14 Hospitals and Schools

INTRODUCTION

A great many school and hospital buildings across the State of Gujarat were affected in this earthquake. The school and hospital buildings themselves were responsible for many deaths and injuries, and seriously affected emergency medical response and disrupted the routine health care programs and educational processes. The majority of the affected population is covered by the government-sponsored health care and education system, which is often stretched just to meet its normal workflow.

The existing health care system in most of the affected Kachchh region failed when it was needed most. About 167,000 persons were injured across the state and needed immediate medical attention. Hospital facilities were housed in seismically vulnerable structures and were badly damaged or destroyed in the earthquake. This chapter offers a brief overview of the damage caused to physical assets and disruption to health care and education services, and the efforts made to restore these essential services.

HOSPITALS AND HEALTH CARE

A large number of health care facilities were affected during the earthquake, causing serious hindrance in providing emergency medical services to injured and sick persons. The widespread damage to buildings and other structures resulted in not only deaths and injuries to patients and service providers (doctors, nurses, and other supporting staff) but also significant loss of medicines, supplies, and other medical equipment (Figures 14-1 and 14-2). Kachchh district was the worst affected. The other seriously affected Districts were: Jamnagar, Rajkot, Surendranagar, and Patan. Both preventive and curative health care activities were disrupted.

The 281-bed Civil Hospital of Bhuj was the largest hospital of the Kachchh district, and was designated as referral hospital to treat the medical needs of about 1 million people. It offered medical services in the area of general surgery, gynecology, pediatrics, and orthopedics, besides attending to general ailments, trauma and emergencies. Collapse of the two-story hospital building disrupted all medical services, killed 172 people, and left a large number of injured and sick persons without any medical treatment. In Bhachau, one doctor and three staff members died. One health worker was killed in Anjar.

As per statistics from the Government of Gujarat, about 167,000 persons were injured due to the earthquake. The physical injuries varied from minor cuts and bruises to more serious life threatening injuries such as major tissue losses, head, spinal, orthopedic, abdominal and thoracic injuries, etc. requiring major surgeries and advanced medical treatment and care.

A 300-bed hospital is now under construction in Bhuj to replace the collapsed civil hospital. The new hospital will be the first major building in India designed with base isolation.

Figure 14-1. Collapse of the Bhuj General Hospital impaired medical emergency response (www.rediff.com). One hundred seventy-two people were killed.

Figure 14-2. Collapsed Jubilee Hospital in Bhuj.

IMMEDIATE EMERGENCY MEDICAL RESPONSE

In the wake of almost complete collapse of health infrastructure in Kachchh region, the immediate challenge was to arrange for the surgical and medical care for orthopedic and spinal injury cases. In Bhuj after the collapse of the General Hospital, the Military Hospital provided Out-Patient Department (OPD) facility and emergency care round-the-clock and carried out 3,000 major and 6,500 minor surgical operations and provided medical treatment to 12,254 patients.

However, the Military Hospital, too, became overcrowded almost immediately. The Jubilee Grounds (fairgrounds) in Bhuj became an instant hospital with no existing infrastructure of any kind. Volunteer doctors started handling the injured on open grounds while slowly, some infrastructure such as tables, instruments, and beds developed around them. Treatment at the Jubilee Grounds was only a life-saving measure, and after initial treatment, patients were immediately shifted to hospitals outside Kachchh — sometimes as far as Mumbai, Pune, and Surat. One member of the family was allowed to accompany every patient. Many flights arriving Bhuj with relief materials took these patients on their return. In the first two days, about 450 patients were airlifted and about 14 buses of patients were dispatched, as there was no post-operative care.

Outside Aid Important

It was not an easy task for the local doctors to handle an emergency of this kind, since they were themselves traumatised. Most had suffered damages to their own homes or clinics. There was pressure on them to move their families out of the area. Some of the local doctors left the area. Often the injured or dead would be a person known to them, adding to their own trauma.

