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Structural safety of flat plate joint reinforced with metal lath bands

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ABSTRACT

In this study, to prevent punching shear by inducing predominant flexural yielding, novel shear reinforcement of metal lath bands was applied at the slab-column connection region. The structural performance was experimentally verified by monotonic static loading tests. As a result of the test, metal lath reinforcement was demonstrated to minimize the spread of punching shear cracks.

1. INTRODUCTION

Recently, flat plate systems consisting of slab-column joints and column capitals have been applied to basement parking lots in Korea. It has advantages of simple construction process and increasing effective floor height. However, one of the main problems is that the flat plate system is often vulnerable to punching shear failure at slab-column connections. The brittle punching shear failure nature may lead to collapse of the upper structure, so meticulous structural safety check is required.

In this study, to prevent punching shear by inducing predominant flexural yielding and large deformation, novel shear reinforcement of metal lath bands was applied at the slab-column connection region. Monotonic static loading tests were conducted with three types of specimens, as shown in Fig. 1. Structural safety was verified by comparing the experimental result of each specimen.

2. CONCEPT OF EXPERIMENTS

2.1 Reinforcing material

The metal lath was made of hot-rolled steel with a yield strength of 275 MPa. The entire shape was like a lattice mesh, forming a rectangular cone (Fig. 2). Its thickness was 4.5 to 7 mm and the spacing between lattice elements was 36 mm. The angle of

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each leg was 70 or 110 degrees. The metal lath was welded to two rebars, which were located at the level of slab bottom reinforcement.

Fig. 1 Specimen set up

Fig. 2 Metal lath bands

2.2 Specimen

Each specimen consisted of a slab, a capital, and a column. S1 was non-shear reinforced, but with only longitudinal rebars in the slab. S2 was reinforced with conventional stirrups as shear reinforcement at the slab-column connection region. In S3, metal lath bands were applied instead of conventional stirrups.

The specimens were designed following ACI 318-19 (2019) and ACI 421 (2007). The shear strength of metal lath was calculated based on inclination angles using Eq. (1), where α is the angle between the inclined stirrups and the longitudinal axis of the member. Details of the specimen are shown in Fig. 3.

