NATIONAL BUREAU OF STANDARDS REPORT

8039

Strength of Concrete Collars Cast
Around Existing Columns

by

L. F. Skoda

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

THE NATIONAL BUREAU OF STANDARDS

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NBS PROJECT		NBS REPORT
1001-12-10411	July 16, 1963	8039

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To
Bureau of Yards and Docks
Department of the Navy

NBS

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

Strength of Concrete Collars Cast Around Existing Columns

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1. INTRODUCTION

A test program was initiated by the Bureau of Yards and Docks to determine a practical and economic method of attaching new concrete slabs to existing columns. The specific problem was to transfer the weight of a new concrete slab installed as fallout protection between the roof and floor of an existing high ceiling building to the existing reinforced concrete columns. An engineering study by the Bureau of Yards and Docks indicated that the additional load could be safely absorbed by the existing concrete columns and column footings. This additional load was calculated to be 60,000 lbs per column. It was decided that the simplest solution to the problem was to cast reinforced collars around the columns that could support this load and transfer it to the column. The primary objective of this test series was to determine the strengths and stiffness of such a column collar assembly. The various factors investigated were the depth of the collar, reinforcement, surface preparation, and load slip relationship.

2. DESCRIPTION OF TEST SPECIMENS

2.1 Columns

The column stub was 14- by 14-in. in cross section and 30-in. long. The longitudinal reinforcement was four 3/4-in. diameter bars. Lateral ties were spaced at 12-in. intervals and were made of 3/8-in. diameter bars. The same column stub was used in all five tests.

The concrete used for the column was made of Type III cement, siliceous sand and a well rounded gravel of 3/4-in. maximum size. The proportions were 1:3.8:4.9 by weight and a compressive strength of 3700 psi was realized at time of test of the first collar.

Prior to casting of the first test collar the peripheral surface of the column stub which was to bond with the concrete collar was sand blasted so that the coarse aggregate was well exposed. The column was similarly cleaned prior to casting each of the subsequent collars tested.

Two different sizes of collars were tested. The first two specimens were 4-in. thick and 8-in. deep. The final three specimens were 4-in. thick and 12-in. deep. Views of typical collars are shown in figure 1.

The main reinforcement was the same in all specimens and consisted of a lap welded continuous 3/4-in. diameter bar located near the top of the collar. Specimen No. 1 had two additional horizontal stirrups spaced 3-in. on center parallel to the main vertical stirrup. The reinforement in specimen No. 2 consisted of a continuous stirrup fashioned of No. 2 bar that provided vertical reinforcement spaced every 2-in. around the periphery of the collar at its midplane. The additional reinforcement used in specimens 3, 4, and 5 consisted of varying amounts of 2- by 2-in. welded wire fabric of different gages that extended throughout the depth of the collar. Specimen No. 3 had a double layer of 6-gage fabric, No. 4 had a single layer of 6-gage fabric, and No. 5 was reinforced with a single layer of 12-gage fabric.

The mortar used in the collars had a sand to cement ratio of 3:1, by weight, with the cement being of Type III. A water-cement ratio of 0.49 was used. The workability of the mortar was improved by adding lime in an amount equal to 0.1 of that of cement, by weight. The specimens were cured under wet burlap for 24 hr and then allowed to dry in air until tested. This method of curing was selected to simulate field curing conditions. The 7-day compressive strength of 2- by 2-in. control cubes averaged 8000 psi. The collars were all 7 days old at time of test.

3. TEST PROCEDURE

The specimens were tested in an inverted position. The assembly was supported by the collar above the platen of a 600,000 lb capacity hydraulic testing machine by two 3- by 8-in. bearing blocks that rested on top of two steel pedestals. The load was applied to the column stub in increments of 10,000 lb until failure. Specimens in the testing machine can be seen in figures 3 through 7.

Slip measurements were made on each side of the column directly over the supports with 0.0001-in. micrometer dial gages. The gages were attached to the column stub so as to measure the displacement of the collar with respect to the column as the load was applied. (Figures 3, 5, and 7).