Hence, outside doctors and paramedics were critical to handling the situation. A team of more than 30 doctors from the All India Institute of Medical Sciences, New Delhi, reached Bhuj the same night, and many more doctors from around the country began reaching the area the next day. Similarly, medicine began arriving in large amounts.

In a short time, while there were plenty of doctors and medicines, there was a shortage of paramedics and surgical instruments. It would have been more effective if the outside doctors had arrived as self-sustaining units consisting of doctors, paramedics, other supporting staff, instruments, etc., so that they could start functioning immediately on arrival without waiting for any support from the local community.

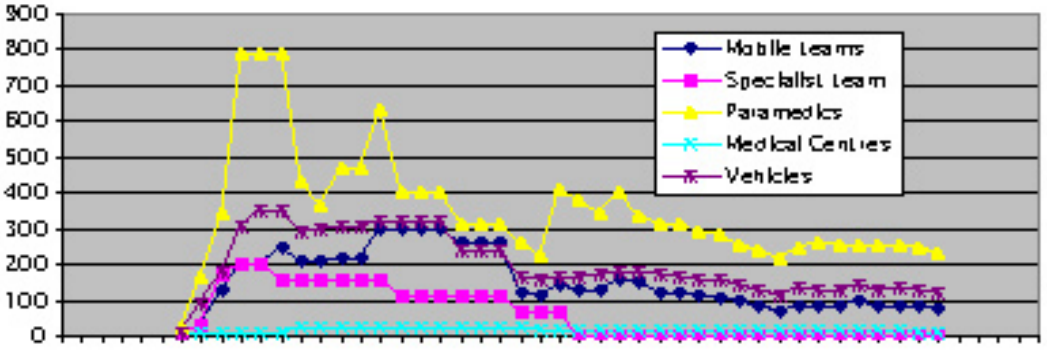

Figure 14-3. Build-up of medical facilities and services in the affected areas after the earthquake.

Many medical teams from foreign countries, such as France, Japan, Norway, Finland, and Korea, also provided medical aid to the affected people. The International Red Cross Society provided a new tent-based hospital to replace the destroyed Bhuj District Hospital. Israel Aid Mission also set up a field hospital in Bhuj and the medical team from Denmark established a hospital in Gandhidham. Similarly, a hospital was provided by Ukraine in Bhachau, and Japanese medical units were operating from Madhapura and Kukuma. In many cases, the international hospitals took a few days to come and set up and by that time many of the patients had been moved out of the area. In that sense, the international medical teams, even though very helpful, cannot in the future be counted on to handle the immediate emergency in the first 72 hours. In addition, communication with international doctors was a problem due to the language barrier.

Considering that the entire situation emerged instantaneously, wherein the patients were moved out immediately after first treatment, proper documentation on the patients could not be maintained. An opportunity to study the types and severity of injuries was lost in the process.

However, the situation improved quickly, and within two days of the earthquake, there were 26 medical treatment centers working. In the worst affected Kachchh district, there were 450 medical teams including 245 teams in the rural areas. These teams consisted of about 200 specialists, 450 doctors, 785 paramedics, and 81 ambulances. In all, they provided first aid to 129,877 persons and preliminary treatment to 136,048.

The gradual build-up of the medical facilities and presence of personnel in the affected areas is shown in Figure 14-3. It took two to three days to put together all the infrastructure that was needed to effectively address the medical needs. These emergency services were maintained for about two weeks at peak strength, and were slowly decreased as the situation improved. Hospitals in Mumbai, Pune, and Surat received 4,829 seriously injured cases evacuated by air or by road.

Local Medical Community Helps Establish Permanent Hospital

One of the interesting examples of what the local medical community of Bhuj did to help the earthquake victims was to act as participatory catalyst in transforming their individual efforts into establishment of a 100-bed temporary hospital, which later became the Government General Hospital, a substitute for the lost Civil Hospital of Bhuj. A group of medical professionals associated with the Indian Medical Association (IMA) realized that once external medical teams

had left the region, there would be once again the problem of caring for the future medical needs of earthquake victims.

