Modified Design of Mobile 3.95 MeV X-band Linac Neutron Source for On-site Social Infrastrure Moisture Detection

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Abstract

The mobile linac driven neutron source for moisture inspection of concrete structure was developed and has been improved, the estimated detection time is about 1 minute and its weight is reduced greatly so that it can be managed by human strength.

Keywords : Neutron Source, Mobile Electron Linear Accelerator, Social Infrastructure Inspection, Moisture Detection

1 Introduction

The existing non-destructive inspection method using high energy X-ray for social infrastructures is aimed to detect the inner flaw in concrete structure and iron rods.
In addition to the conventional method, development of an innovative inspection system using mobile neutron source to perform neutron backscatter moisture detection to measure moisture distribution in concrete structure is progressing, in order to estimate the corrosion probability distribution of iron rods.

2 Outline of the neutron source

Beryllium, having the lowest threshold energy for (γ, n) reaction, is combined with a lead beam collimator, a boric acid resin layer for neutron shielding and a lead layer for γ-ray shielding (Fig.1).
The Be target and 3.95 MV mobile X-ray source compose a mobile neutron source system. The optimization of Be thickness, the neutron/γ-ray shielding simulation, and neutron flux computation was done by using Monte-Carlo method.

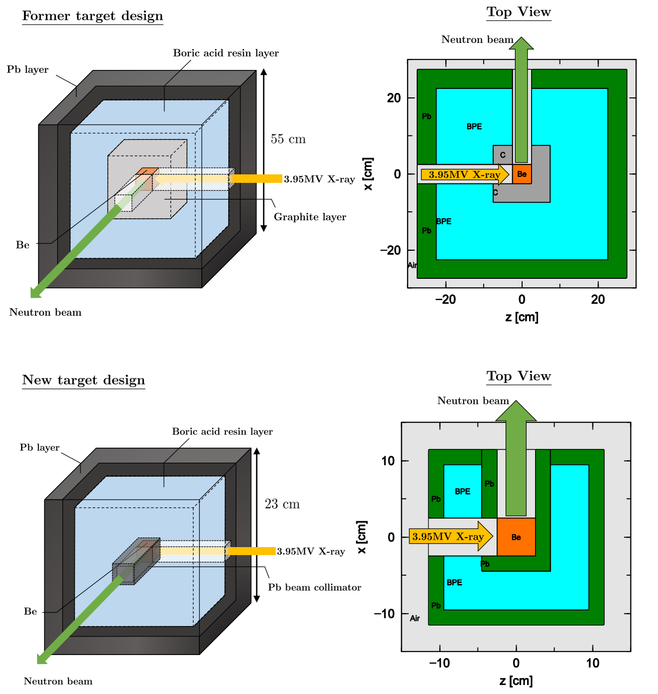

Fig. 1 Former and new design of the neutron source

3 Simulation result and discussion

The calculated neutron flux in the newly designed neutron source is 7.13×10^6 n/s, increased by a factor of 10 compared to our former design neutron source (Table 1). The old design neutron source succeeded in detecting the moisture of concrete structure (Fig.2), however, the detection time and its weight was a problem.
In our new design, the estimated detection time is approximately 1 miute, and the target weight is reduced to 70 kg. The radiation safety is sufficient even after the target shield reduction.

Table 1 Comparison of former and new design of the neutron source

		Former	New
Total yield	(n/s)	2.79×10^5	7.13×10^6
Flux	(n/cm^2/s)	1.86×10^3	4.76×10^4
Weight	(kg)	1500	70
Detection time	(min)	30	1

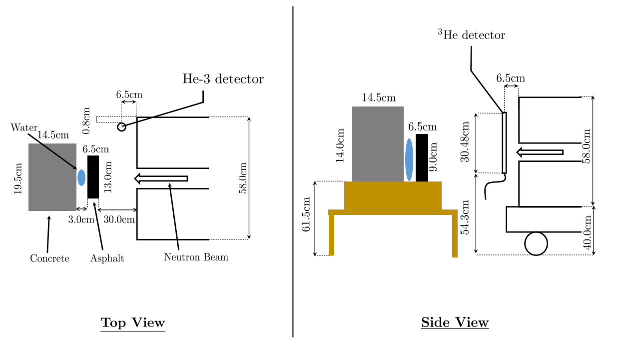

Fig. 2 Setup of the moisture detection experiment

4 Summary & Future work

The new target design has larger neutron flux and lighter weight, which makes it much more manageable than the former target design.
As the future work, the moisture detection experiment using the new neutron source will be performed and the radiation safety will be evaluated for actual use.

References

[1] M. Uesaka et al. : J. Phys. B: At. Mol. Opt. Phys. 47(2014) 234008 (9pp)