Readings were taken before and after each increment of load. A time lapse of 2 min was observed between successive increments of load so as to determine any slip that might occur at any given applied load.

4. RESULTS

Load-slip relationships for the five specimens are shown in figure 8. Specimens numbered 1 and 2 had collars 8 in. deep, while 3, 4, and 5 were 12 in. deep. The loads corresponding to first visible cracks appear as enlarged points on each load-slip curve. The maximum plotted values of slip shown on the curves were the last observed values before failure. Table I summarizes the pertinent results shown in figure 8.

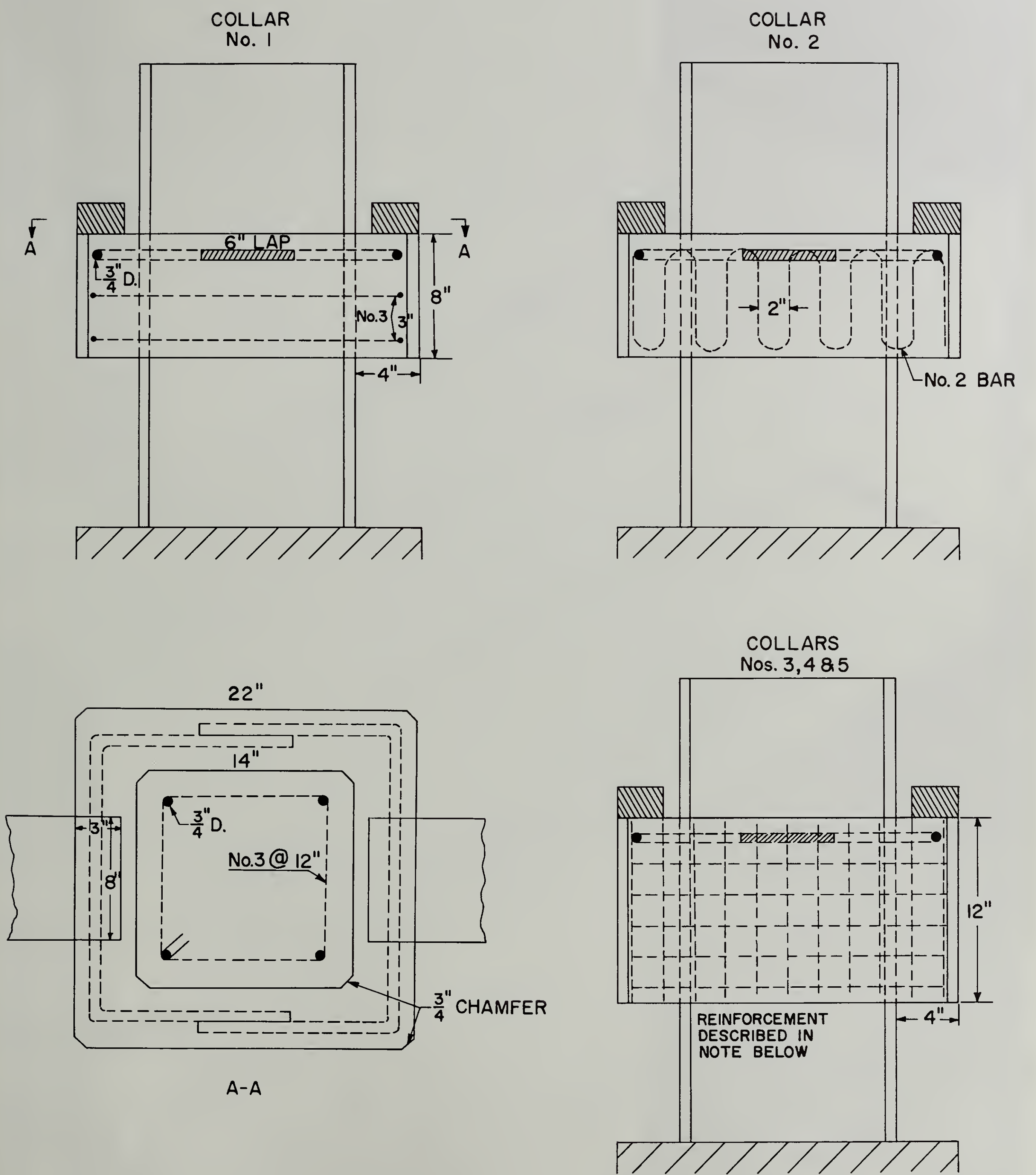
The mode of failure in all of the specimens was punching shear. There was no evidence of bond failure at the interface of the column and collar. The initial cracking in all cases occured at the top of the collar just over the 3- by 8-in. reaction plates. Figures 2 through 7 are photographs of the specimens after test.