With help from the Bhuj local chapter of the IMA, and local medical community and government, they set up a temporary hospital to replace the lost emergency medical services of the Civil Hospital.

On February 4, the IMA General Hospital started functioning on the Jubilee Grounds from a prefabricated structure of three wings of 400 square feet each, housing an Out-Patient Department (OPD), an operation theater complex, and a 20-bed ward. In the next few days, the hospital grew to a total floor area of 6,400 square feet with a 4,000 square foot indoor wing. OPD section, laboratories and X-ray department, and two operation theatres occupied an additional 2,400 square feet. On a typical day, it provided OPD care to 600 to 800 patients, day care to 10 to 40 patients while up to 8 surgeries were performed. Many local and visiting doctors volunteered their time and services. This hospital was later handed over to Civil Hospital authorities.

Hospitals in Ahmedabad

In Ahmedabad, medical response was satisfactory primarily because the number of casualties were not large considering the medical infrastructure of the metropolitan city. However, this earthquake did expose the lack of preparedness on the part of hospitals to deal with major crises. Ahmedabad Municipal Corporation runs four major hospitals in the city, namely, Vadilal Sarabhai (V.S.) Hospital, Lalubhai Gordhandas (L.G.) Hospital, Saradabehn Hospital, and Civil Hospital. These hospitals treated patients from the Bhuj and Anjar areas as well. The Ahmedabad Civil Hospital treated 148 patients from the city, 486 patients from Bhuj, and 41 patients from other places up to February 18. They were adequately equipped and staffed to treat earthquake victims; however, there was an initial shortage of bandages. A lot of absences were reported among the clerical staff, especially among women employees. The trauma ward of V.S. Hospital was closed down due to damage to the building. There was no adequate arrangement for backup electric power supply at these hospitals. Saradabehn Hospital had no diesel generator sets and L.G. Hospital had only two sets for the surgical ward and ICU. The dead brought to these hospitals were cremated without postmortem because only two hospitals in the city were authorized to perform postmortems.

DAMAGE TO PHYSICAL ASSETS

The majority of the people in the affected area are covered by the government-provided health care system, which has a tiered structure of health facilities organized at primary, *taluka* (sub-administrative units within a district), and district levels.

The most basic services are available at large number of Primary Health Centers (PHCs). District Hospitals act as referral hospitals and are equipped with various facilities for surgical and medical treatment. Super-specialty hospitals are few and located in major towns only. The Health Sub-Centers (HSC) are staffed with an Auxiliary Nurse Midwife (ANM) or a Family Health Worker, whereas Primary Health Center (PHC) is staffed by one or two doctors (Medical Officers). Many programs for routine immunization, family welfare, and prevention of epidemics outbreak are carried out through PHCs and HSCs. The Community Health Centers (CHCs) offer major medical services and are supported by three to four doctors who are usually specialists. The area is further served by many dispensaries, which offer medications in the Indian system of medicine (*Ayurveda*) and homeopathy. There are also significant facilities for the Integrated Child Development Scheme (ICDS), a program directed to the nutritional and developmental needs of children between the ages of birth and six years and the special needs of pregnant and lactating mothers. Table 14-1 summarizes the damage to physical assets to these medical facilities across the State of Gujarat.

Table 14-1. Damage to physical assets.

