

5. TRANSPORTATION FACILITIES

5.1 Railways

Figure 5.1 shows the railway network in Kutch region. Damage to railways can be classified as follows:

- 1) Damage to railway tracks,
- 2) Damage to signal & telecommunication system,
- 3) Damage to electrical facilities,
- 4) Damage to stations,
- 5) Damage to bridges.



Figure 5.1 Railway network in Kutch Region

Damage to railway tracks occurred along the following sections of the railway network

- (a) Viramgam-Gandhidham (Broad Gauge:BG)
- (b) Gandhidham-Bhuj (BG)
- (c) Viramgam-Okha (BG)
- (d) Palanpur-Gandhidham (Metre Gauge:MG)

Damage to railway tracks was observed in the form of bending and distortion of rails and tracks due to ground shaking and deformation (Figure 5.2). This situation could be clearly observed at Gandhidham railway station (Figure 5.3). There were three railway lines at this station. Two of them were under construction. It was apparent that some rails were bent or were offset although they were repaired after the earthquake. The restoration of tracks of railway segments are as follows:

BG Tracks

Rajkot-Okha on 26.1.2001

Viramgram-Samakhiali on 25.1.2001

Wankaner-Navalakhi on 25.1.2001

Samakhiali-Gandhidham on 25.1.2001

Gandhidham-Kukma on 25.1.2001

Kukma-New Bhuj on 3.2.2001

MG Tracks

Palanput-Kidiyanagar on 25.1.2001

Kidiyanagar-Gandhidham on 31.1.2001.

20 railway stations across Kutch were damaged as a result of the earthquake. Gandhidham station was the worst-hit. Gandhidham railway station was an RC structure and some structural damage was observed (Figure 5.4).



Figure 5.2 Restored railway line in Ratnal (note the damaged railway ties)

Signalling equipments at 25 stations and Control communications on Viramgram-Gandhidham section damaged. There was a complete communication cut-off at Gandhidham station following the earthquake. Signalling-5 stations restored until 30/1/2001. At 13 stations working restored until 1/2/2001.

Two railway workers have lost their lives at Charai station near Gandhidham. It was also reported that an accident took place on the railway due to de-railment of a train at Ratnal.



Figure 5.3 Railway lines in Gandhidham station and a close-up view of distorted rails



Figure 5.4 Damaged Gandhidham railway station

5.2 Roadways and Highways

Figure 5.5 shows roadways and highways in Kutch region. Out of 650 Kms of highways, 100 Kms severely damaged. Most of roadways had to be re-surfaced due to extensional and bulging type cracking (Figure 5.6). Furthermore, the settlement of embankments of bridges caused differential settlement and slow down of the traffic (Figure 5.7). In some places, the traffic had to be diverted for the repairment of embankments. The toll-gate buildings of the highway 5A were broken at their base columns (Figure 5.8).



Figure 5.5 Roadway and highway network in Kutch region



(a) Bachau-Bhuj roadway

(b) Roadway to Manfera

Figure 5.6 Damaged roadways due to ground deformation



(a) Damaged bridge on Kankawati River



(b) Settlement

Figure 5.7 Settlement of roadway at a bridge on Kankawati River (7km to halvad)



Figure 5.8 Collapsed toll gate of Highway 5A nearby Bachau

5.3 Railway and Roadway Bridges

Except a few bridges, railway bridges were almost not damaged. At a railway bridge 7km from Halvad (100km from the USGS epicenter) there was no visible damage while some damage to roadway bridges at the same location was observed (Figure 5.9). The direction of the bridge with 10 spans was EW. Its height was 5m with a span of 12m. The piers were concrete with dimensions of 1.5m in thickness and 7m in width. The only reported damage occurred at Bridge No.45 between Kukma and Bhuj and it was restored on 3rd Feb., 2001.



Figure 5.9 Non-damaged railway bridge on Kankawati River (7km from Halvad)

Most of the minor/major roadway and highway bridges in Kutch region were damaged (Figure 5.10). Paraphets of the minor and major bridges were totally or partially toppled or displaced in the entire region affected by the earthquake.



Figure 5.10 Collapse of a minor roadway bridge (Oyo corporation)

The investigation team took the route from Ahmedabad to Gandhidham through Virangham, Danghadra, Halvad, Malia, Bachau and Anjar. Along the route the damage started to appear in various forms after Virangham. Damage to roadway bridges after Virangham are briefly presented below:

Dhagadhra Bridge on Godra River (116 km from the USGS epicenter)

The roadway has 2 lanes and the piers of the bridge is stone masonry. The distortion and rupturing of some sliders took place. Embankments settled on the both sides. The direction of bridge N45W-S45E and the girders were displaced by 25cm. The bridge has 10 spans and the foundation is based on sandstone.

Bridge on Kankawati River (7km to Halvad and 100 km from the USGS epicenter)

The bridge has 10 span and each span is 6m wide. Piers are masonry (Figure 5.7). Each pier is 1.3m thick and 7.3m wide. The girders moved in the direction of N75E.

Bridge on Brahmani River (55 km from the USGS epicenter)

It is an RC bridge of Gerber type. Each span is 20m wide. Some visible cracks are seen at the top of the piers of the footings.

Bridge on Malia creek (60 km from the USGS epicenter)

The Bridge has 16 spans. Pier width was 5m by 1.5m and of masonry type with a height of 7m. Movement of girders is in the direction of N36E.

Bridge on Macchu River (55 km from the USGS epicenter)

The bridge has 3 spans which are 25m wide. The embankment failure occurred and liquefaction and lateral spreading of ground nearby the bridge were observed (Figure 5.11).



Figure 5.11 Damage to parapets and settlement of bridge over Macchu River

Hadakiya Creek Bridge (Suraj Bari bridge) (50 km from the USGS epicenter)

The bridge has 30 spans and is of Gerber type. The length of each span is 32.2m. The bridge has caisson type foundations over the Little Rann. The bridge is either uplifted or its northern embankment settled by 60cm. The bridge seems to be subjected to

compression along its longitudinal axis which is aligned in the direction of almost NS. Extensive liquefaction and lateral spreading were observed and a very long ground rupture with a strike of N50E was observed in the ground on the western side of the bridge.



Figure 5.12 Damage to Hadakiya Bridge (Suraj Bari)

Rudramata Bridge (60 km from the USGS epicenter)

This bridge spans over the reservoir of Rudramata earth-fill dam. Its total length is about 120m and it consisted of 10 spans (Figure 5.13). Bridge footings were placed on piles. The length of piles are not known. The soil at both sides of the settled and spread towards the center of the valley (Figure 5.14). Linear cracks run along the longitudinal axis of the valley. Many rock slope failures observed next to its northern embankment. Nevertheless, the bridge was structurally safe although some visible cracks on its piers and girders were observed. The quality of the concrete was poor and the corrosion of reinforcement bars were visible. In addition, some damage to girders due to collision during shaking and rupturing of parapets were observed.

5..4 Airports

The major airports in the area Ahmedabad, Bhuj and Kandla. Ahmedabad airport was not damaged while there were some damage to Bhuj airport. Particularly some damage to buildings of the airport occurred while the runways were non-damaged.



Figure 5.13 Rudramata bridge



Figure 5.14 Settlement of ground around a pier of Rudramata bridge and its damaged state (note also the fallen rock blocks in the vicinity of the pier)