The slip measurements made of the column collar assemblies at the beginning and at the end of each period of sustained increment of load indicated that no appreciable movement occured under sustained load except at loads near failure.

5. DISCUSSION

An examination of the load-slip curves indicates that the significant difference in load carrying capacity of the collars is almost wholly due to the difference in the depth of the collar. The maximum loads attained by the 8-in. collars were approximately half of those attained by the 12-in. collars. While the primary horizontal stirrups was a 3/4-in. bar in all specimens, the auxiliary reinforcing varied considerably in the 8-in. and 12-in. collars; however, the shape of the load-slip curves as well as the maximum loads attained were essentially dependent on the depth of the collars.

The photographs show the comparative crack patterns in the 8-in. and 12-in. collars. Considerably larger cracks and greater displacements are visible in the 8-in. collars. The close-up of specimen No. 1 (figure 2) shows that no bond failure occured. This was typical of all specimens. This supports the assumption that if the surfaces are properly prepared and reasonable care is taken in casting of collars, bond is no problem in spite of the minimal amount of curing.



NOTE:
No. 3 – 2 LAYERS 22-66 WELDED WIRE FABRIC
No. 4 – 1 LAYER 22-66 WELDED WIRE FABRIC
No. 5 – 1 LAYER 22-1212 WELDED WIRE FABRIC

FIG. 1. DETAILS OF COLUMN AND COLLAR REINFORCEMENT.

FIG. 2. CLOSE-UP OF COLLAR No. 1 AFTER FAILURE.

FIG. 3. COLLAR No. I AT FAILURE.

FIG. 4. COLLAR No. 2 AT FAILURE.