Facilities	Destroyed	Damaged
District/*Taluka* Hospitals	5	26
Community Health Center (CHC)	21	46
Primary Health Center (PHC)	48	118
Sub-centers	227	357
Integrated Child Development Scheme (ICDS) *Anganwadis* (kindergartens)	800	2180
Chief District Project Officers office	11	4
Go-downs (warehouses)	6	4
Ayurvedic/homeopathic dispensaries	110	8
Medical colleges and specialty hospitals	-	15

(Source: Department of Health and Family Welfare (DOHFW), Government of Gujarat)

Many other supporting and training facilities were affected. In Bhuj, in addition to collapse of the main hospital building, serious damage occurred to the Nursing School Hostel, ANM Training School, Tuberculosis Center, and the Mental Hospital and staff quarters located in the same building complex. Regular operations of the state-of-art food laboratory in the Bhuj district were disrupted requiring all laboratory tests to be carried out at another facility in Vadodara. Hospitals for tertiary care in Ahmedabad operated by the municipality suffered damage to their structures. In addition, significant damage occurred to medical facilities in the private sector. In Bhuj, services of about 80 private doctors suffered, most of which could have provided curative care.

The go-downs (warehouses) of Central Medical Stores Organizations (CMSO) in the affected region were safe and the medical supplies were available for distribution. However, they were not available in sufficient quantity at the regional stores and needed to be brought from the CMSO Depot in Ahmedabad. There was no shortage of drugs and medical supplies, as they were made available by various state governments, private sector, and many NGOs.

PREVENTION OF EPIDEMICS

To prevent outbreaks of epidemics, an extensive surveillance system instituted throughout the affected area. Expert teams from the National Institute of Communicable Diseases (NICD) assessed the prescribed preventive measures to be followed. A Disease Surveillance Cell was also set up in Bhuj on February 5. In the first one and a half weeks, about 6 million chlorine tablets and 70,000 units oral rehydration solution (ORS) were distributed in the area. The water supply system was routinely tested for chlorine level and presence of coli bacteria to prevent water-borne diseases. Medical expert teams from UNICEF and WHO also assisted the local authorities in surveillance efforts and re-establishing the routine immunization program, which was severely disrupted due to widespread damage to infrastructure and displacement of medical personnel.

LESSONS LEARNED

- Infrastructure of health care facilities must be earthquake resistant so that they are not only available for post earthquake emergency care, but can continue to provide routine medical services to earthquake victims and the community.
- Doctors and paramedics from unaffected areas were far more effective than local medical personnel who may have been affected by earthquake damages and losses, traumatized, and possibly displaced.
- To be most effective, visiting medical teams should come fully prepared to handle the patients and should include adequate number of paramedics. They should also carry surgical instruments, medicines, provisions for laundry, kitchen, toilets, sanitation, hospital waste disposal facilities, etc.
- Considering an all round collapse of the medical infrastructure and the large number of injured, patients were moved to hospitals outside the affected area, especially those requiring post operative care. Many such patients were conveniently air-lifted by planes bringing relief supplies on their return flights to Ahmedabad, Mumbai and Pune.
- Regional stores of CMSO should stock up medicines and medical supplies in quantities that would be required in case of emergency. Medicines were later available in plenty, but there was shortage of surgical instruments and paramedic personnel. Further, ready-to-administer medications (such as, prepared injections) were needed to save time and enhance the efficiency of emergency care.
- Though international medical teams provided much-needed immediate assistance, they required sometime to be set up and could not be available for follow-ups, because of their short-term presence. Further, many teams required the local help to set up their facilities, which was difficult to gather among the affected and displaced medical personnel. They also faced difficulty conversing with patients because they spoke different languages. Hence, in future such emergencies, domestic medical teams could be far more effective.
- An opportunity to study scientifically the nature and extent of injuries inflicted in such a disaster was lost due to lack of any monitoring and recording of services rendered to injured persons at various treatment centers.

SCHOOLS AND EDUCATION

Formal education processes at primary and secondary/higher secondary levels were affected in 18 districts of the State of Gujarat following the earthquake, due to widespread damage to physical infrastructure including classroom buildings. Though these facilities are spread over the entire affected area, a great majority of them are in the Kachchh region, which was most affected by the earthquake, as shown in Figure 14-4. The worst affected districts were: Kachchh, Banaskantha, Patan, Rajkot and Surendranagar. A total of 1,884 school buildings collapsed, resulting in a loss of 5,950 classrooms. In addition, 11,761 school buildings suffered major to minor damages, rendering an additional 36,584 rooms unfit for holding instruction sessions. The Department of Primary Education of Government of Gujarat had previously launched a massive program of providing 6,000 school buildings using precast structures for speedy construction during April 1999 to November 2000 in phase I. About three-fourths of such newly built classrooms were either destroyed or damaged. Damage to buildings in school/college premises caused serious disruption to academic activities. Classroom instruction was suspended for 30 days, especially affecting the students in 10^{th} and 12^{th} standards (i.e., 10 and 12 years in school) for which they must take a statewide examination held in March-April each year.

