The Study of Internal Impact Limiter for Reduction of Acceleration Load of Content Inside the Cask

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1. Introduction

Rubber is a material commonly used in many places today. It is mainly used as a means to reduce vibration and shock. But rubber can't be often used for transport cask of spent nuclear fuel. It's because of the high heat and radiation of the spent nuclear fuel. However, the rubber is preferentially applied to fresh fuel or low and intermediate level radioactive waste transport cask.

Therefore, this study suggests an internal impact limiter using rubber as a means to reduce the impact transmitted to the content under the normal condition for transport.

2. Transport Cask Structure Analysis

2.1 Transport Cask Model

The transport cask used in this study is a virtual transport cask aimed at transporting radioactive material. The cask, as shown in fig.1 consists of a basket containing the radioactive material, a cask containing the basket and an impact limiter to reduce the external impact. The shielding material was not reflected. The outer dimensions of the cask are 690 mm in diameter, 1250 mm in height, 1,270 kg in weight, and the cask is 25 t thick.

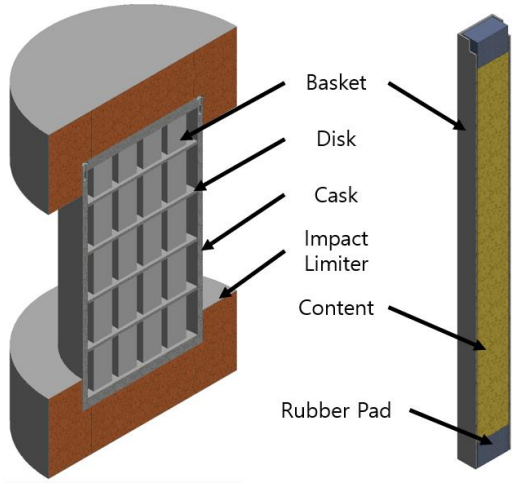

Fig. 1. transport cask model

The impact limiter measures 1,100 mm in diameter, 400 mm in height, weighs 111.5 kg, and the skin has a thickness of 2 t.

2.2 Analysis Model and Condition

In the drop analysis using the cask, ABAQUS, a finite element analysis program, was used. Because the transport cask analysis model is symmetrical, it is composed of 1/2 model.

The shell element was used for the thin plate of impact limiter and the basket of the cask's internal structure, and the rest was modeled using solid element. The drop analysis model can be seen as fig.2.

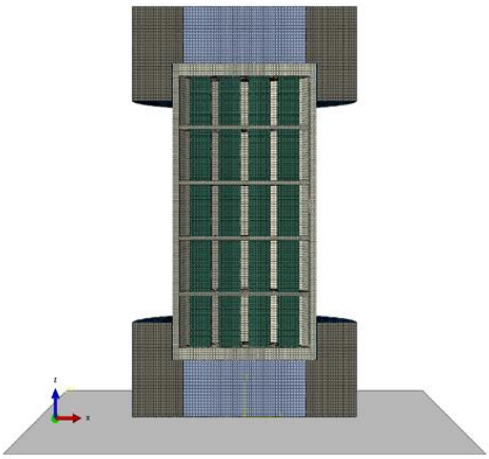

Fig. 2. FE model of transport cask

It is assumed that the bolt bond between the cask and cask lid and the bolt bond between the cask and impact limiter are perfect bond, so the bolt is excluded from the modeling. Internal contact of the cask reflects the general contact conditions. As the boundary condition, the axial symmetry condition is given because the cask is 1/2 model, and the unyielding surface was designated as the rigid surface without yielding.

As the load, the gravity and the initial velocity of 4.852 m/s when free drop at 1.2m height are applied.

The drop analysis of the cask is analyzed by the vertical drop and the moment of horizontal crush between the rigid surface and the bottom surface of the cask is

interpreted. The total analysis time is 20 ms.
The drop analysis is performed for rubber pad thicknesses of 70, 50, and 30 mm, respectively, and for the support material of rigid.

2.3 Material Properties

The cask, cask lid, impact limiter and internal structure are made of SA-240 TYPE 304 material. The properties of Balsa Wood are shown in Table 1. The material properties of rubber were taken from the data of uniaxial compression test. Those can be seen is fig. 3.

Table 1 Balsa Wood Property

	Elastic modulus(MPa)	Density (Kg/m^3)	Poisson's ratio
Parallel to grain	146.7	151	0.27
Perpendicular to grain	3796.9	151	0.27

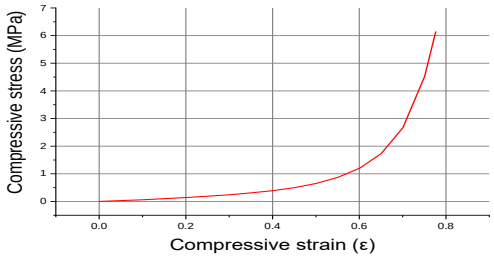

Fig. 3. stress-strain curve of rubber

2.4 Result

The acceleration values obtained by performing each drop analysis are normalized and shown in Table2.

Table. 2. Result of Analysis

Material	Height (mm)	Normalized Acceleration(g)	Compression ratio
Steel	70	1	-
Rubber	70	0.283	0.23
	50	0.318	0.25
	30	0.424	0.28

When the rigid material support is used, the maximum acceleration value generated in the package is 1, and the acceleration value obtained in the package when the rubber pad is applied is the ratio. Butterworth filters in ABAQUS were filtered using a cut-off frequency of 1000 Hz, and acceleration values were obtained at a constant location of the package.

When rubber pads are used, the acceleration load transmitted to the internal package can be seen to decrease by more than 60 ~ 70%.

3. Conclusions

Too thin rubber pads have a low reduction ratio, while thicker rubber pads increase the weight of the cask, so finding the appropriate thickness and gap is very important.
If rubber material is developed to improve heat and radiation resistance, it is expected to be used more in the transport cask field. In the future, perform the study the influence of rubber deformation to basket.

REFERENCES

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[3] The American Society of Mechanical Engineers, ASME Boiler & Pressure Vessel Code, section II, Part D, ASME (2010).