I-359 ESTIMATION OF INCREMENTAL COEFFICIENT BASED ON SYSTEM RELIABILITY

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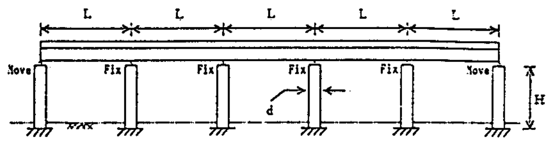
1. INTRODUCTION

Recently,there are many attention to the development of design code based on a probability-based load and resistance factor design(LRFD) and the reinvestigation of the current design code(allowable stress design). Load factors and allowable stresses used in both design methods are mostly determined based on element reliability. However,such values may be not suitable to use in statically indeterminate structures. It is known that in such structures the failure of one element does not necessarily mean the collapse of the whole structure. It consideres factors of safety based on the initial(element) failure not the failure of the whole structure. This paper attempts to investigate the reliability of multi-span continuous bridges designed by the current design code at structural element and system level and to find how level of increment coefficient should be assigned.



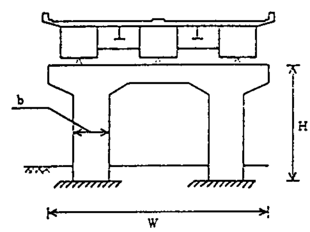


Figure 1

2. RELIABILITY OF STRUCTURES DESIGNED BY THE CURRENT DESIGN CODE

In this paper,six models of multi-span continuous bridges having superstructures of five and seven-span continuous box girder bridges and substructures of reinforced concrete rigid-frame pier as shown in Fig. 1,are selected for this investigation. Table 1 and 2 shows the geometrical dimensions of each models and design load combination format. The sectional design of substructures are controlled by combination of dead,live and temperature loads.

2.1 Actual Loads <u>Dead Load</u>: Here,only the own weight of structure is considered and is assumed to be deterministic. <u>Temperature Load</u>: Distribution of temperature loads are obtained from temperature records in Tokyo metropolitain area and assumed to be normal distribution. <u>Earthquake Load</u>: Actual earthquake load is modeled as $Kh = Sa/g$, where Sa = linear acceleration response spectrum and g = acceleration of gravity.The probability distribution of Sa is determined from earthquake data during 59 year and assumed to be the extreme value distribution of the first kind. The combination of actual loads used in this analysis are shown in Table 3.

2.2 Reliability analysis For element reliability, we consider the reliability of pier at the point where the maximum failure probability occurs.

Table 1

Unit: metre

Model No.		Span Length L	Pier Height H	Pier Width W	Column Width b	Column depth d
5-SPAN	1	40.0	12.0	19.0	2.70	2.70
	2	50.0	12.0	19.0	2.80	2.80
	3	60.0	12.0	19.0	2.90	2.90
7-SPAN	4	50.0	12.0	19.0	3.10	3.10
	5	50.0	12.0	19.0	3.20	3.20
	6	50.0	12.0	19.0	3.30	3.30

Table 2

Code No.	Load Combination Format	Incremental Factor R.C	Incremental Factor Steel
1	D + L	1.00	1.00
2	D + L + T	1.15	1.15
3	D + EQ	1.50	1.50

Turkstra's rule of load combination is used to evaluate the failure probability of each elements. The capacity of the elements expressed by the bending moment. For System reliability,the computation of structural system reliability is complex because all the failure modes must be considered. Due to the difficulties of mode identification, mode combination ,etc.,this paper uses the method presented by Murotsu[1] in the analysis. Figure 2 and 3 show the failure probability of element and structure systems which its section are designed by Code 2. It is found that failure probability of element is low in Case 2 but large in Case 3 and 4. However,when considering of system reliability,failure probabilities of Case 3 and 4 are higher than Case 2. It is also found that the current design code gives high level of safety when number of span and span length are increased.

3. ESTIMATION OF INCREMENTAL COEFFICIENT

From the above results,it is found that decision of incremental coefficient should consider both element and structural system reliability. The computing of incremental coefficient are here considered based on method presented in reference[2]. Here the target failure probability for element and structural system are assumed as 10^{-3} and 10^{-5}. Table 4 shows the suitable incremental factor for D+L+T. It is found that if only element reliability are considered, increment coefficient of 1.50 should be used. But if both reliabilities are considered,incremental coefficient of 1.35 should be used. However,if we consider structural reliability under the combined load effect of bending moment and axial force,the increment coefficient will be nearly the value used in the current code.

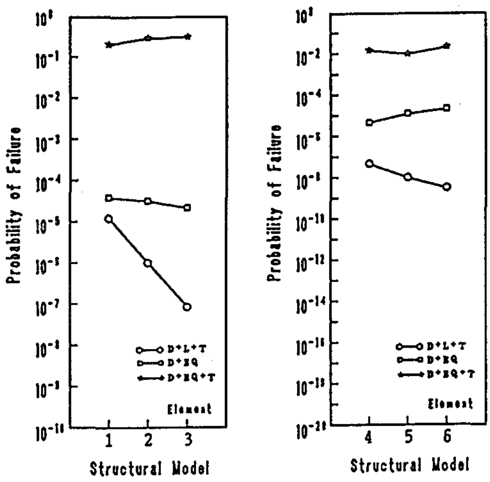


Figure 2

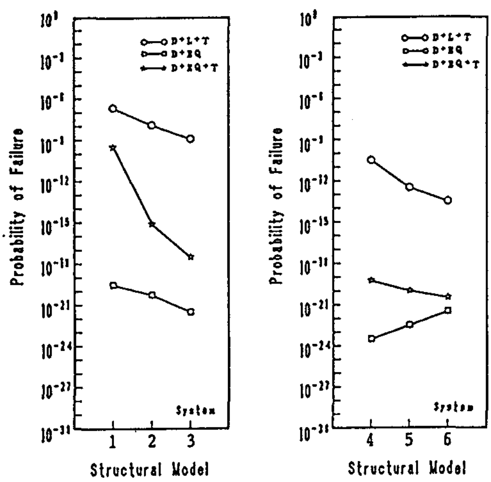


Figure 3

Table 3

Case No.	Load Combination Format
1	D + L
2	D + L + T
3	D + EQ
4	D + EQ + T

Table 4

Incremental Factor	Ωe	Ωs	Ω=Ωe+Ωs
1.15	2.2167	0.0250	2.2417
1.25	1.0368	0.0281	1.0650
1.35	0.4225	0.1570	0.5798
1.45	0.2309	0.4584	0.6894
1.50	0.2274	0.5758	0.8033
1.56	0.2298	0.7481	0.9780

REFERENCES

[1] Murotsu,Y.,Okada,H.,et al.,Automatic Generation of Stochastically Dominant Modes of Structural Failure in Frame Structure.,Bulletin of University of Osaka Prefecture,Series A,Vol.32,No.2, 1983,pp.85-101. [2] Susumu E.,Osamu,A.,Probabilistic Load and Resistance Factor Design,Structural Safety and Reliability,Vol.II,ICOSSAR,1985.