ANALYSIS OF LOAD TEST RESULTS FOR MAUBIN BRIDGE IN MYANMAR

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1. INTRODUCTION

Maubin Bridge, a 480 m long 4 span continuous steel truss bridge on the Ayeyarwady River in Myanmar, was constructed in 1998 and it was originally designed with the assumed earthquake load of 0.1g, which was lower than the recommended values described in the new seismic zone map of Myanmar (2012). Hence, the performance of the bridge under the increased seismic loads is urgently evaluated for the potential seismic retrofit. To evaluate the current situation and dynamic characteristics of the bridge, static and dynamic load tests were done on the bridge on 21^{st} and 22^{nd} September 2016 while the traffic was closed during the test. Then the measured results were compared with the values obtained from the ABAQUS bridge model to perform model updating.

2. BACKGROUND

There are some major problems with the construction and maintenance of bridges in Myanmar after 1990 due to limited construction time and materials, and nearly half of them were located in the delta and coastal regions. Hence, corrosion due to the sea salt and the movement of bridge substructures on soft soil became major problems. In 2000, the abutment of Maubin Bridge on the Maubin side moved forward due to lateral earth pressure tilting some piers, and the bridge shoes were found to be greatly deformed due to the horizontal shear force.
Moreover, Myanmar is also one of the disaster prone countries in South East Asia and, many strong earthquakes had occurred along the active Sagaing Fault, which runs from north to south passing through near major cities like Yangon, Bago, Nay Pyi Taw and Mandalay. As an example, one span of Yadana Theinga Bridge, a bridge being in construction, fell into the Ayeyarwady River in 2012 Thabeikkyin Earthquake. According to 2012 Seismic Zone Map of Myanmar, Maubin is located in the seismic zone where the peak ground acceleration is expected from 0.11 to 0.2 g for the return period of 475 years (Level I earthquake) and from 0.21 to 0.4 g for the return period of 2475 years (Level II earthquake).

3. STATIC AND DYNAMIC LOAD TESTING RESULTS

Static and dynamic loading tests on Maubin Bridge were done on 21^{st} and 22^{nd} September 2016 while the traffic was closed during the tests. For static loading tests, strains were measured on four different members (D12, D13, L7, U10) as shown in Fig. 1 with a strain checker on the upper surface of U10 and three strain gages on flanges and web on each of other members. Deflection of the truss at point 2 was also measured by a digital camera from the ground and the results were processed later by the OpticG 2D software. For the dynamic test, accelerometers were installed on the top of floor beams at locations 2, 3, 4 on the upstream side truss and another one at location 3 on the downstream side truss. For both load tests, two 6-axle (60 ton trucks) were used from the Ministry of Construction, and the trucks was running with 20 km/h and 40 km/h speeds as well as ambient vibration condition for dynamic loading tests. For static tests, a 60 ton truck was placed with the center rear axle at each of the locations from point 1 to 8 while going from Yangon side to Maubin side, and then two trucks were placed on locations 2 and 5 simultaneously on the upstream side lane. A slip between the strain checker and the surface of top chord U10 occurred during the test.

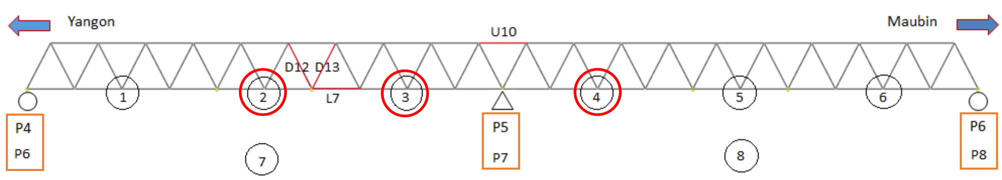

Fig. 1 Location of 60 ton trucks load points: O, accelerometers: O, strain gages: – and piers: □ on the bridge.

3.1 Results from static loading test

During the static loading tests, strains were measured for members D12, D13, L7, U10, and truss deflection at point 2. Comparison results between the measured results and ABAQUS FE bridge model analysis results are shown in Table 1 for the strain and the deflection. All the data show comparable results between the measure data and the model data, except for some of the data for the load point 2 and for the member D13 where a transverse portal bracing frame is attached. The difference between measured and model data for member U10 may be due to the occurrence of slip between the magnetic strain checker and the surface of steel member. Differences for member D13 may be due to the model connection between the truss and the portal frame.

Keywords: Maubin Bridge, static and dynamic load tests, model updating
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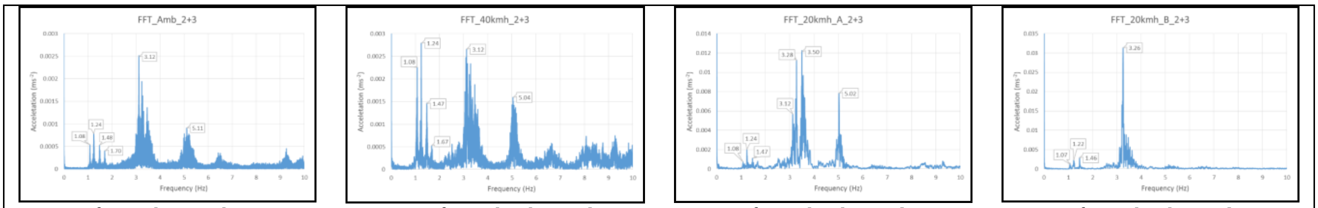
3.2 Results from dynamic loading test