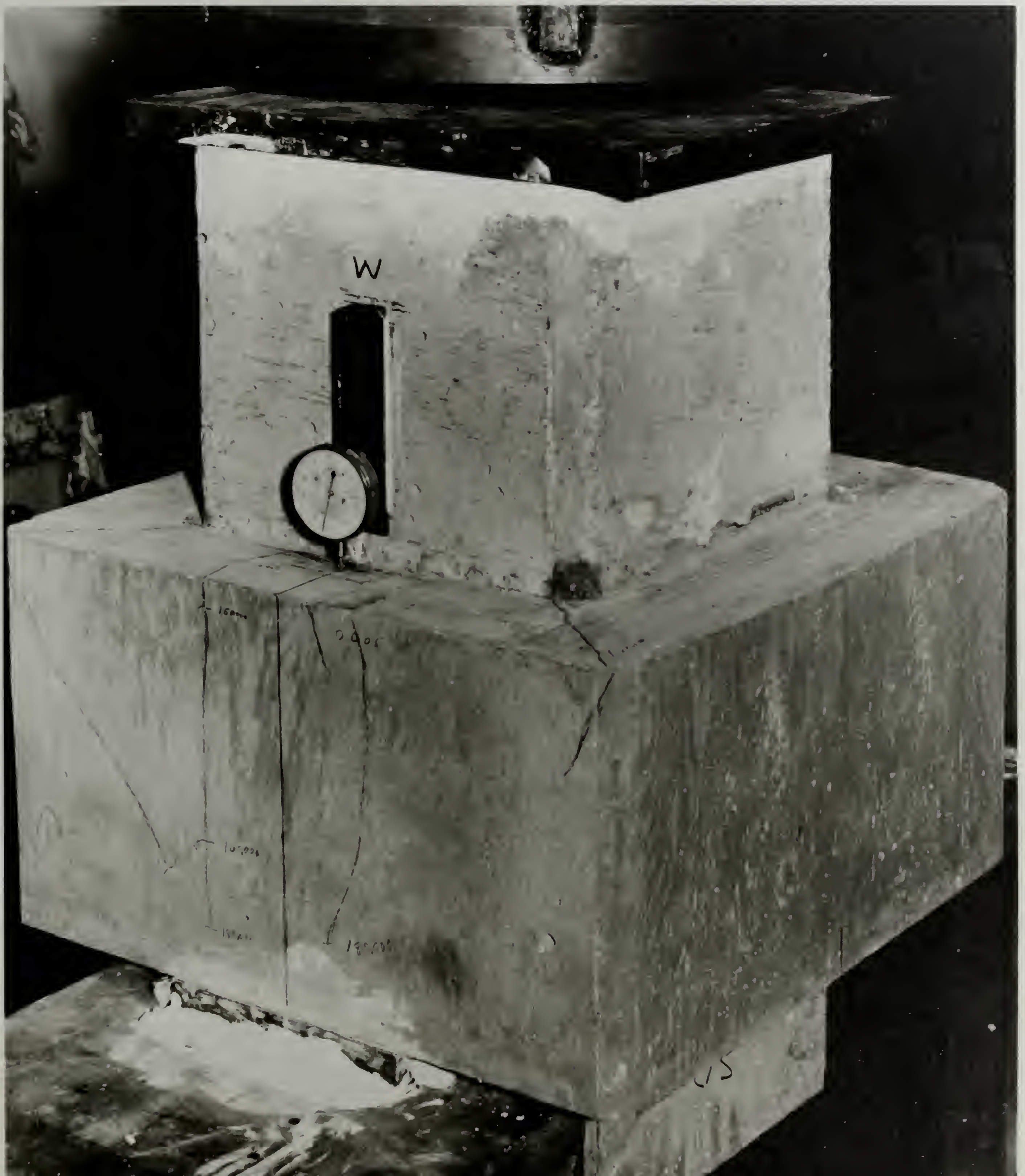


FIG. 5. COLLAR No. 3 AT FAILURE.

