

Highway Network Performance in the Hanshin-Awaji Earthquake Disaster

Part 1. Hanshin Expressway Route 3 and Route 5

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Abstract

Network performance of Hanshin Expressway Route 3 and 5 in terms of average daily traffic volumes (ADT) has been compiled on monthly basis for pre- and post-earthquake period from October 1994 through October 1996. Locations of highway closure and network configuration strongly affected the network performance both in advantageous and disadvantageous manners.

Background

The January 17, 1995 Hyogoken-Nanbu earthquake (M=7.2 on the Japan Meteorological Agency (JMA) scale) caused severe physical damage to highway structures, and the damage caused long-term disruption to highway network in the Hanshin area. The most significant damage occurred to Hanshin Expressway Route 3 (Kobe Line). Before the earthquake, Route 3 shared approximately 40 percent (average daily traffic (ADT)=101,900) of east-west corridor traffic at Ashiya screen line (ADT=252,800), providing an important connection between the Osaka and Kobe metropolitan areas. Approximately half of the 1,175 piers in Hyogo Prefecture suffered major to minor damage. Major damage included turnover of 18 spans at Higashinada-ward in Kobe city and collapse of 10 spans at Nishinomiya and Kobe city, leaving approximately 28km closed to traffic until September 30, 1996, or more than 20 months after the earthquake.

On Hanshin Expressway Route 5 (Wangan Line, pre-quake ADT=28,300 at Ashiya screen line), collapse of the Nishinomiya-ko Bridge and major damage to three bridges occurred. After partial reopening, Route 5 began to serve as a main alternative to Route 3, together with Routes 7 and 16 which did not experience physical damage. During the daytime, access was limited to emergency transportation for reconstruction work and disaster relief activities based on the the Road Traffic Law.

Observation

Fig.1 shows section ADT (total of two directions) at Hanshin Expressway Route 3 calculated using traffic volume observed at toll gates and on/off ramps. Eight time phases are selected : (1) before the earthquake (October, 1994), (2) immediately after the earthquake (January 1995), (3) after the damage inspection finished (February 1995), (4) after reopening of Maya-Kyobashi (February 1996), (5) after reopening of Kyobashi-Yanagihara (July 1996), (6) after reopening of Fukae-Maya (August 1996), (7) after reopening of Yanagihara-Tsukimiyama (September 1996), and (8) after the completion of reconstruction work (October 1996). Major progress of recovery in terms of traffic volumes can be seen at phase (7) and phase (8), while partial reopening at phase (3)-(6) less contributed to functional restoration. At phase (7), direct

connection between Hanshin Expressway Route 3 and Daini-shinmei Line was recovered at western Kobe. At phase (8), vital interconnection between Kobe and Osaka was finally recovered as a result of completion of the most significantly damaged portion. Since a series connection of links composes “weakest link system,” even a small portion of traffic closure causes severe traffic disruption.

Fig.2 shows monthly ADT at Route 5 for pre- and post-earthquake period from October 1994 through October 1996. It can be seen that Route 5 played an important role as a detour route of severely disrupted Route 3. During the three months before the completion of restoration work, in particular, ADT at each sections increases approximately as much as 30,000-40,000 (vehicles/day) from the pre-quake level. Parallel setup of highway network, in other words, “redundancy,” was effective in avoiding total disruption of east-west traffic connection.

Conclusions

Pre- and post-earthquake process of average daily traffic on Hanshin Expressway Route 3 and Route 5 suggests that progress of reconstruction work is not necessarily proportional to recovery of highway network function. Network configuration and its systematical behavior should be taken into account in damage assessment, pre-earthquake retrofitting plan, and post-earthquake reconstruction work.

References

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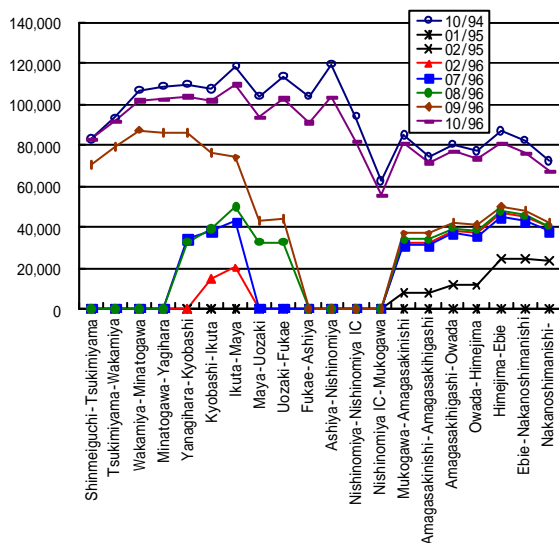


Fig.1: Section average daily traffic in Hanshin Expressway Route 3

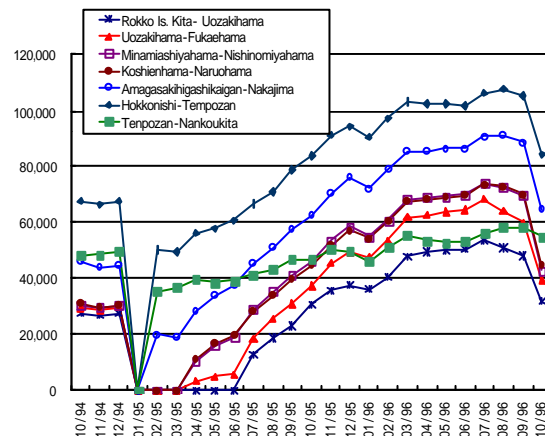


Fig.2: Average daily traffic in Hanshin Expressway Route 5