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Development of the Selection of Optimal Conceptual Design for the Noise-reduced Aluminum System Form

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Abstract: In Korea, a series of noise-reduced aluminum forms are being recently used in apartment housing construction. However, their complicated and time-consuming work processes, and the noise which is still generated due to the inherent property of aluminum when especially installing and dismantling them are have been pointed out as a problem to be certainly solved for increasing their practical use in construction sites. The primary objectives of this study are to propose a conceptual design of a newly designed noise-reduced aluminum form in which the noise can be enormously decreased during form works. The conceptual design in this study improved problems of conventional system aluminum forms, and, later, a system aluminum form developed based on this conceptual design will be able to ensure noise-reduction and safety as well as excellent applicability.

Keywords: Conceptual Design, Optimal, Noise-reduced, Aluminum Form

I. Introduction

A. Background

In Korea, a series of noise-reduced aluminum forms are being recently used as a solution for minimizing the noise which essentially occurs when installing or dismantling the conventional aluminum forms in apartment housing construction. However, their complicated and time-consuming work processes, and the noise which is still generated due to the inherent property of aluminum when especially installing and dismantling them are have been pointed out as a problem to be certainly solved for increasing their practical use in construction sites. The primary objectives of this study are to propose a conceptual design of a newly designed noise-reduced aluminum form in which the noise can be enormously decreased during form works. It is anticipated that the noise-reduced aluminum form proposed in this study can not only greatly decrease the noise by fundamentally eliminating the free falling process required when especially dismantling the slab forms but also reduce the safety concerns of construction workers. Finally, conclusions and recommendations are made concerning the value of practically using the newly designed noise-reduced aluminum form.

B. Scope and Method

To propose a conceptual design for noise-reduced aluminum system form and select the optimal conceptual design, the research used the following method:
1) By analyzing components of major system aluminum forms in Korea, the study proposed a conceptual design for a noise-reduction system aluminum form.
2) Evaluation items were chosen to select the optimal conceptual design and advantages and disadvantages of the proposed conceptual design of a noise-reduced aluminum system form were analyzed.
3) Based on a trade-off analysis, the optimal conceptual design for a noise-reduced aluminum system was selected.

II. Proposal of a Conceptual Design for Noise-reduced Aluminum System Form

In this study, by analyzing strengths and requested improvements of an existing system aluminum form, three factors for improved productivity, i.e., 1)reduction of hitting noise by minimizing the hinge, 2)prevention of free fall of materials based on step-by-step descent of the beam and slab, 3)and simplification of the descent and dismantling process during installation and dismantling of forms were taken into account in designing a concept for a system aluminum form that ensures noise-reduction and safety. Based on the above three considerations, a conceptual design for a system aluminum mold that ensures noise-reduction and safety was created in the following three forms (ALT1, ALT2, ALT3):

A. Noise-reduced Aluminum System Form with a Drop-Down Floor Post and Adaptive Beam

The noise-reduced aluminum system form with a drop-down floor post and adaptive beam performs descent based on combination of drop-down floor post, middle beam, and adaptive beam. And the drop-down floor post is inserted through the punch station, which is in the middle between the middle beam and adaptive beam, to enable elevation and descent of the floor post(Fig. 1-a).

B. Noise-reduced Aluminum System Form with Lattice Beam and Pulley

The noise-reduced aluminum system form with lattice beam and pulley was designed in a way that connects a lattice beam connector with the lattice beam and binds the wire connected to the pulley to it for elevating and

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descending. Also, to improve utility, the lattice beam connector and pulley were designed in a one-touch system and the system form ascends and descends by stepping on the pedal of the one-touch pulley that is installed on the floor (Fig. 1-b).

C. Noise-Reduced Aluminum System Form with a Bevel Gear Floor Post and X-Beam

The noise-reduced aluminum system form with a bevel gear floor post and X beam descends based on combination of the bevel gear floor post, middle beam, and X beam, and the bevel gear floor post is inserted through the punch station that is in between the middle beam and X beam. A bevel gear is installed in the middle part of the floor post so that the floor post can ascend and descend, and the upper part of the floor post is inserted into the lower part by rotating the bevel gear(Fig. 1-c).

