

Safety assessment of a nuclear power plant building subjected to an aircraft crash



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HIGHLIGHTS

- Numerical analysis of a nuclear auxiliary building under aircraft crash is conducted.
- The analysis result of impact force is verified using the Riera function.
- The safety assessment is performed with regard to different impact scenarios.
- Discussions and conclusions on safety of the nuclear building are presented.

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ABSTRACT

This paper presents a safety assessment of a nuclear building subjected to an aircraft crash using numerical analysis. For impact simulation, the reinforced concrete (RC) Primary Auxiliary Building (PAB) of the Korea Standard Nuclear Power Plant (KSNP) is fully modeled and an aircraft model of a Boeing 767–400 is used. The Riera function is used to verify the analysis result of impact force–time history. The IRIS test is used to verify the structural behavior of the RC wall under impact loading. The safety assessment of the building is performed with regard to different impact scenarios. The safety of the nuclear building under aircraft crash, including (1) global structural safety, (2) local structural safety, and (3) vibration safety are evaluated and discussed. The results show that the global and local structural safety of the PAB is ensured in all impact scenarios. However, the vibration safety of the building is not ensured. In accordance, the regulatory guide of United States Nuclear Regulatory Commission (U.S. NRC), shutdown of the nuclear power plant is required.

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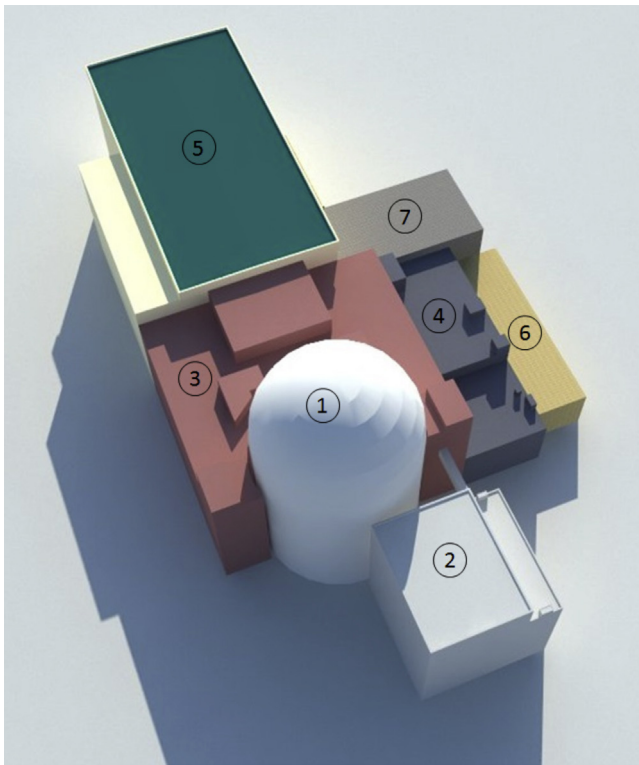
1. Introduction

A safety standard on external events, including an aircraft crash, in the design of nuclear power plants has been established by the IAEA (2003). Although the IAEA's safety standards are not legally binding on member countries, it is recommended that they adopt and apply for NPP safety assessment in national regulations. According to the IAEA's safety standard, in an evaluation for an aircraft crash, the following issues should generally be considered: (1) global structural damage, (2) local structural damage, (3) functional failure of structures, systems and components (SSCs) due to induced vibrations in structural members and safety related equipment, and (4) the effects of fuel-initiated fires. A safety assessment

of the A92 reactor building under a large commercial aircraft crash was carried out by Kostov et al. (2014).

Many researches focused on the numerical analysis of a nuclear power plant under an aircraft crash. Different types of nuclear containment buildings subjected to various aircraft crashes were studied by Frano and Forasassi (2012), Sadique et al. (2013), and Lee et al. (2013). Arros and Doumbalski (2007) performed an analysis of a fictitious nuclear building subjected to a Boeing 747–400 aircraft crash. In Arros' works, the comparison of impact force–time history between the Riera function and numerical analysis was carried out, and sensitivity studies were also conducted. Thai et al. (2014) also studied the structural behavior of a simplified model of a fictitious nuclear building under a Boeing 767–400 aircraft impact. In Thai's works, the effects of the horizontal and vertical rebar ratio and the number of rebar layers on the structural behavior of the nuclear building were investigated. Although there were several studies on nuclear building under aircraft crash, the safety assessment of an auxiliary nuclear building has not been carried out.

