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Analysis of continuous composite beams, December 1970 (Ph. D. dissertation)

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FINAL SUMMARY REPORT

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1.0 List of test data

Book 1 Beam SC-3SA (gage readings)

Book 2 Beam SC-3SA reduced data file

Book 3 Beam SC-3SB gage readings

Book 4 Beam SC-3SB reduced data file

Book 5 Beam SC-4S gage readings

Book 6 Beam SC-4S reduced data file

Book 7 Beam SC-5S reduced data file

Book 8 Beam SC-6S reduced data file

Book 9 Beam SC-7S reduced data file

Book 10 Beam SC-8S reduced data file

Book 11 Beam CC-3F reduced data file

Book 12 Beam CC-4F reduced data file

Book 13 Auxiliary test

Book 14 Test set up drawings, Instrumentation, Prediction Curves

Book 15 Project 359 General File

Book 16 Cracks reduced data

2.0 List of special equipment and spare material

Two and fixtures to load and support test specimens

4 short tension hangers

2 long tension hangers

3.0 List of drawings

1. Composite Beam Test 359-SC-3S, 4S, 5S, 6S, 7S, 8S
   Steel Fabrication No. 359-2

2. Composite Beam Test 359-SC-3S
   Slab Reinforcement Details No. 359-3

3. Composite Beam Test 359-SC- S
   Slab Reinforcement Details No. 359-4

4.0 List of Slides for Project 359-9

1. Beam during negative moment test
2. Negative moment test - end view
3. Close-up of negative moment test
4. Instrument table
5. Settlement reading recorded at the west support
6. Plotter for the positive moment test
7. Plotter for the negative moment test
8. Close-up of the buckle flange after failure
9. Dial gauge registering slip and uplift
10. Dial gauges registering slip and uplift
11. Protection devices for strain gauges
12. Dial gauge registering slip and uplift
13. Overall view of specimen after casting
14. Forms for casting specimen
15. Close-up of west-end support taken from north side
16. Close-up of west-end support taken from south side
17. Overall view of negative moment test
18. Close-up of a plastic hinge on the load point
19. Close-up of buckle failure
20. Close-up of buckle failure
21. Cracked slab
22. Cracked slab
23. Detail of west-end support
24. Cracked slab

25. Cracked slab
26. Casting details
27. Casting details
28. Casting details
29. Casting details
30. Casting details
31. Casting details
32. Positive moment testing
33. Steel distribution sketch
34. Negative moment testing
35. Detail of positive moment test and dial gauges
36. Plotter for the positive moment test
37. Plotter for the negative moment test
38. Instrument table
39. Close-up of loading device at west end
40. Cracked slab
41. Close-up of the fixed end support
42. Overall view for center support
43. End bracing for preventing sway
44. Instrument table
45. Cracked slab
46. Plotter for the positive moment test
47. Overall view for the positive moment test
48. Overall view for the positive moment test
49. Overall view for center support
50. Close-up of buckling failure

51. Close-up of buckling failure
52. Group taking readings
53. Group taking readings
54. Group taking readings
55. West end load point detail
56. East end detail
57. Loading Mechanism
58. Separation at the interface detail
59. Yield lines developed at ultimate load (typical)
60. Beam SC-4S after test
61. Beam SC-4S final crack pattern
62. Plotter for Pos. Moment test SC-4S
63. Beam SC-4S (initial yield)
64. Load Mechanism
65. Beam SC-4S buckling wave
66. Beam SC-4S buckling wave
67. Beam SC-4S partially plastified
68. Initial yield detail SC-4S
69. Test Set-up (SC-4S)
70. Broken Bond (SC-4S)
71. SC-4S after test
72. SC-4S final crack pattern
73. SC-5S Plastic hinge
74. SC-5S Buckled flange
75. SC-5S final crack pattern
76. SC-7S final crack pattern

77. Local buckling (typical)
78. Local buckling (typical)
79. SC-5S final crack pattern
80. SC-7S final crack pattern
81. SC-7S after test
82. SC-7S local buckling
83. SC-7S plastic hinge
84. SC-7S Local buckling and plastic hinge
85. SC-7S failure
86. SC-7S after test
87. SC-7S plotter
88. SC-5S honeycomb
89. Sc-5S honeycomb
90. Gage and wires protection
91. Gages and wires protection
92. SC-5S honeycomb
93. Loaded end of SC- S beams (typical)
94. Slip and separation instrumentation
95. Overall view SC-7S
96. Local buckling (typical)
97. SC-7S lateral view
98. SC-7S end attached to the floor
99. Loading mechanism
100. SC-7S local buckling
101. SC-4S side view
102. SC-4S positive bending test

5.0 List of Publications

Garcia, I., and Daniels, J. H.
NEGATIVE MOMENT BEHAVIOR OF COMPOSITE BEAMS, Fritz Engineering Laboratory, Report No. 359.1, Lehigh University, July, 1970

Garcia, I., and Daniels, J. H.
VARIABLES AFFECTING THE NEGATIVE MOMENT REGION BEHAVIOR OF COMPOSITE BEAMS, Fritz Engineering Laboratory, Report No. 359.3, Lehigh University (Paper in preparation)

Garcia, I.
NEGATIVE MOMENT ANALYSIS OF COMPOSITE BEAMS. Dissertation, October, 1970

Garcia, I., Daniels, J. H.
NEGATIVE MOMENT ANALYSIS OF COMPOSITE BEAMS, Fritz Engineering Laboratory, Report 359.4, Lehigh University, November, 1970

6.0 Address and future employment

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7.0 List of Computer Programs

The following computer programs have been written. All of them used FORTRAN IV language.

