Column test information

The testing program for this survey was carried out at the Tye Gilb Laboratory of the Simpson Strong-Tie company, in Stockton, CA. Details of the test program are provided below.

Test specimen

An image of the test specimen is shown in Figure 1. The test specimen consists of a reinforced concrete column with dimensions of 14" (356 mm) by 14" (356 mm) in cross section. The column clear height is 105" (2667 mm) between the top and bottom enlarged end sections, which are 20" (508 mm) by 20" (508 mm) in cross section.

Vertical reinforcement (Figure 1) consists of 8-#10 deformed longitudinal bars (A = 1.27 in^2 = 819 mm^2 each) arranged around the perimeter of the column and extending over the full length of the specimen (throughout the column clear height and end sections) with no lap splices. Transverse reinforcement is #3 (A = 0.11 in^2 and 71 mm^2 each) deformed bar hoops with 135-degree hooks. The hoops are spaced at 3" (76 mm) on center at the top and bottom 12" (305 mm) of the column length (Figure 1). The remaining hoops are spaced at 12.8" (326 mm) on center.

At the end sections above and below the column, 8-#7 (A = 0.6 in^2 = 387 mm^2 each) vertical bars are added around the perimeter of the block (Figure 1). Transverse reinforcement at the upper end sections is #4 (A = 0.20 in^2 and 129 mm^2 each) deformed bar hoops with 135-degree hooks spaced at 4 in (101.6 mm). Transverse reinforcement at the lower end sections is #4 (A = 0.20 in^2 and 129 mm^2 each) deformed bar hoops with 135-degree hooks spaced at 8 in (203.2 mm).

Concrete material properties

The column specimen uses normal-weight concrete. Concrete compression tests were performed on 4" (101.6 mm) diameter by 8" (203.2 mm) high cylinders. Test results for the cylinders are shown in the table below. Each row represents an individual cylinder test. The column test was conducted on day 28 after placement of concrete.

The average compressive strength of six cylinders measured on days 27, 28, and 29 is f'_c = 2,568 psi (17.71 MPa). You can use this value in your predictions. Alternatively, you may calculate your own estimate of concrete compressive strength.

Age	Strength		Notes
(days)	(lb/in^2)	(MPa)	-
3	1455	10.03	
7	2404	16.57	
14	2882	19.87	
22	2328	16.05	
27	2359	16.26	
27	2233	15.40	
28	2720	18.75	Test date
28	2484	17.13	Test date
29	2827	19.49	
29	2782	19.18	

Steel reinforcement material properties

All steel reinforcement is ASTM A615. Vertical (longitudinal) reinforcement is Grade 60. Hoops are Grade 40. Tension test results for the materials are shown in the table below.

Material	Application	Yield strength (f_y)		Tensile strength (f_u)		Elongation
-	-	(lb/in^2)	(MPa)	(lb/in^2)	(MPa)	(%)
A615 Gr. 40	Hoops	55,000	379	82,500	568	21.0
A615 Gr. 60	Vertical (longitudinal) reinf.	69,400	478	98,758	680	18.8

Test setup and procedures

The column was tested under imposed lateral displacement, with fixed-fixed end conditions. No axial load (other than self weight) was applied to the specimen (see Figure 2 and Figure 3). The fixed base was achieved by clamping the lower section of the specimen to a concrete abutment with a steel plate and threaded rods. The abutment was anchored to the laboratory strong floor.

The upper section of the specimen was restrained from rotation by attaching it to two fixtures that each deliver the lateral load to the specimen from a horizontal hydraulic actuator and horizontal HSS sections that act as loading struts. The actuators were coordinated and controlled to keep a fixed condition at the top of the column, with the top end section of the specimen translating but not rotating.

Each actuator was equipped with a load cell for force measurement. Each HSS loading strut had two strain gages installed, one on each vertical face, near the end of the strut adjacent to the test specimen. These strain gages were used to calibrate slight corrections between the actuator load and the actual applied load that occur because of a small amount of friction in the test setup. Such corrections were less than 3% of the applied load.

Displacement measurement

The top of column displacement measurements were taken from an independent reference frame using a string potentiometer connected one inch below the top of the column clear height. The bottom of column displacement measurements were taken from the same independent reference frame using a displacement transducer connected at the bottom of the column clear height. Base slip of the large concrete abutment relative to the strong floor was also measured with a displacement transducer. Test results were corrected to remove the small amount of base lateral movement.

All measurements were recorded with a central data acquisition system throughout the duration of each test.

Loading protocol

The column was subjected to the loading protocol shown in Figure 4. Raw data with the loading protocol are provided in a separate excel spreadsheet (“Loading protocol.xlsx”).

