

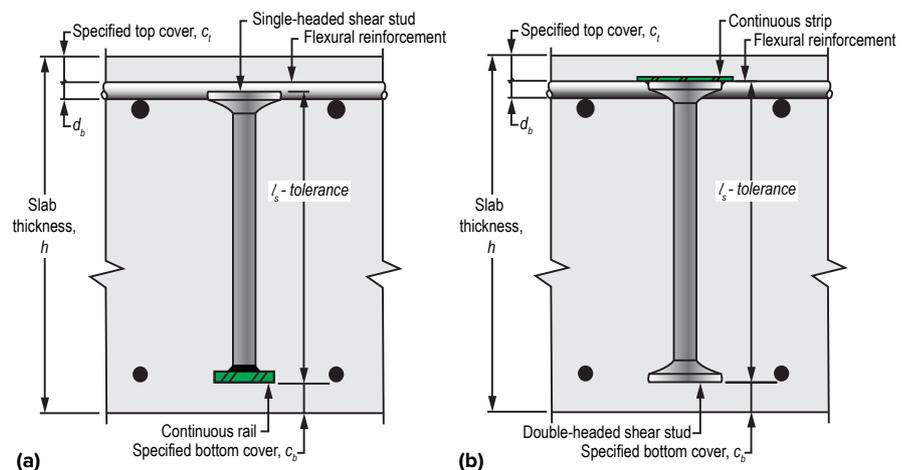
## Placement of Headed Shear Stud Reinforcement

**Q.** We specified headed shear stud reinforcement per Fig. 1(a) at slab-column connections. However, the concrete contractor submitted placing drawings with shear stud reinforcement shown in an “upside-down” configuration per Fig. 1(b). Does this submittal meet the requirements of ACI 318-19?

**A.** Requirements for the overall height of a shear stud assembly are provided in Section 8.7.7.1.1 of ACI 318-19, and they are illustrated in Commentary Fig. R20.5.1.3.6. Paraphrasing these requirements, the overall height of the stud assembly must be **at least** the slab thickness minus the sum of the top cover, the bottom cover, and a placement tolerance of  $d_b/2$ , where  $d_b$  is the diameter of the flexural tension reinforcement.

Similarly, Fig. 6 in ACI 421.1R-20<sup>2</sup> illustrates the overall height of the stud assembly as  $l_s - \text{tolerance}$ . In this illustration,  $l_s = h - c_t - c_b$ , where  $h$  is the thickness of the slab,  $c_t$  is the concrete cover on the top flexural reinforcement, and  $c_b$  is the concrete cover on the base rail; and  $\text{tolerance} \leq d_b/2$ . That notation is also used in Fig. 1.

Per Section 20.4.1 of ACI 318-19, headed shear stud reinforcement and stud assemblies shall conform to ASTM A1044/A1044M.<sup>3</sup> Further, Section 2.3 of ACI 318-19 defines headed shear stud reinforcement as “reinforcement consisting of individual headed studs or groups of studs, with anchorage provided by a head at each end, or by a



**Fig. 1: Slab section with flexural and headed shear stud reinforcement: (a) studs welded to a base rail supported on slab bolsters, installed prior to placement of flexural reinforcement (based on Fig. 6 in ACI 421.1R-20<sup>2</sup>); and (b) double-headed studs welded to a top strip resting on top bars, installed after placement of flexural reinforcement (Note:  $l_s = h - c_t - c_b$ ; and  $0 \leq \text{tolerance} \leq d_b/2$ )**

head at one end and a common base rail consisting of a steel plate or shape at the other end.”

Thus, ACI 318-19 permits headed shear stud installations comprising stud assemblies with double-headed studs held by a continuous strip resting on top bars (or simply individual double-headed studs wired in place at the specified spacing). Because Fig. R20.5.1.3.6 is included in the Commentary of ACI 318-19, it serves merely as an example and does not limit assemblies to only the type that is illustrated. The final selection will be made by the concrete contractor based on labor, material, and schedule costs.

In summary, the so-called “upside-down” shear stud reinforcement assembly submitted by your contractor (Fig. 1(b)) meets ACI 318-19

requirements and your specification.

### References

1. ACI Committee 318, “Building Code Requirements for Structural Concrete (ACI 318-19) and Commentary (ACI 318R-19),” American Concrete Institute, Farmington Hills, MI, 2019, 623 pp.
2. ACI Committee 421, “Guide for Shear Reinforcement for Slabs (ACI 421.1R-20),” American Concrete Institute, Farmington Hills, MI, 2020, 27 pp.
3. ASTM A1044/A1044M-16a, “Standard Specification for Steel Stud Assemblies for Shear Reinforcement of Concrete,” ASTM International, West Conshohocken, PA, 2016, 5 pp.

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