To measure the vibration response of the bridge, four accelerometers (Ch 1~ Ch 4) were installed on the top of floor beams at locations 2, 3 and 4 on upstream side truss and at location 3 on downstream truss. The vibrations were measured for ambient condition as well as while the trucks were running with 20 km/h and 40 km/h speeds on the bridge. FFT graphs drawn from the half sum of Ch 2 and Ch 3 data for bending modes are shown in Fig. 2, and fundamental frequencies of the bridge obtained from FE analysis are compared from the first four peaks from FFT graphs showing around 1.08 Hz, 1.24 Hz, 1.47 Hz, 1.67 Hz. The graphs also show that 40 km/h speed and ambient vibration excited more range of frequencies than 20 km/h speed, and it can be said that measured frequencies can be comparable with the frequencies obtained from FE analysis.

Table.1 Comparison between the measured and the FE model strain and deflection by (60) ton trucks.

Load Points	Measure strain in members ^{a} (x10^{-6})				Model strain in members ^{b} (x10^{-6})				Difference in member strain $^{(b-a)}$ (x10^{-6})				Measure deflection ^{c} (mm)	Model deflection ^{d} (mm)	Deflection difference $^{d-c}$ (mm)
	U10	D12	D13	L7	U10	D12	D13	L7	U10	D12	D13	L7			
1	11	-25	39	13	17	-46	65	6	6	-21	26	-7	-7.3	-12.0	-4.7
2	22	-29	87	38	33	-36	171	24	11	-7	84	-14	-6.0	-21.1	-15.1
3	13	16	-16	24	27	13	-17	8	14	-3	-1	-16	-2.9	-7.2	-4.3
4	17	-6	2	-9	36	-8	10	-5	19	-2	8	4	-1.9	3.7	5.6
5	16	-5	2	-10	32	-8	10	-5	16	-3	8	5	-1.5	3.7	5.2
5 + 2	41	-34	85	24	65	-44	181	19	24	-10	96	-5	-1.6	-17.4	-15.8
6	-16	2	-2	-1	10	-3	4	-2	26	-5	6	-1	0.6	1.3	0.7
7	-31	6	-11	6	-6	2	-3	1	25	-4	8	-5	0.8	-0.8	-1.6
8	-26	4	-9	4	1	0	0	0	27	-4	9	-4	1.2	0.2	-1.0
5	27	-7	8	-13	30	-9	13	-6	3	-2	5	7	-	-	-
2	27	-36	53	29	26	-57	90	14	-1	-21	37	-15	-	-	-
2 + 5	51	-43	60	14	56	-66	103	8	5	-23	43	-6	-	-	-



FFT for Ambient Vibration | FFT for 40 km/h speed | FFT for 20 km/h speed - A | FFT for 20 km/h speed - B

Fig.2 FFT graphs showing fundamental bridge frequencies in bending mode

4. ADJUSTMENT OF FE BRIDGE MODEL

In order to adjust the bridge model with the measured results from the load tests, the mass of bridge decks were increased because the mass of parapet walls and handrails were not included in the previous analysis. The mass of main decks were increased from 25.3 cm to 32 cm and the mass of side decks were increased from 16.6 cm to 20 cm. After updating, fundamental frequencies of the bridge became close to measured values, but there was no change for strain and deflection because mass is not related with the stiffness, and the weight of the bridge is not included in the analysis for load test. The original and updated model frequencies are compared with measured frequencies as shown in Table 2.

Table.2 Measured and Updated Model Frequencies

Bending Mode	Measured Frequency ^{a}	First Model Frequency ^{b}	% Difference (b-a)/a	Updated Model Frequency ^{c}	% Difference (c-a)/a
1st	1.08 Hz	1.18 Hz	9.26 %	1.09Hz	0.93%
2nd	1.24 Hz	1.34 Hz	8.06%	1.24 Hz	0%
3rd	1.47 Hz	1.57 Hz	6.80%	1.46 Hz	-0.68%
4th	1.67 Hz	1.77 Hz	5.99%	1.65 Hz	-1.20%

5. CONCLUSIONS

The following conclusions can be drawn from the analysis of Maubin Bridge between FE model and load testing results:

- Member strains, deflections and frequencies of the bridge from load tests show comparable results with the values from the bridge FE model except for member D13 and at loading point 2.
- FFT graphs for ambient vibration and 40 km/h truck speed excite more frequencies than 20 km/h truck speed.

REFERENCES

Khin Maung Zaw, Suzuki, Y., Matsumura, M. and Sugiura, K.: Analysis of Maubin Bridge in Myanmar for seismic retrofit, Proceedings of the 11th German-Japan Bridge Symposium, 2016, Osaka, Japan.

Khin Maung Zaw, Suzuki, Y., Matsumura, M. and Sugiura, K.: Analysis and load testing results of Maubin Bridge in Myanmar, Proceedings of the 29h KKHTCNN Symposium on Civil Engineering, 2016, Hong Kong, China.