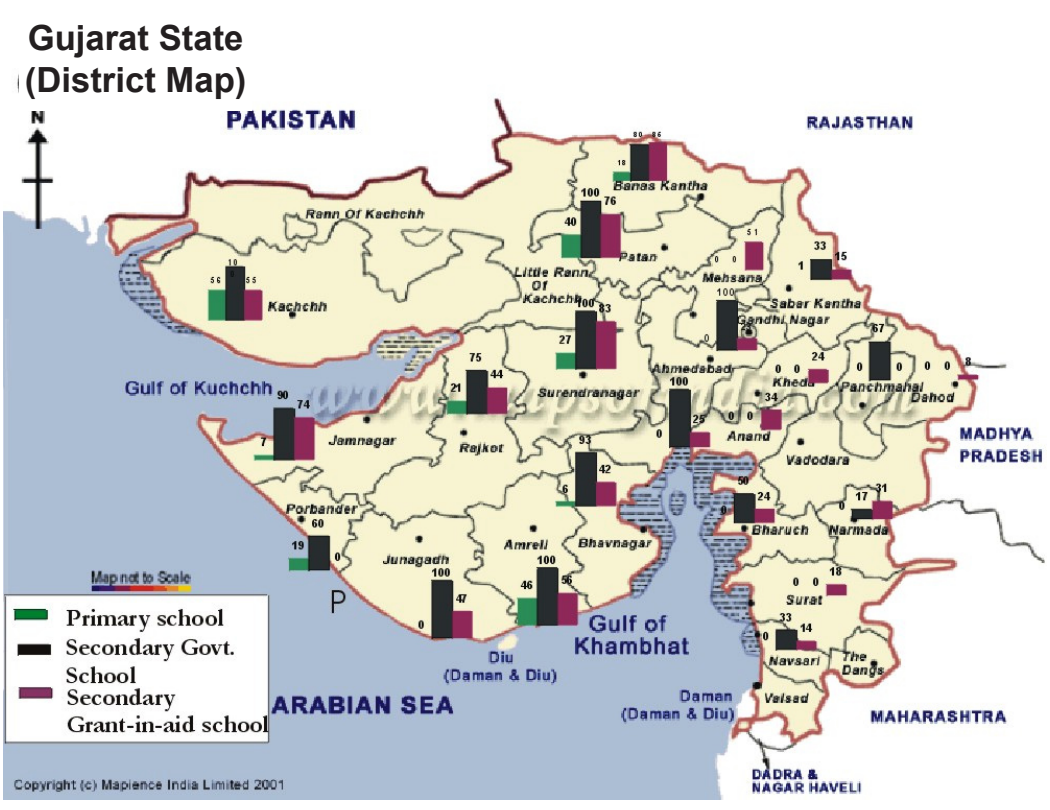

Figure 14-4. Geographical distribution of damages to primary and secondary school buildings.

Besides damage to physical assets, both instructors and students suffered severe psychological trauma as many in their ranks died or were injured in collapsed/damaged school buildings. According to Government of Gujarat, a total of 31 teachers died and 95 were injured, 971 students perished (910 in primary schools, 37 in secondary schools, 3 in colleges and 21 in technical schools) and 1,051 were injured.