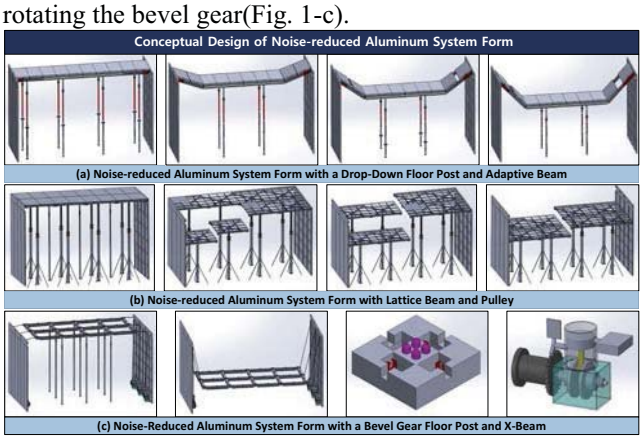

Fig 1. Conceptual Design of Noise-reduced Aluminum System Form

III. Selection of Optimal Conceptual Design of a Noise-Reduced Aluminum System Form

In this study, based on an expert interview, 1)safety, 2)noise-reduction, 3)work convenience, 4)economic feasibility were chosen as evaluation items based on characteristics of aluminum form construction for apartment houses. And then, advantages and disadvantages of each conceptual design were analyzed based on the chosen items

Also to calculate reliable weight of the evaluation items chosen earlier (safety, noise reduction, economic feasibility, work convenience), a survey was conducted with 27 construction companies managers and 9 framework company managers (Table 1). And, based on the analysis of advantages and disadvantages of different conceptual design alternatives, pairwise comparison of alternatives for four evaluation items was performed to calculate weight of each conceptual design alternative (Table 2). Based on the weight of evaluation items and conceptual design alternatives, AHP analysis was performed and, as a result, ALT1 was chosen as the optimal conceptual design (Table 3).

Table 1. Calculate weight of the evaluation items

	Safety	Noise reduction	Economic feasibility	Work convenience	Total
Weight	0.318	0.185	0.197	0.296	1

Table 2. Alternative weight calculation results

Division		ALT1	ALT2	ALT3	Total	Weight
Safety	ALT1	1	3	2	1.57	0.52
	ALT2	1/3	1	1/3	0.42	0.14
	ALT3	1/2	2	1	1.00	0.33
	Total	1.83	7	3.33	3.00	1
Noise reduction	ALT1	1	1/3	1/2	0.49	0.16
	ALT2	3	1	2	1.62	0.54
	ALT3	2	1/2	1	0.89	0.30
	Total	6	1.83	3.5	3.00	1
Economic feasibility	ALT1	1	3	1/2	0.96	0.32
	ALT2	1/3	1	1/4	0.37	0.12
	ALT3	2	4	1	1.67	0.56
	Total	1.83	6	3.5	3.00	1
Work convenience	ALT1	1	3	2	1.57	0.54
	ALT2	1/3	1	1/2	0.42	0.16
	ALT3	1/2	2	1	1.00	0.30
	Total	1.83	7	3.33	3.00	1

Table 3. Selection of the Optimal Alternative

Division	Calculation process	Total
ALT1	0.52*(0.318) + 0.16*(0.165) + 0.32*(0.197) + 0.54*(0.296)	0.42
ALT2	0.14*(0.318) + 0.54*(0.165) + 0.12*(0.197) + 0.16*(0.296)	0.22
ALT3	0.33*(0.318) + 0.30*(0.165) + 0.56*(0.197) + 0.30*(0.296)	0.36

IV. Conclusion

The following conclusion was made from this study:

1) The study proposed conceptual designs of noise-reduction system aluminum form (ALT1, ALT2, ALT3) to solve problems of conventional noise-reduced aluminum form.

2) To select the optimal conceptual design, safety, noise-reduction, work convenience, economic feasibility were chosen as evaluation items based on characteristics of aluminum form construction for apartment houses, and then, advantages and disadvantages of each conceptual design were analyzed based on the chosen items.

3) A survey was conducted with construction and framework company managers to calculate reliable weight of evaluation items. And then, weight of each alternative was calculated based on pairwise comparison of conceptual design.

4) Finally, based on calculated weight, AHP analysis was performed and, as a result, 'noise-reduced aluminum system framework with a drop-down floor post and adaptive beam' was chosen as the optimal conceptual design.

The conceptual design of the 'a noise-reduced aluminum system form with a drop-down floor post and adaptive beam' in this study improved problems of conventional system aluminum forms, and, later, a system aluminum form developed based on this conceptual design will be able to ensure noise-reduction and safety as well as excellent applicability.

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