Figures

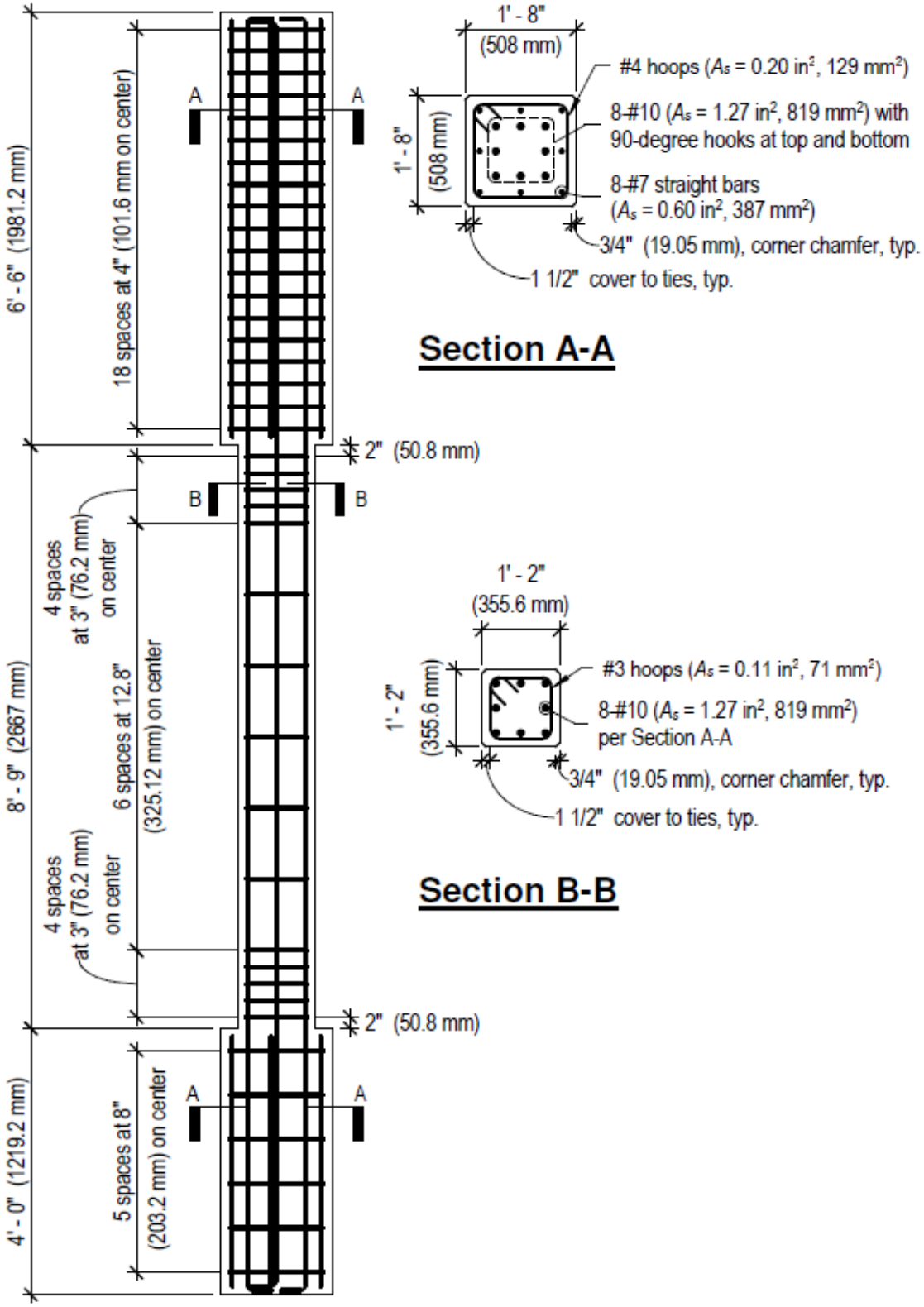

Figure 1 Column specimen reinforcement elevation and sections.