The number of deaths and injuries might have been much higher had it been another typical weekday, and not the January 26 Republic Day holiday, when many students were either at home or were in open spaces observing the celebrations. In Anjar, there occurred a very tragic incident wherein about 300 children marching in the Republic Day Procession in the narrow lanes were killed when buildings collapsed into the narrow street from both sides. In anticipation of terrorists trying to make a major strike on the Republic Day, some of the schools had warned children to be cautious — there were reports of children running towards the school building from the open ground fearing a bomb blast as the ground shaking started.

Table 14-2. Summary of damage to physical assets of government and grant-in-aid academic institutions.

Sector	No. of institutions affected
Primary education	
School buildings	9593
Teacher training institutes	42
Kitchens for Midday Meal program	1871
Secondary/higher secondary education	
Government schools	127
Grant-in-aid schools	1913
Higher education (universities & colleges)	47
Technical education (polytechnics & engineering colleges)	
Government schools	58
Grant-in-aid schools	51

(Source: Department of Education, Government of Gujarat)

DAMAGE TO INFRASTRUCTURE OF SCHOOLS

Facilities associated with primary education were worst affected in the earthquake. In addition to damage to classroom buildings, a large number of teacher training institute buildings and Midday Meal kitchen sheds suffered extensive damage, and affecting the education process. Table 14-2 summarizes the damage to the infrastructure of the various government and grant-in-aid schools/ colleges in the affected area. There are a large number of privately funded academic institutions, which also suffered extensive damage to their physical assets. However, data on damage to these was not readily available.

The majority of these school buildings were poorly constructed using inferior materials, and completely lacked earthquake-resistant features. A detailed description of seismic deficiencies of such structures that led to poor performance is discussed in Chapter 10, Reinforced Concrete, and in Chapter 11, Masonry. After the earthquake, worst affected schools and colleges were provided with prefabricated structures for holding classes. These structures were typically constructed with steel sections forming primary structural members, and skin consisted of plastic, fiber reinforced plastic, or corrugated galvanized iron sheets with adequate insulation (Figure 14-5). These quickly-erected classroom buildings helped restore formal learning sessions, however, they were fewer in number and could hardly makeup for the lost facilities.

DAMAGE TO PRECAST SCHOOL BUILDINGS

The project of building new precast schools, executed from April 1999 to November 2000, proved to be disastrous. About three-fourths of these newly built precast schools either collapsed or were seriously damaged. The Department of Primary Education, Government of Gujarat, was responsible for the construction of 6,000 schools spread over the entire State of Gujarat. Though the precast structures were designed for seismic forces, about 73 percent of the school buildings (Table 14-3) in the state suffered damage that ranged from severe near the epicenter to minor

Figure 14-5. Prefabricated classroom buildings to restore instruction sessions.

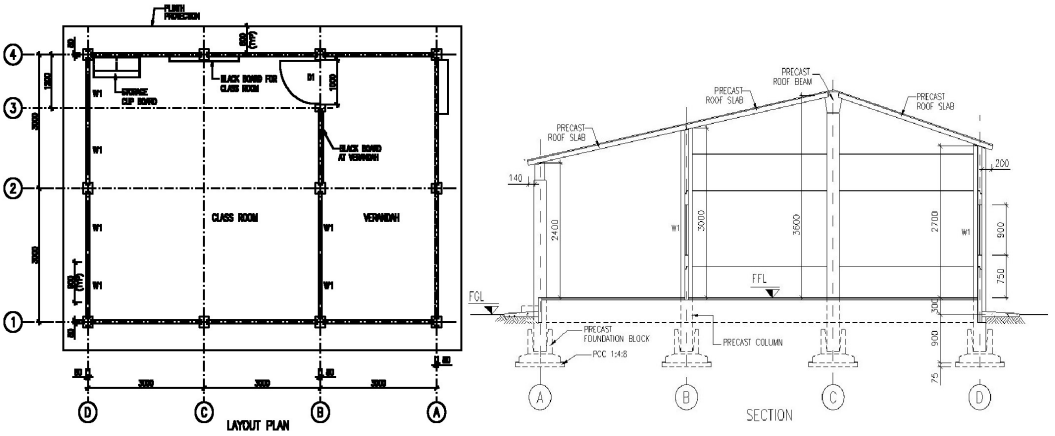

Figure 14-6. Plan and elevation of a typical precast classroom building.

opening of grouted joints farther away from the epicenter. Five centrally located mechanized prefabrication yards were established. Elements were cast at these yards and transported to the required location. A separate erection scheme was planned to speed up erection time.