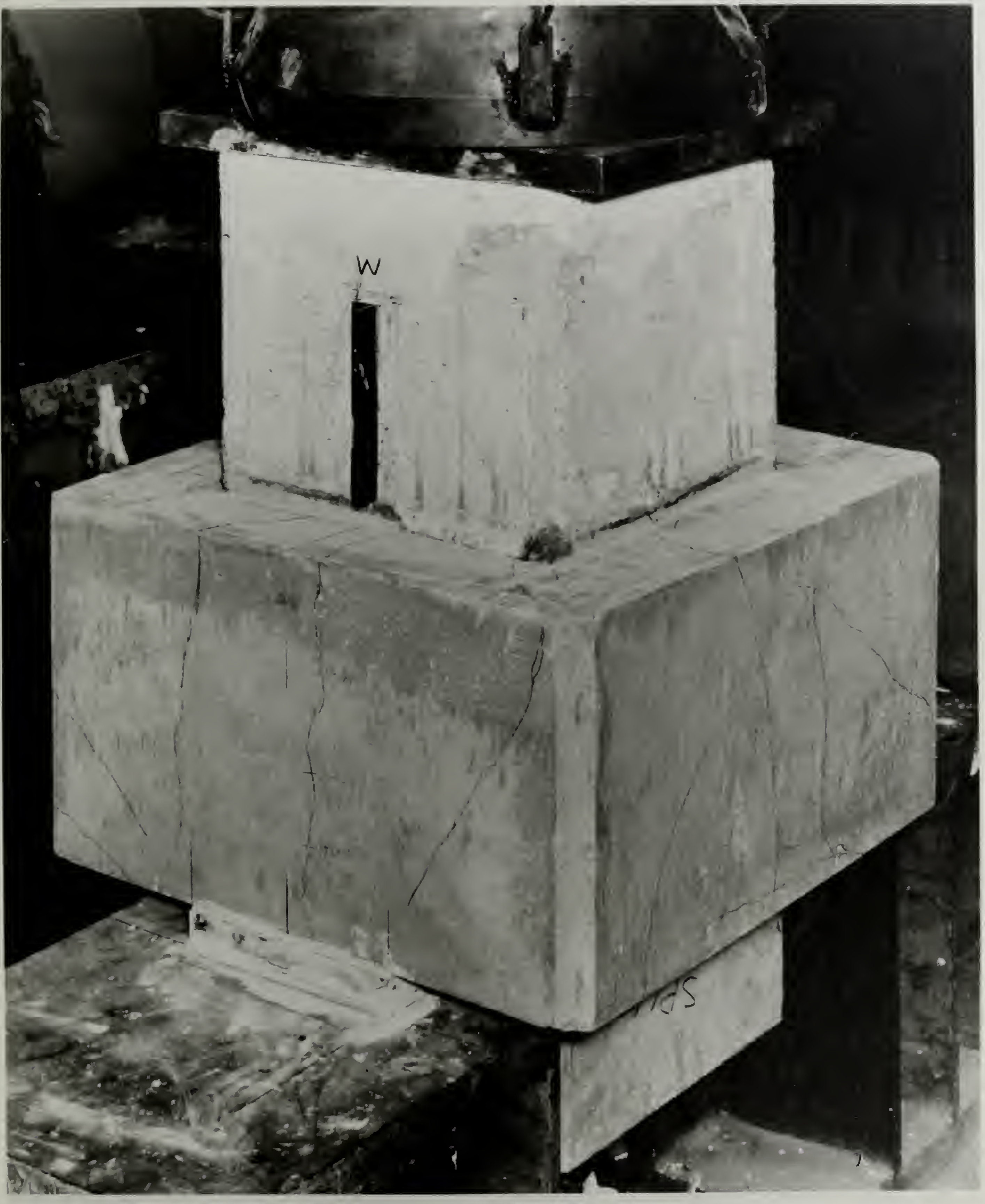


FIG. 6. COLLAR No. 4 AT FAILURE.