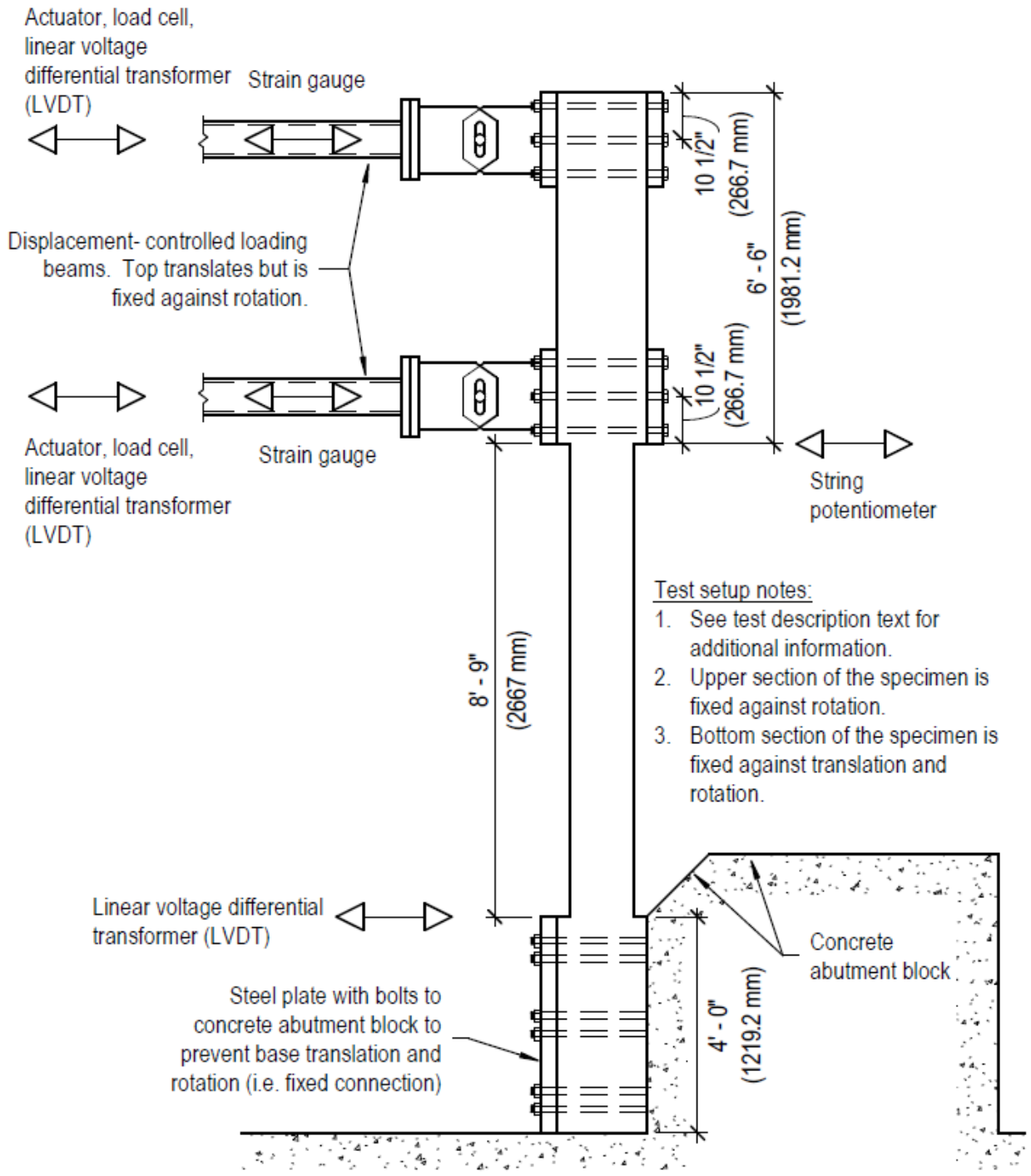

Figure 2 Schematic drawing of test setup. The base of the specimen is bolted to the concrete abutment to restrain translation and rotation. At the top of the specimen, the actuators are coordinated to apply horizontal translation only (i.e., the displacement of two actuators is equal).

Figure 3 Photograph of the test setup and load frame.

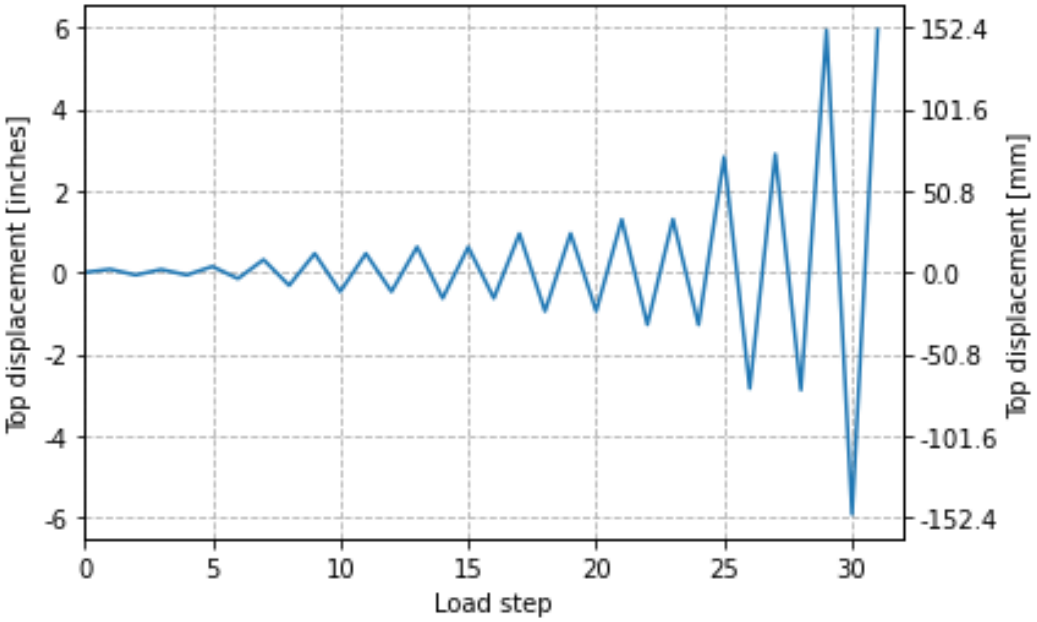

Figure 4 Loading protocol.