

Emergency Rescue Apparatus for People with Severe Disabilities

Hyosun Kweon¹, Won-Kyung Song¹, Ki-Hun Cho², Pan-Ju Na³, Kyu Chool Choi⁴, Seoku Kang³, Youngmi Seol³

¹National Rehabilitation Research Institute (Seoul, Korea), ²Korea National University of Transportation (Jeungpyeong, Korea), ³Asia Fire Protection., LTD. (Seoul, Korea), ⁴Tongwon Univ.(Gwangju, Korea)

INTRODUCTION

Increase of accident rate in people with disabilities caused by disaster has been serious problem in all over the world. In 2009 in Korea, two serious disabilities got fire disaster. Even though all of them were able to recognize the fire, they could not escape from the fire because of their lack of mobility capabilities. If people with disabilities cannot walk, for example wheelchair users and bedridden patients, other people have to assist the escape of them. However, it is hard to evacuate them from a building with stairs like people capable of running. Also, most of cities have high-rise buildings and buildings with stairs because of insufficient residential space. For these reasons, some devices are necessary for bedridden patients and people with severe disabilities to escape more fast, safely, easily. So, emergency rescue apparatus, NERIMI-SD for evacuating bedridden patients, people with severe disabilities has been developed. With NERIMI-SD, we can evacuate people with severe disabilities and bedridden patients more fast, safely and easily even in a high-rise building.

PURPOSE

The purpose of this study was to develop the Non-Power Emergency Rescue Apparatus(NERIMI-SD), and to evaluate the effect of the apparatus. With NERIMI-SD, the bedridden patients and people with severe disabilities should be rescued more fast, easily, safely, continuously from fire disaster in a building. To evaluate effect of the NERIME-SD on evacuation time, NERIME-SD was installed at a building.

METHODS

Design concept

It is necessary to have 2 and more assistants for evacuating the bedridden patients from the building with stair only with the existing emergency rescue equipment like stretche, hand carried stair chair, etc. Only one patient could be rescued at one time, the other patient should wait the assistants coming back after transferring the patient to the ground. So, The emergency rescue apparatus, NERIMI-SD, has designed and developed with the followed concept. NERIMI-SD should be operated even in the blackout caused by fire. NERIMI-SD should be operated more easily by 2 people with fewer effort. NERIMI-SD should be operated continuously because a building like hospital, nursing facility could have many bedridden patients and people with severe disabilities.

Development of NERIMI-SD

NERIME-SD apparatus has 2 parts, transfer pocket and transfer support device that lower the pocket. Transfer pocket (shown in Fig 1) is made of frame retarding material like a fire suit. The pocket size is 200(W)*50(D)*30(H) cm. A person laid on a stretcher is put in the pocket. The person with severe disability including bedridden patient



can be transferred by a stretcher from a bed to the place that the transfer support device is installed at the same story of the building. Transfer support device (shown in Fig 2) is installed at each story of a building and in the building wall through an opening like a window. The doors of the transfer support device are closed normally. The device is made with corrosion-resistant steel frames, 2 speed controllers which will be connected the transfer pocket by ropes. The structure can support the weight 150kg maximally. The speed controllers maintain the descend velocity of the pocket within 50~130cm/s and the horizontality of the pocket when falling down.

Operation of NERIMI-SD

As shown in Fig. 3, NERIME-SD operation procedure as like:

1. Put a bedridden patient into the transfer pocket, fasten the safety belt
2. Transfer the pocket to the apparatus
3. Open the door of the apparatus
4. Connect the pocket with two ropes to the support device of the apparatus
5. Push the pocket out of the building
6. The falling pocket is controlled at a speed.

NERIMI-SD uses patient’s weight and descent the transfer pocket, based on the law of gravity. So the apparatus does not need electric power and can be operated even in the blackout. The two speed controllers of NERIMI-SD can maintain the descend velocity within the designed range and the transfer pocket’s balance evenly. The each of two ropes is connected between the speed controller and one side of the transfer pocket. The each rope has one end connected to the transfer pocket, the other end is hanging down through the speed controller. As the transfer pocket goes down, the other ends of the ropes go up. The next transfer pocket can be connected to the other ends of the ropes as soon as the former transfer pocket settle on the ground. Namely, patients can be transferred continuously. NERIMI-SD can be installed at the each story of a building, patients don’t have to go through the stairs, so it can be operated more easily by 2 people with fewer effort.



Figure 3 Operating Order of NERIME-SD

RESULTS

As shown in Table 1, each of 3 subjects tried 5 times to test the NERIMI-SD. On average, the subject with a weight of 86kg can descend within 4.5 seconds at 99.6cm/sec from height of 4.5m. The subject with a weight of 63kg can descend within 5.1 seconds at 88.6cm/sec from height of 4.5m. the subject with a weight of 43kg can descend within 8.4 seconds at 53.7cm/sec from height of 4.5m. NERIMI-SD can control the descend velocity with the range of 50cm/sec ~ 130cm/sec regardless of subjects' weight.

Table 1. Test results

Test No.	Subject Weight(kg)	Falling Distance(cm)	Falling Time(second)	Falling Velocity(cm/sec)	Comments
1	86	450	4.3	104.7	50 cm/sec
	63	450	5.0	90.0	
	43	450	8.3	54.2	

2	86	450	4.5	100.0	130 cm/sec
	63	450	4.9	91.8	
	43	450	8.5	52.9	
3	86	450	4.6	97.8	
	63	450	5.1	88.2	
	43	450	8.3	54.2	
4	86	450	4.6	97.8	
	63	450	5.2	86.5	
	43	450	8.4	53.6	
5	86	450	4.6	97.8	
	63	450	5.2	86.5	
	43	450	8.4	53.6	
Average	86	450	4.5	99.6	
	63	450	5.1	88.6	
	43	450	8.4	53.7	

DISCUSSION AND CONCLUSION

Most people with disabilities have difficulty to escape from the disaster or other accident by themselves. Especially the people on upper than second floor have more risk in emergency. The result of this study shows that NERIMI-SD can be used to evacuate people with severe disabilities including bedridden patients fast, easily, safely from a building having more than the second floor.

Acknowledgements

This study was supported by the grants (14-B-01, No.2015002, 18-A-02) of the Korea National Rehabilitation Center, Ministry of Health & Welfare.

REFERENCES

- [1] Jang JS, Rie DH. A Comparative Study for Dispersion Model in Evacuation Plan by using MAS-based Evacuation Simulation. *Journal of the Korean Society of Safety*. 2014 29(1): 59-63.
- [2] Ko Y, Youn H, Kim J. Equipment design for stairs to evacuate people with a mobility impairment when fire occurs. *Korean Society of Design Science*. 2013 26(1): 339-353.
- [3] Sim G, Park S, Jung S. Research and analysis of disaster prevention measures for vulnerable populations in disasters. Korea National Disaster Management Institute; 2010.
- [4] Kweon H. The effect of developed Non-Power Fire Evacuation Assistive Device on evacuation time of wheelchair users. In R. Simpson (Ed.), *Proceedings of the RESNA 2015 Annual Conference*. Denver: RESNA Press; 2015.