SECTION 2

EXPERIMENTAL PROGRAM

Most of the existing flat-plate buildings range in height from five to fifteen stories and may or may not have drop panels and spandrel beams. This investigation focused only on flat-plate construction without drop panels. Since spandrel beams are commonly present in flat-plate buildings, their effect on the response of connections was also studied in this investigation.

2.1 Prototype Building

The prototype structure for this investigation was a five story flat-plate building with three bays in the short direction and four bays in the long direction. This configuration of the prototype building was chosen to facilitate comparison of results with small-scale shake-table tests on slab-column frame systems in other NCEER supported projects. The columns were typically 20 in.x 20 in. in cross section and were spaced 20 ft. apart with each story of 10 ft. height. The compression strength of concrete was chosen as 3000 psi with reinforcement of Grade 40 steel. These material properties are typical of older buildings.

The prototype building was assumed as an office building with a live load of 50 $lbs/ft.^2$. The total gravity load on the floors, including the slab weight, was estimated as 145.5 $lbs/ft.^2$. Details of the design calculations, which are based on ACI 318-47 Building Code, are given in Appendix A of this report. The slab thickness in this case was governed by shear considerations which was chosen as 9 inches. Moments in the frame under gravity loads were determined using the direct design method and the slab reinforcement in the column and middle strips was selected based on the working stress design procedure.

2.2 Specimen Design

The test specimens were half-scale slab-column connection subassemblies, each consisting of two exterior connections and one interior connection. The overall configuration of the test specimen and the individual connection details are shown in figure 2-1. Since the study focused on the slab response in the connection region, the columns were designed to remain elastic with reinforcement consisting of six No.7 Grade 60 bars. The gravity load applied to the subassemblies was adjusted such that the resulting shear in the connection region was approximately the same as in the protoype building. The reinforcement ratio of the slab top reinforcement in the column strip for both exterior and interior connection was 0.59%. The reinforcement ratio for the slab bottom reinforcement in the column strip of both interior and exterior connections was 0.22% for bent-up detail and 0.3% for the straight bar detail. Furthermore, the slab bottom reinforcement in the column strip was