The precast school building is a single-story 6 m × 9 m (including 6 m × 3 m verandah) sloped modular building with a provision that will accommodate horizontal expansion in future (Figure 14-6). The system is comprised of the following precast elements:

- Footings (~850 × 850 mm, 600 mm high)
- Columns (~250 × 250 mm)
- Wall planks (~2830 × 1000 mm, 80 mm thick)
- Roof beams (~250 × 370 mm)
- Roof planks (~3000 × 1000 mm, 80 mm thick)

Precast footings are of socket type, and the precast column is erected into the socket and grouted. Rectangular grooves are provided along the length in columns to receive wall planks. Each wall consists of three or four wall planks stacked one over the other with pre-formed openings for doors

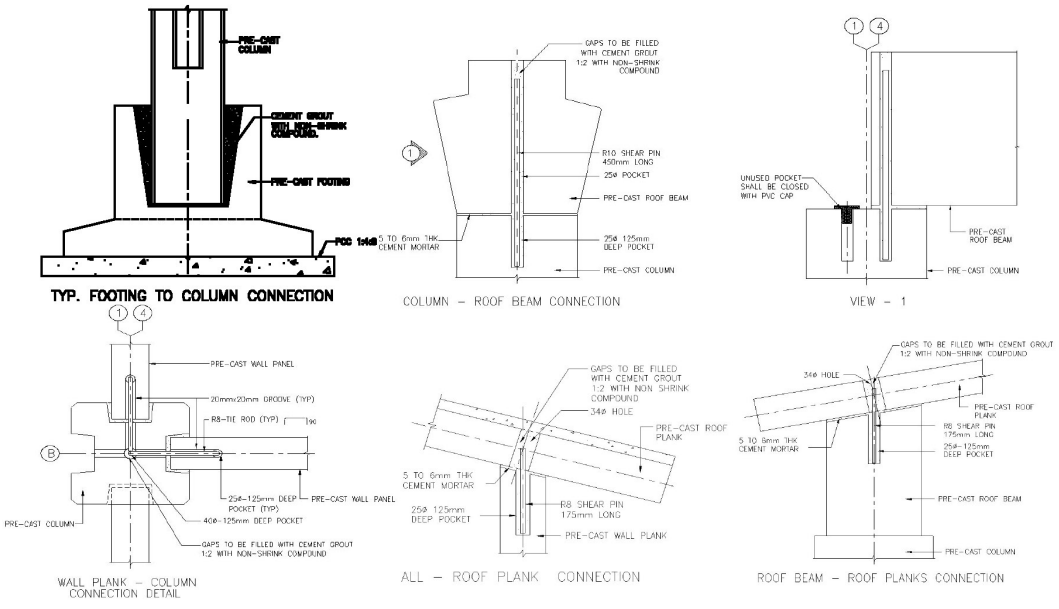

Figure 14-7. Typical details of various connections between precast elements.

and windows. The roof system consists of roof planks resting on roof beams and wall planks. A layer of screed concrete is poured over the roof, and bituminous waterproofing membrane is applied. Typical connections provided in this building are shown in Figure 14-7.

Observed damages can be broadly classified into four categories:

- Type A – Major damage to structure (Figure 14-9)
- Type B – Slipping of roof planks (Figure 14-10)
- Type C – Minor dislocation of roof planks (Figure 14-11)
- Type D – Minor opening of grouted joints (Figure 14-12)

As shown in Figure 14-8, schools near epicenter were severely damaged due to the high intensity of horizontal and vertical ground accelerations. Damage decreased with distance from the epicenter. Major damage occurred only around the Kachchh District (Table 14-4). Almost all building rooms suffered damage, and about half of them experienced severe damage of Type A and B.