$$V_s = \frac{A_v f_{yt}(\sin\alpha + \cos\alpha)d}{s} \tag{1}$$

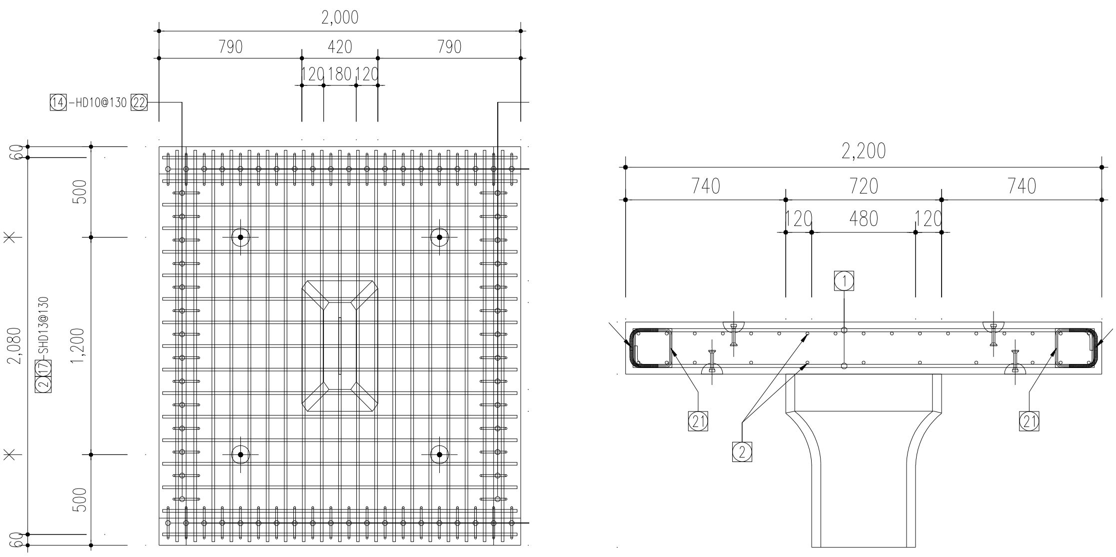


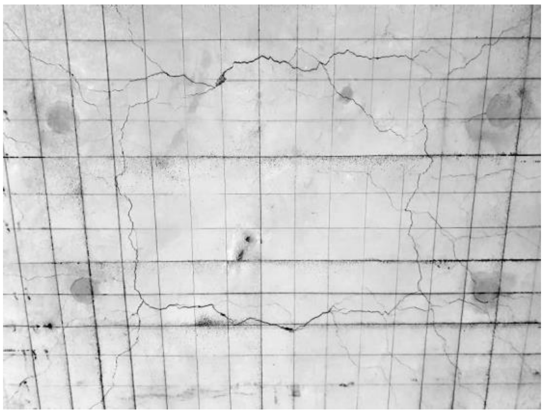
Fig. 3 Detail of specimen

3. RESULTS

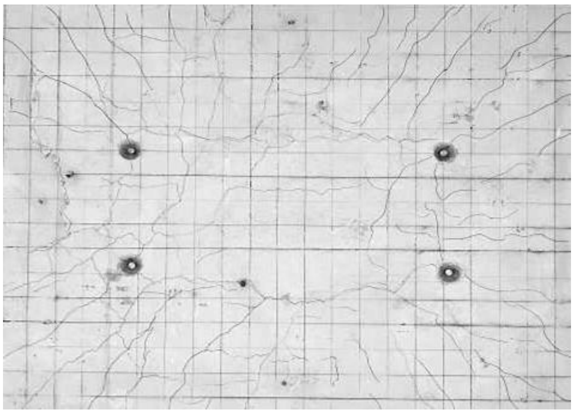
As a result of the experiments, performance was compared between the specimens with conventional shear reinforcement and the novel shear reinforcement.

3.1 Crack pattern

As shown in Fig. 4, cracks of S2 had occurred due to bending moment in tension zoon. Soon after, clear punching shear cracks occurred around the critical section zoon. In case of S3, fewer punching shear cracks occurred and radial flexure cracks were dominant.



(a) S2



(b) S3

Fig. 4 Crack pattern

3.2 Load-displacement relationship

Load-displacement envelope curves of the specimens were plotted as shown in Fig. 5. For all specimens, flexural strength was reached as the slab rebar yielded with the applied load increased. S1 had typical rapid load degradation due to punching shear. In case of the shear-reinforced specimens of S2 and S3, the shear reinforcement was capable of resisting applied shear stress adequately.

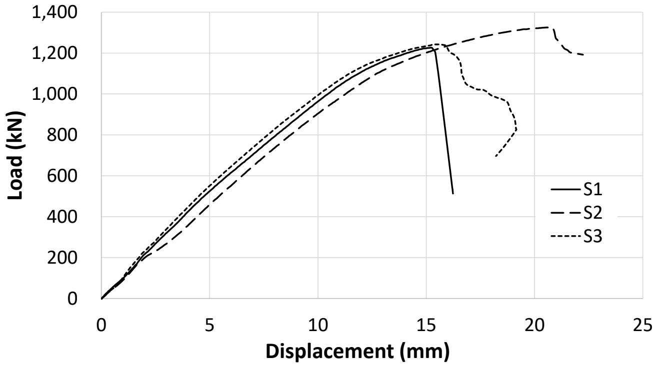


Fig. 5 Load-displacement curves

4. CONCLUSIONS

As a result of the experiments, the effect of the metal lath bands was demonstrated to minimize the spread of punching shear cracks due to effective resistance of metal lath in the critical section zoon. Since predominant flexural yielding was induced before punching shear failure occurred, the metal lath reinforcement method appeared to prevent abrupt punching shear failure and contributed to structural safety with reduced deterioration of the connection region.

ACKNOWLEDGEMENT

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