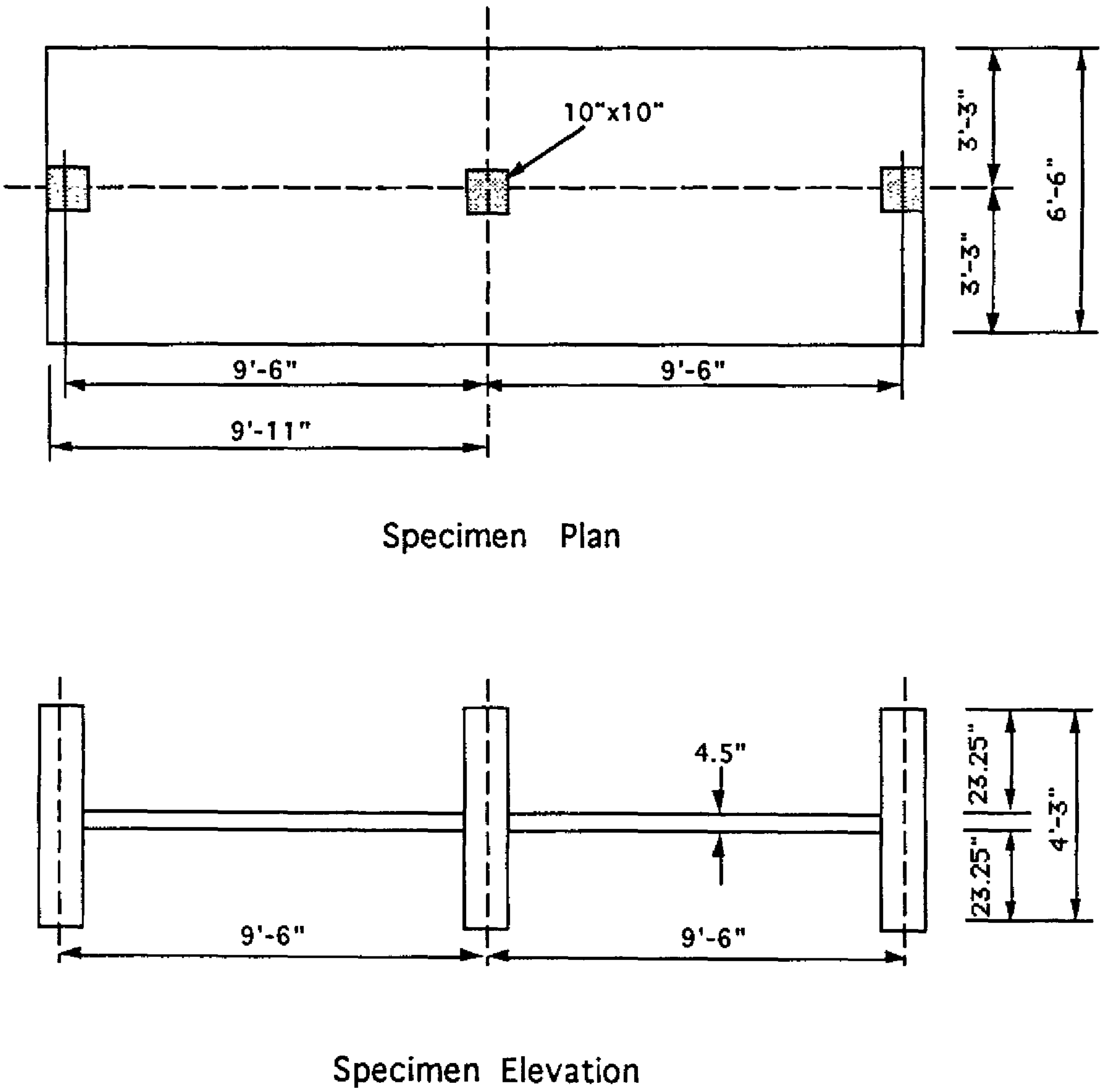

FIGURE 2-1 The Overall Specimen Configuration

37.6% of the slab top reinforcement for the bent-up bar configuration and 63% of the slab top reinforcement in the straight bar detail. Reinforcing detail of the interior and exterior connections is shown in figures 2-2 and 2-3. The specimens were constructed with ready-mixed concrete of 3000 psi specified compressive strength. Figures 2-4 through 2-6 show the formwork with reinforcement in place prior to placing of concrete.

For a true half-scale modeling of the chosen prototype, the specimens would have a span of 10 ft. and slab width of 9 ft. Due to constrains of the testing frame, these dimensions were reduced to 9.5 ft. and 6.5 ft., respectively. The columns in the test subassemblies were terminated at inflection points which were assumed stationary at mid-height of the story above and below the slab. Based on the intended scope of the study and typical construction details of the existing flat-slab buildings, three variables were studied during this investigation. These included configuration of the slab reinforcement in the connection region, presence of the spandrel beams at exterior connections, and intensity of the gravity load on the slab at the time of lateral cyclic loading. Further details of the variables and material properties are given in table 2-I.

TABLE 2-I Specimen Configuration and Material Properties

Specimen	Reinf. Detail	Gravity Load	Concrete strength (psi)	Steel Strength (ksi)
DNY_1	Bent-Up	DL+0.3LL	5115	54
DNY_2	Bent-Up	DL+LL	3731	54
DNY_3	Straight	DL+0.3LL	3566	54
DNY_4	Edge Beam	DL+0.3LL	2772	54

2.3 Test Set-Up

The slab-column connection subassemblies were tested in a steel reaction frame as shown schematically in figure 2-6. The top of columns were all connected to a rigid beam through load cells with the bottom of each column attached to the reaction frame with a hinge connection. The lateral cyclic load was applied to the specimen through the distribution beam with a servo-controlled closed-loop hydraulic actuator. The shear in each column was independently measured along with the vertical reaction at the center column which rendered the subassembly statically determinate. A photo of the actual test set-up is shown in figure 2-7.