I Data Reduction:

1. Main Program - DTARDC

   Sub-routines -: DTAINP
   STRRDG
   SECPLT
   LNGPLT
   CRUPLT
   LSSQRS
   STRRES
   AXSNTR

II Theoretical Calculations

1. FORCE
2. THEORY
3. SHRLAZ

Programs Documentation:

The data reduction program consists of a main program plus nine routines. This computer program allows to enter the readings recorded from the SR-4 electrical strain gages and a set of instructions, to come out with the following results

1. Transformation of the readings into strains and storage
2. Printing of strains
3. Plots the strains obtained at each cross section
4. Plots the strains obtained along the beam
5. Plots section and longitudinal strains using a least square technique
6. Calculate stress resultors:
   - Force in the steel beam along with an index of correlation
   - Force in the reinforcing bars
   - Unbalanced force between slab and steel beam
   - Moment resisted by the steel beam
   - Moment contributed by the slab
   - Total Moments
   - Position of the neutral axis
   - Checks equilibrium
7. Plots the following stress resultants along the beam
   - Force in the beam
   - Force in the slab
   - Moment in the beam

- Moment contributed by the slab
- Neutral axis

The orderly sequence of the data is as follows:

1. Six cards given instructions to the main program
2. Strain gage readings
3. Two cards given instructions to the STRRES routine.

The first five data cards are as follows:

Cards No. 1 to 3 require:

a. Number of instrumented sections of the beam

b. Number of loads analyzed

c. Logical to print the stresses

d. First load to be plotted

e. Last load to be plotted

f. Logical to plot strains at each section

g. Initial section to be plotted

h. Last section to be plotted

i. Logical to joint the plotted points with a smooth curve

FORMAT: (28X, I3, 19X, I3, 20X, L3, /, 36X, I3, 27X, I3, /, 22X, L2, 14X, I2, 3X, I2, 31X, L2)

Card No. 4 requires:

a. Logical to plot strains along the beam

b. Initial gage to be plotted

c. Last gage to be plotted

d. Logical to join the points with a smooth curve

e. Order of the polynomial curve to join the points

FORMAT: (27X, L3, 11X, I2, 3X, I2, 14X, L3, 9X, I3)

Card No. 5 requires:

a. Logical to calculate stress resultants

b. Number of bars of the top layer having no strain gages

FORMAT: (26X, L3, 35X, I3)

Card No. 6 requires:

a. Reference load No. 1

b. Starting load for reference load 1

c. End load for reference load 1

d. Reference load 2

e. Stat load for reference load 2

f. End load for reference load 2

g. Logical to indicate whether all the headings of the bars of sections 2, 4 and 6 are given or not

FORMAT: (11X, I2, 10X, I2, 3X, I2, 6X, I2, 10X, I2, 3X, I2, 22X, L2)

Cards containing the readings:

These cards are supposed to have no mistakes. Each card contains nine pieces of information divided into three groups of three data quantities each. The first number corresponds to the gage number (see X file "General" for gage number) and is not to be read by the compiler. The second number is the recorder reading, and the third number the multiplier of the reading.

The information is given in sequential order, 3 gages each card and nine cards per cross-section which makes a total of 27 gages per cross-section. This modulus is repeated for the number of sections times the number of loads analyzed. The maximum capacity is

for nine sections and fourteen loads.

FORMAT: (5X, 3(6X, F6.0, 2X, F2.0, 2X))

Two end data cards require:

a. Area of the bars in the bottom layer

b. Area of instrumented bar in the top layer

c. Area of non instrumented bars in the top layer

d. σy in the flanges

e. Ey in the flanges

f. σy in the web

g. Ey in the web

h. Logical to suppress printing of results

i. Logical to plot force in the beam

j. Logical to plot moment in the beam

k. Logical to plot moment contributed by the slab

l. Logical to plot total moment

m. Logical to plot neutral axis position

n. First load to be plotted

o. Last load to be plotted

p. Power of the polynomial to be fitted

q. Logical to joint points with smooth curve

r. Thickness of the flanges

s. Thickness of the web

t. Depth of the steel beams

FORMAT: (6X, 3(F3.0, 1X), 4(F10.0, 1X), 6(L2, 1X), / 6X,
3(I2, 1X), L2, 3(6X, 2F6.0))