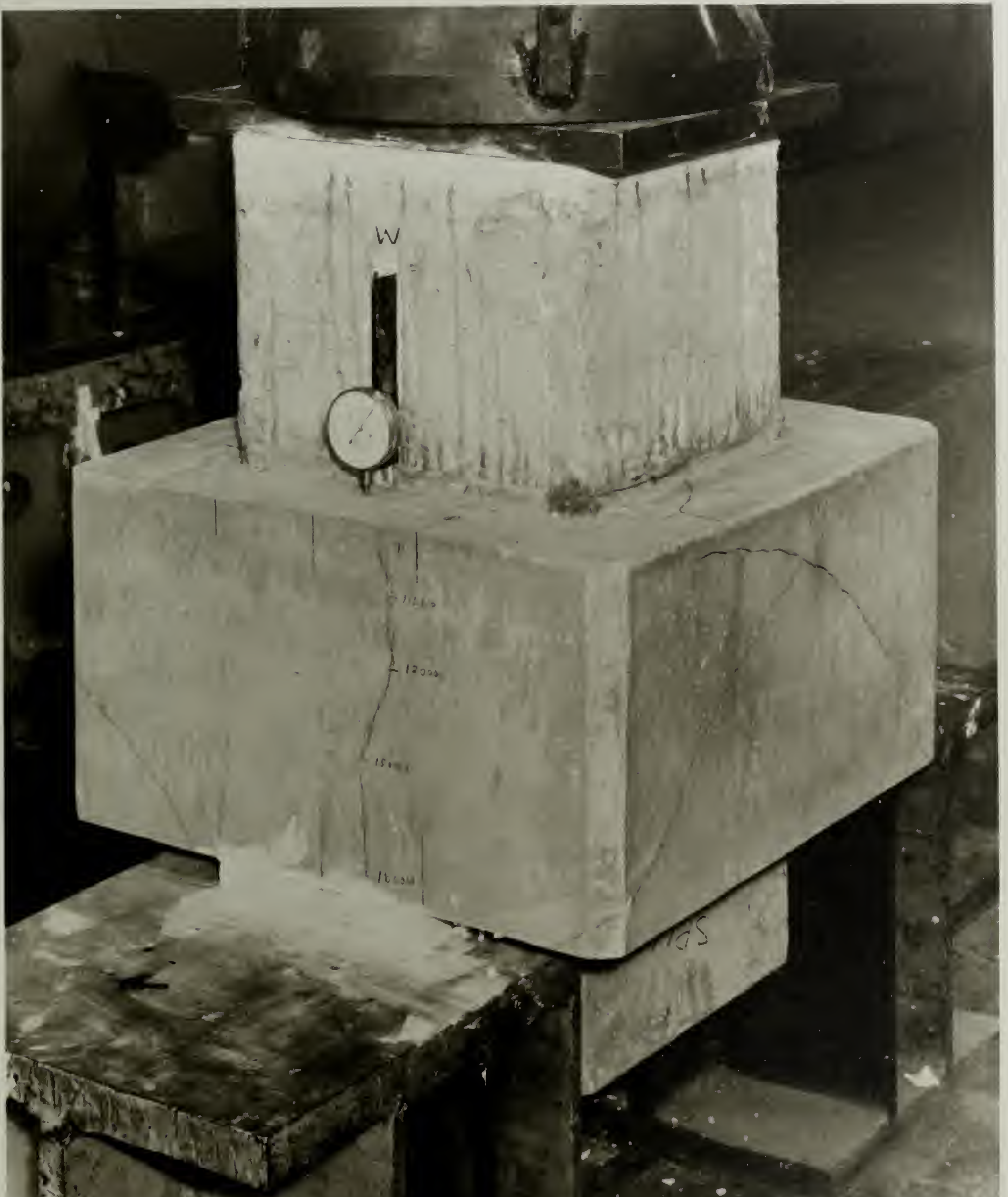


FIG. 7. COLLAR No. 5 AT FAILURE.