It is clear from observed damage patterns that the weakest links in the precast school buildings were the connections between the structural elements. Roof planks resting on the beam slipped, indicating that the bearing area was inadequate and no positive anchorage was provided. Because of the poor connections, the provided roof slab system did not act as one unit to develop necessary diaphragm action, and the frames in the building system acted mostly independently. The building frames had different column heights, and therefore the displacement at roof level for each frame was different.

Columns with isolated footings behaved as if they were hinged at the bottom (the soil might not have offered much rotational restraint), and as a result, the building frames were subjected to excessive lateral deflection. Had a plinth beam been provided, these deformations could have reduced. Moreover, the redistribution of the forces was not possible because of the lack of redundancy in the building system. Even though the individual elements have not shown distress, the precast system could not perform satisfactorily because the elements were not tied together.

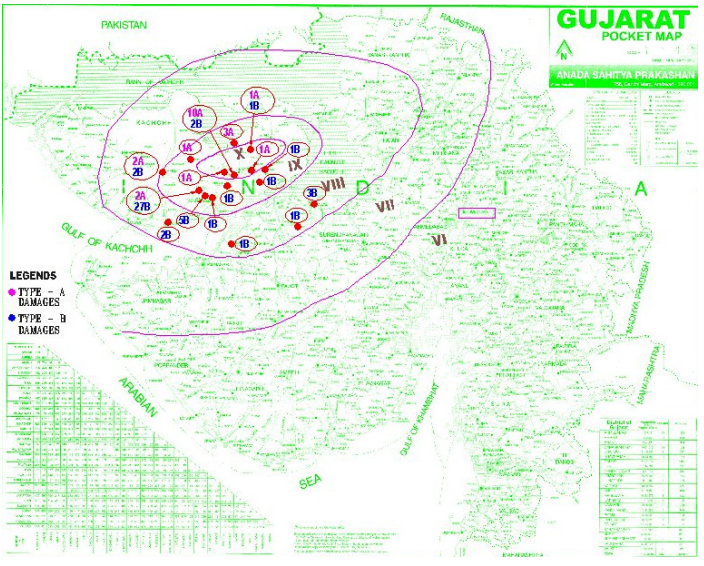

Figure 14-8. Geographical distribution of damaged precast school buildings.

Figure 14-9. Type A damage — major damage to structure.

Figure 14-10. Type B damage — roof planks slipped.

Figure 14-11. Type C damage — minor dislocation of roof planks.

Figure 14-12. Type D damage — minor opening of grouted joints.

Table 14-3. Statistics of damage to precast school buildings in the State of Gujarat, including Kachchh region

Type of Damage	Schoolrooms Damaged	
	Number	% of Total
Type A	52	0.8
Type B	106	1.7
Type C	538	9.0
Type D	3,689	61.5
No Damage	1,615	27.0

Table 14-4. Statistics of damage to precast school buildings in the Kachchh region.

Type of Damage	Schoolrooms Damaged	
	Number	% of Total
Type A	48	15.0
Type B	90	28.2
Type C	140	43.9
Type D	30	9.4
No Damage	11	3.5

Note: 50% of rooms in Kachchh region were under construction at the time of earthquake.

LESSONS LEARNED

Schools are generally neglected, poorly constructed and maintained buildings, especially in rural and semi-urban areas under government agencies. The condition of community owned and operated schools is no better. Many of these facilities were old and susceptible to earthquakes. Even recently constructed primary school buildings using precast construction performed extremely unsatisfactorily. It is very important that school buildings are constructed with higher standards of earthquake-resistant construction so that they can continue to function with minimal disruption after an earthquake. Further, these structures can be used as centers for rescue and relief operations immediately after the earthquake.

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