Study on Strain Calculational Technique of Concrete Bridges by Frame Analysis

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Summary

In the strain measurement by the loading examination of a real bridge and the analysis by the reproduction design, it is known that a big difference is generated between the two. Here, the cause of this problem is clarified, and the authors introduce one technique for unlimitedly reducing this difference by the frame analysis. In the report, the strain result of a measurement by loading examination and the result by frame analysis that simply modeled bridge like a grid are used. And (1) the section evaluation to disregard concrete tension zone applied by design in general, (2) the section evaluation assuming full cross-sections to be effective, and (3) the method of reading strain of referenced section directly by using fiber element for frame analysis were tried, and comparative study of the stress is made. The difference of each solution is clarified, and the case of assuming effective full cross-sections and reading strain directly from the fiber element obtained good results.

Keywords: reinforced concrete T type girder bridge, reproduction design, loading test, frame analysis.

1. Purpose of the research

In the strain measurement by the loading examination of a real bridge and the analysis by the reproduction design, it is known that a big difference is generated between the two. The cause of this problem was clarified, and the technique for reducing this difference was examined by the frame analysis that the designers use in general.

2. Research content

Based on the report of the loading examination executed in reinforced concrete T girder bridge under use, the method for estimation was examined by using the reinforced concrete strain (stress) in the main girder based on the frame analysis.

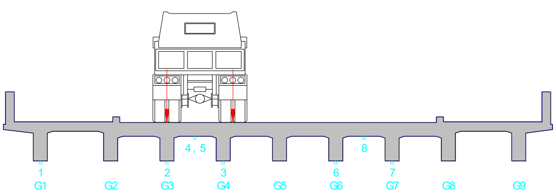

Fig. 1: Loading point

One example of loading method in the loading examination is shown in figure1, where a load is applied to G3 and G4. G1-G9 in the figure shows the main girder number, and other figures show

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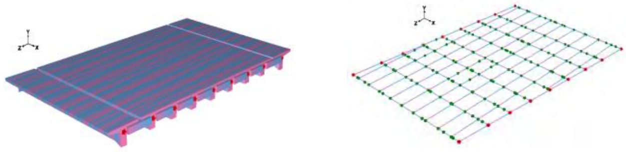

Fig. 2: Analytical model

Table 1: Stress examination pattern

Pattern	Method of evaluating stress degree
1	Linear element - RC sectional calculattion (Stress average of refferenced reinforcing bar position)
2	Linear element - RC sectional calculattion (disregard tension zone of concrete)
3	Linear element - RC sectional calculattion (effective full cross-section)

Table 2: Analytical result

Gauge point	Number of girder	Stress (N/mm²)			
		Loading Data	Pattern1 Fiber model	Pattern2 L.Frame1	Pattern3 L.Frame2
M.G.L.Flng	G1	1	0.5	2.1	0.4
M.G.L.Flng	G3	9	10.8	52.8	9.7
M.G.L.Flng	G4	8	10.6	52.0	9.5
M.G.L.Flng	G6	2	0.8	4.0	0.7
M.G.L.Flng	G7	1	0.1	0.4	0.1

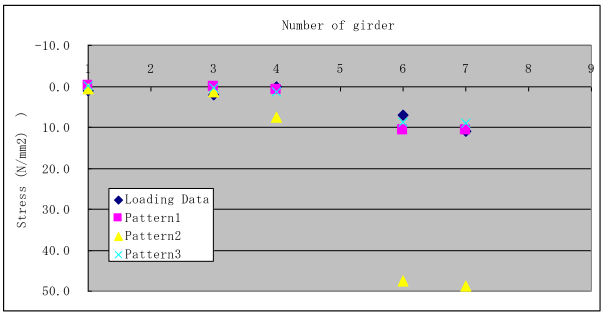

Fig. 3: Stress generation distribution chart

the gauge number in the loading examination.

The deck is divided into nine cross beams, because this bridge has no intermediate cross beams. The grid model show in Figure2 was set. The stress examination was done employing the fiber linear element by which stress-strain can be obtained directly when section is checked using modulus of elasticity and section constant. The reinforced concrete stress calculation in linear element was executed for the case of disregarding concrete cross sectional tension zone (Young's modulus ratio 15) and for the case of concrete effective full cross-section(Young's modulus ratio 7.55) (See Table1). In addition, Young's modulus ratio for effective full cross-section is what calculated based on Young's modulus presumed from strength of concrete, and is equal to that in the case of the fiber element analysis.

These numerical results were compared with the loading test outcome as shown in Table2 and Figure3. Only the pattern to disregard tension zone of concrete obtains a big value in case of loading to G3 and G4 girders, and, as for other patterns, an almost identical results are obtained. Comparable results are obtained in the examination in other loading positions.

3. Conclusion

1. In reinforcement concrete T girder simple bridge(RCt bridge), the stress calculated from a linear analysis assuming full cross-section effective and the stress that used the fibre element almost became equal with the measured value though divided deck and main girders were simply combined in the middle. The latter was able to show the stress directly as an output of the frame analysis though the former required two stages: the stress check and the analysis of the frame.

2. In usual RCt bridge, the stress calculated from general section check (ignoring the tension zone of concrete) reaches a big value compared to the stress calculated assuming full cross-section effective. Ignoring the tension zone of concrete over estimates the actual stress.

3. In usual RCt bridge, using linear grid model and assuming full cross-section to be effective give a satisfactory result.

4. The section evaluation disregarding the tension zone of concrete should be applied to the section where the crack has progressed over neutral axis.

5. The influence on the whole model is comparatively small even if the method of transmitting the load differs whether the load is distributed to main girder or the cross beam(the deck).