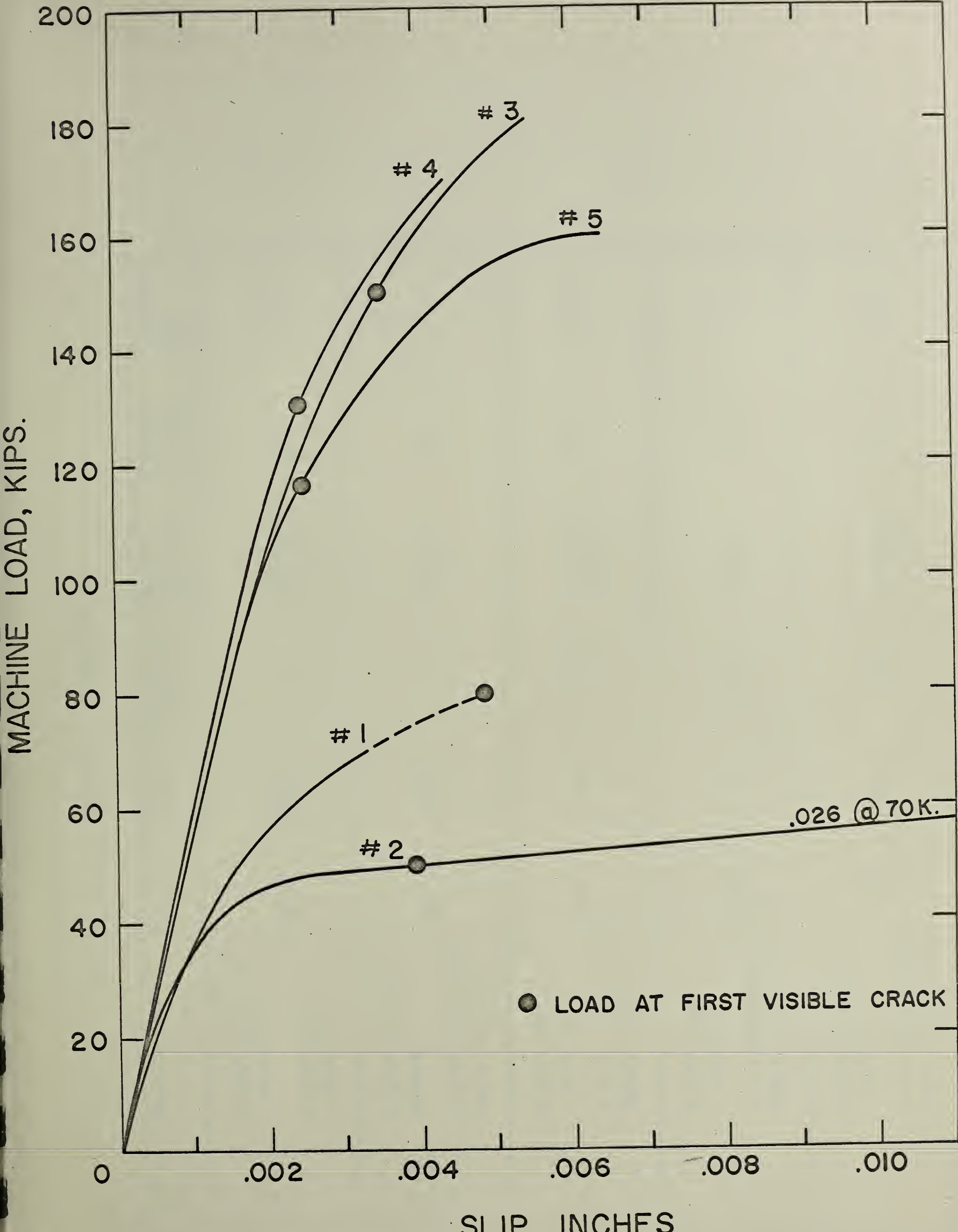


FIG. 8. LOAD-SLIP RELATIONSHIPS FOR COLLARS 1. THRU 5.

Table 1. Test Results

Specimen No.	Reinforcement	Slip @ 30 kips in.	Slip @ 60 kips in.	Slip @ 120 kips in.	Maximum Observed Slip	Visible Cracking Load Kips	Ultimate Load Kips
1	1-3/4" horiz. stirrup 2-3/8" horiz. stirrups	.00076	.00228	-	.00331 @ 70 K	80	82.6
2	1-3/4" horiz. stirrup 1-1/4" sine-wave vert. stirrup	.00072	.01788	-	.02615 @ 70 K	50	79.6
3	1-3/4" horiz. stirrup 2-22-66 welded wire fabric cages	.00055	.00109	.00240	.00544 @ 180 K	150	180.0
4	1-3/4" horiz. stirrup 1-22-66 welded wire fabric cage	.00047	.00099	.00217	.00438 @ 170 K	130	177.0
5	1-3/4" horiz. stirrup 1-22-1212 welded wire fabric cage	.00052	.00105	.00266	.00642 @ 160 K	116	160.0

U. S. DEPARTMENT OF COMMERCE
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THE NATIONAL BUREAU OF STANDARDS

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Metrology. Photometry and Colorimetry. Refractometry. Photographic Research. Length. Engineering Metrology. Mass and Volume.

Heat. Temperature Physics. Heat Measurements. Cryogenic Physics. Equation of State. Statistical Physics.

Radiation Physics. X-ray. Radioactivity. Radiation Theory. High Energy Radiation. Radiological Equipment. Nucleonic Instrumentation. Neutron Physics.

Analytical and Inorganic Chemistry. Pure Substances. Spectrochemistry. Solution Chemistry. Standard Reference Materials. Applied Analytical Research. Crystal Chemistry.

Mechanics. Sound. Pressure and Vacuum. Fluid Mechanics. Engineering Mechanics. Rheology. Combustion Controls.

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