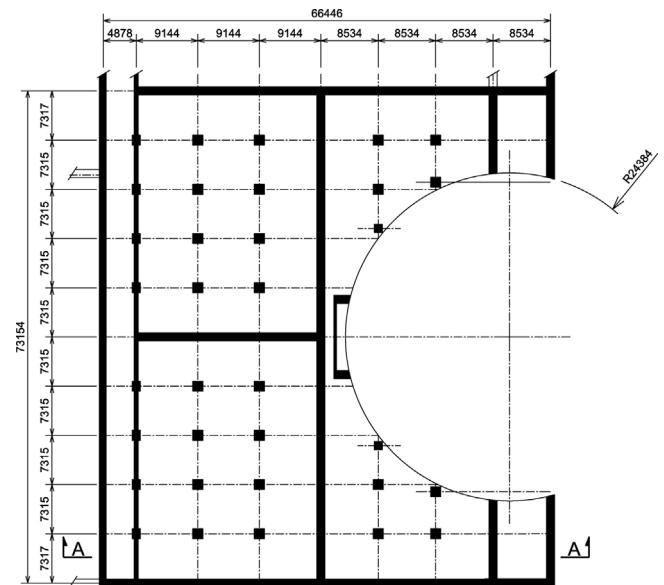
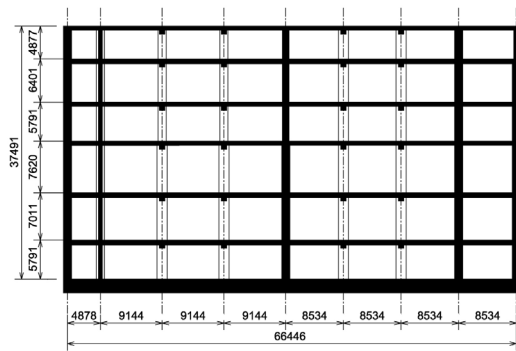
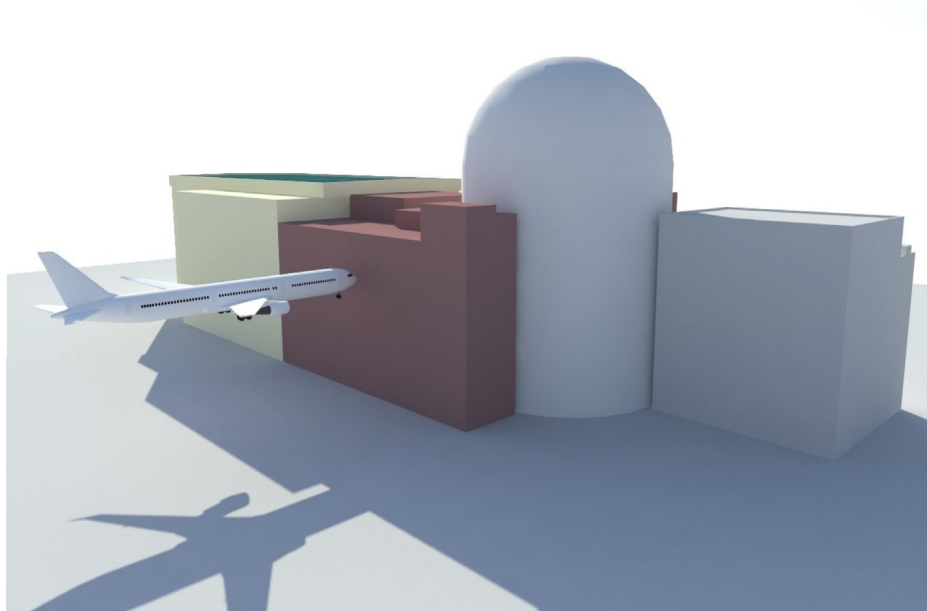
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**Note:**

- | | |
|------------------------------|---------------------------|
| 1 Containment | 5 Turbine Building |
| 2 Fuel Building | 6 D/G Building |
| 3 Primary Auxiliary Building | 7 Access Control Building |
| 4 Second Auxiliary Building | |

Fig. 1. Korea Standard Nuclear Power Plant.

The KSNP type shown in Fig. 1 has been widely constructed in Korea (Park and Hong, 2009). In this study, a safety assessment of the PAB of the KSNP subjected to Boeing 767-400 aircraft crash is performed using the finite element analysis approach. The LS-DYNA program is used for the numerical analysis. The impact force–time

**(a)** Typical floor plan of the building**(b)** Cross section A-A**Fig. 3.** Typical floor plan and cross section of the Primary Auxiliary Building.**Fig. 2.** Aircraft crash on the Primary Auxiliary Building.

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