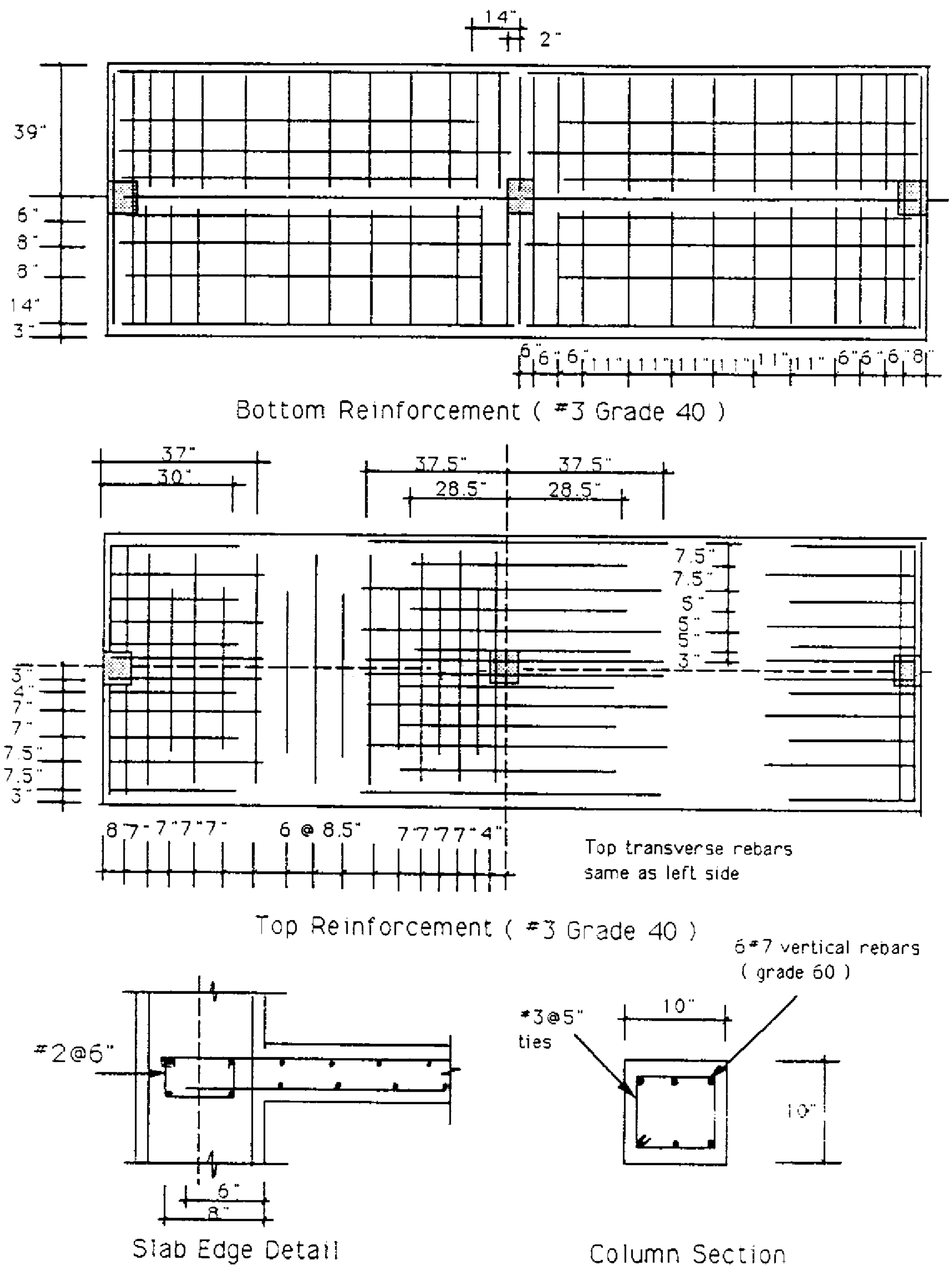

FIGURE 2-2 Reinforcement Detail of Specimens

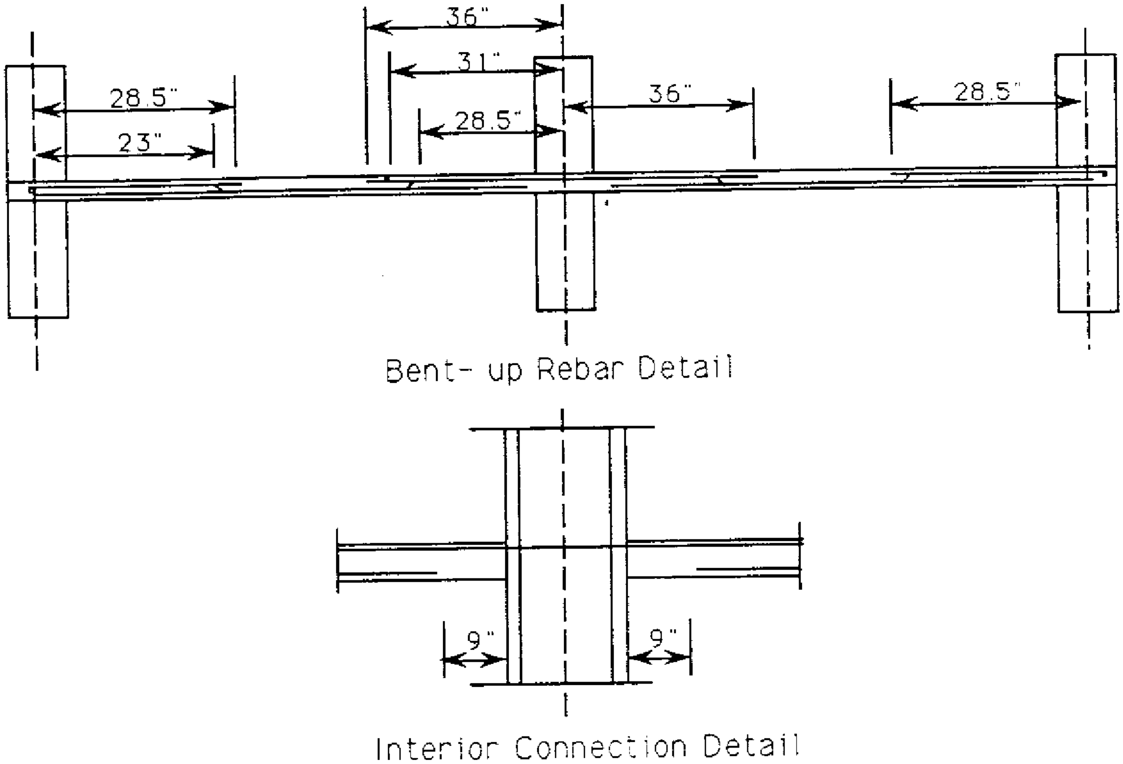

