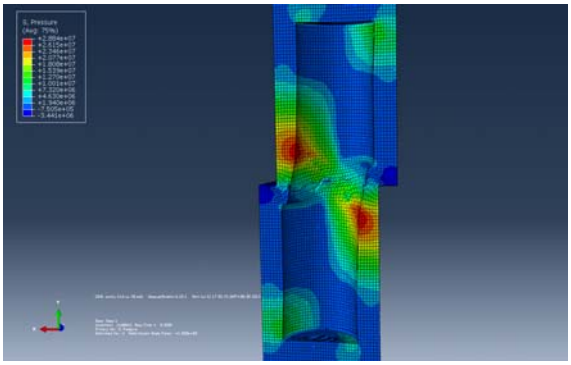


(a) (b)

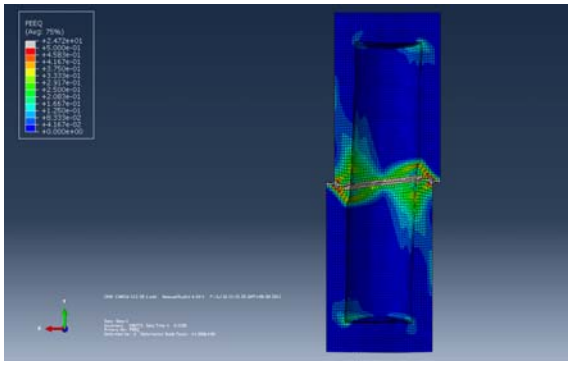
Fig. 3 ABAQUS analytic model for (a) the general buffer and (b) the earthquake-resistance buffer.

2.2 Numerical results

Fig. 4 shows the pressure distribution and the strain distribution on the buffer when the earthquake is generated. The strain was greatest in the base rock electrolytic dissociation, and the pressure is max in the surrounding.

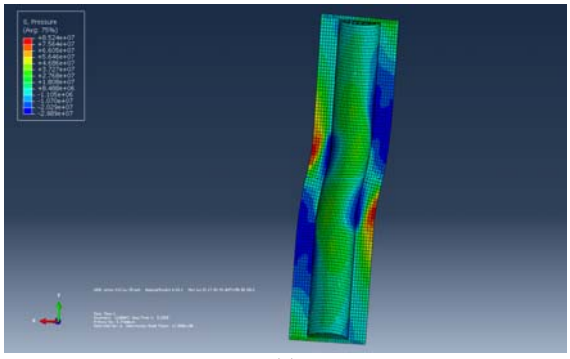


(a)

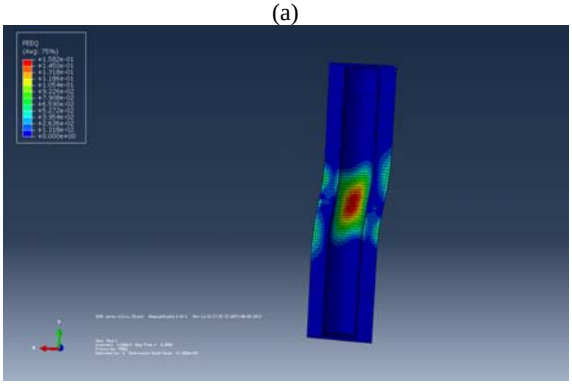


(b)

Fig. 4 ABAQUS analytic results in the case of the earthquake-resistance buffer (a) Pressure distribution and (b) Strain distribution on the buffer



(a)



(b)

Fig. 5 ABAQUS analytic results in the case of the earthquake-resistance buffer (a) Pressure distribution and (b) Strain distribution on the canister

Fig. 5 shows the pressure distribution and the strain distribution on the canister when the shear displacement is 0.3m. Particularly, the rapid strain rate showed up in the central of the disposal canister.

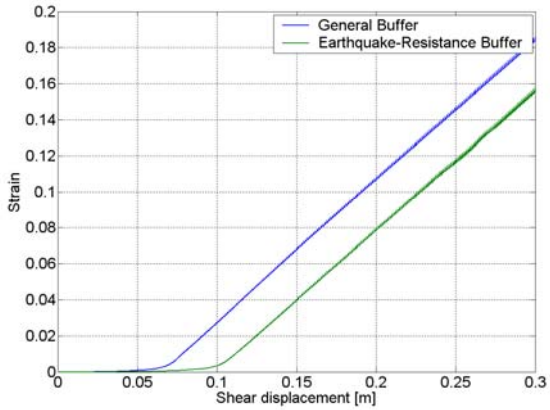


Fig. 6 The earthquake-resistance performance comparison result between the general buffer and the earthquake-resistance buffer

Fig. 6 shows the earthquake-resistance performance comparison result between the general buffer and the earthquake-resistance buffer. The strain indicates the value where is the maximum strain on the disposal canister. In case the general buffer is used, the disposal canister is damaged when the shear displacement is 0.06m. In the case of the earthquake-resistance buffer, the canister is not damaged although it is displaced about 0.1m. It confirmed that the earthquake-resistance performance of the earthquake-resistance buffer was improved about 80% in comparison of the general buffer.

3. Conclusions

The dynamic behavior of the radioactive waste disposal canister was analyzed in case the earthquake was generated. In the case, the disposal canister gets the serious damage. In this paper, the earthquake-resistance buffer material was developed in order to prevent this damage. By putting the buffer in which the density is small between the canister and buffer, the earthquake-resistant performance was improved about 80%.

REFERENCES

[1] Morimasa NAITA et. al., Experimental Study on the Effects of Fault Movement on the Engineered Barrier System, Journal of Power and Energy Systems, Vol.3, p. 158, 2008.
[2] Y.C, Choi et. al. Development of a Earthquake-Resistance Buffer, Technical Report, KAERI/TR-5489/2014, 2014