FIGURE 2-3 Reinforcement Detail of Specimens

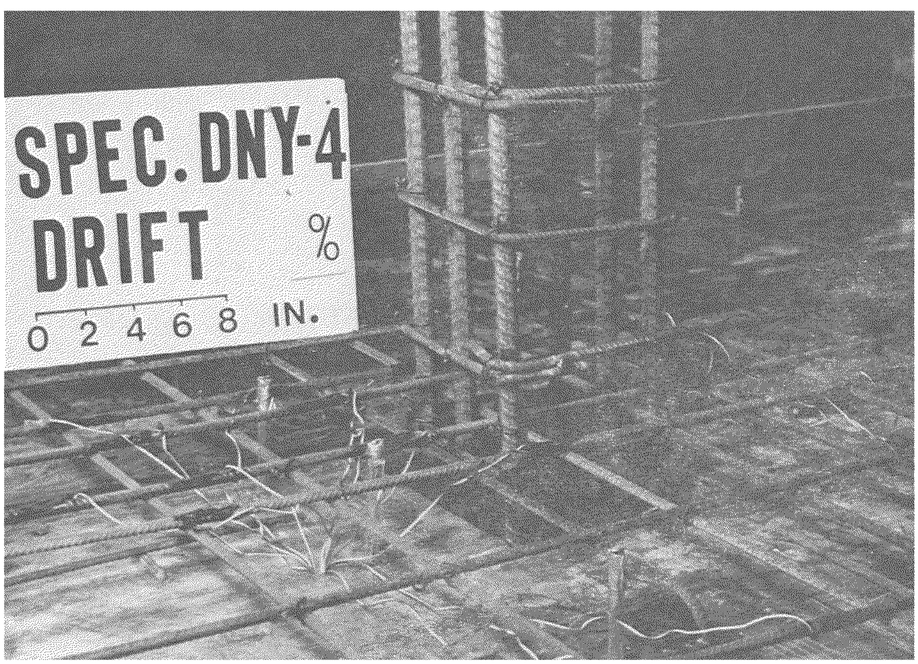

FIGURE 2-4 Interior Connection Reinforcement in DNY_4