stone masonry exterior walls and the clay tile partitions in the part which is still standing. Of particular interest in this view is the clean separation between that portion which still stands and the wing which collapsed. It is evident that no attempt had been made to form a structural tie between the two parts of the structure. A closer view of the pile of debris which is all that remained of the collapsed wing of the hospital is shown in FIG. 29. The complete lack of any semblance of the original structure should be noted; it is apparent that the building simply fell apart.

The New City also presented many examples of severely damaged or completely collapsed masonry structures, a few of which are shown in FIG. 30. The structure in the left foreground of FIG. 30 is shown again in FIG. 31, a complete collapse typical of many in this district. The street at the right of FIG. 30 is shown in a close-up view in FIG. 32. The structure to the left in FIG. 32 was the Sud Building, a reinforced concrete frame structure which will be discussed in the next section of this chapter. The building to the right was a masonry structure part of which collapsed completely, the remainder being very severely damaged. The other side of this building is shown in FIG. 33.

The vertical embankment maintained by the soil at the edge of the streets in FIG. 30 is of interest. Clearly the ground was extremely hard and well compacted, and even the very sharp earthquake shock caused very little sloughing of the embankment. Such conditions were characteristic of the entire city. There was no evidence anywhere (except in the port) of any foundation failures or damages caused by poor soil conditions.

Portico and entry structures of the big hotels were found to be particularly vulnerable to the earthquake forces. An example of such a failure is shown in FIG. 34, the entrance of the Marhaba Hotel. The structure over the entry

Fig. 30. General View in New City; Sud Building in Center

Fig. 31. Collapse of Typical New City Masonry Construction

Fig. 32. View of Reinforced Concrete Sud Building on Left, Masonry Structure on Right

Fig. 33. Collapse of Masonry Bearing Wall Leaves Floor Slabs Unsupported

Fig. 34. Damage to Portico of Marhaba Hotel, Typical of Several Examples in Agadir

Fig. 35. Racking of Buildings in First Story

Fig. 36. Note Bracing Effect of Flexible Steel Screens

Fig. 37. Roof System of Rialto Theater Damaged by Collapse of Masonry Bearing Wall

drive was supported on long columns having no lateral restraint; and as the earthquake shock hit the structure, the base merely moved over, allowing the structure to drop directly down. The main portion of the structure was severely damaged but did not collapse. Similar damages were observed at several other hotels.

FIGS. 35 and 36 show interesting examples of earthquake damage to small masonry buildings. These two buildings faced each other across a street in the New City. The street was oriented NW-SE, and it is apparent that the principal ground shock was directed parallel with the axis of the street, toward the northwest. The bases of both buildings lurched in this direction, leaving the upper part of the structure behind. It seems likely that the flexible steel screens which were rolled down to cover the store windows provided the lateral shearing resistance which prevented complete collapse of these structures.

An unusual form of construction was utilized in the Rialto Theater, shown in FIG. 37. The reinforced concrete bowstring arches supporting the roof of this structure rested directly on bearing walls of unreinforced stone masonry. Toward the rear of the structure, these bearing walls also supported the balcony deck, which therefore served to brace the masonry walls at about midheight, but in the forward part of the theater the masonry walls were unbraced for their full height of approximately 25 feet. The earthquake shock caused this unsupported masonry wall to collapse outward, dropping one truss completely and allowing a second to drop a few feet at one end. Again, the unfortunate effect of neglecting to provide support or ties for the unreinforced masonry walls is clearly evident.

CONCRETE STRUCTURES

Some of the most spectacular structural failures in the Agadir earthquake were found among the structures having reinforced concrete frames. In several such structures, the principal resistance to lateral forces was provided by the unreinforced masonry filler walls, either of stone or clay tile, which were framed between the concrete columns and girders. Many of the newest and most modern-appearing hotels and apartment house structures in Agadir had been built in this way, and several of these collapsed completely during the earth-

Fig. 38. View of Immeuble Consulaire from the Kasbah Hill, Before the Earthquake

Fig. 39. Immeuble Consulaire from the South, Before the Earthquake

quake. It was difficult in such cases to deduce from the confused pile of debris which remained, exactly what the mechanism of failure was, however, it will be instructive to review a few of these cases.

Consulaire Building

One of the most spectacular and tragic structural failures in Agadir was that of the Immeuble Consulaire. This was an eight-story office and apartment building, built between 1952 and 1954; at the time of the earthquake, it housed approximately 300 people. Its very attractive architectural style is shown in Figs. 38 and 39. The total collapse of this structure is evident from the remains shown in Fig. 40, or in Fig. 41 where the successive floor panels are seen piled one on another.

Some indications of the basic structural weakness which led to this collapse may be noted in other views of the shattered remains. In Figs. 42 and 43 are seen the precast floor beams which were used throughout the structure. It is apparent that these supported the floor panels but were not actually integrated into them, with the result that the whole system simply came apart. The ultimate cause of the collapse of this structure was the lack of any primary mechanism for resisting lateral forces, resulting in fracture of the beam-column connections under the action of the earthquake. The lack of continuity between the various elements of the structure then permitted it to disintegrate as the beam-column connections ruptured.

Fig. 40. Immeuble Consulaire from the South, After the Earthquake

Fig. 41. Immeuble Consulaire, Note the Stack of Successive Floor Slabs

Fig. 42. Precast Floor Beams Used in the Immeuble Consulaire

Fig. 43. Precast Floor Beams and Hollow Precast Floor Panels

Fig. 44. Saada Hotel from the Northeast, Before Earthquake

Fig. 45. Saada Hotel from the Northeast, After the Earthquake

Saada Hotel

The Saada Hotel provided the most publicized structural collapse of the earthquake, primarily because of the large proportion of Europeans and Americans who were guests of the hotel at the time of the tragedy. Built in 1951–52, this hotel had been one of the most fashionable and luxurious in the city (Fig. 44), but the broken remains which were left after the earthquake (Fig. 45) gave little evidence of its former grandeur. As in the case of the Consulaire Building, the structure collapsed completely, leaving the floor slabs piled one on another. The details of the failure were somewhat different in this case (the floor system included cast-in-place rather than prefabricated joists, as may be seen in Fig. 46), but the basic mechanism was similar. Beam-column joints were inadequately reinforced, if at all (Fig. 47), and the reinforcing in the flexural members was not designed and placed (Fig. 48) to resist substantial dynamic lateral forces. Thus, under the action of the earthquake, the joints in the vertical members ruptured, and lack of continuity permitted the entire structure to come apart.

Fig. 46. Hollow Precast Floor Panels of the Saada Hotel

Fig. 47. Saada Hotel Detail, Note Lack of Continuity Between Members

Fig. 48. Saada Hotel Detail, Note Fracture of Beam and Girder

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Sud Building

There were several other complete collapses of reinforced concrete structures, but little additional information can be gained from a study of the debris of such total collapses. Some of the structures which collapsed only partially are of interest, however, and one of the most instructive examples was the Sud Building, located in the New City. This structure is shown in the center of FIG. 30 and at the left of FIG. 32. A front view of the building is presented in FIG. 49. At the street level, this four-story structure was approximately rectangular in shape, but in the top three stories it was a rounded L-shape with the curve of the L facing the street corner shown in FIG. 49. The structure was cantilevered out over both of the streets on which it faced, with the projection of the fourth floor deck extending almost 10 feet beyond the face of the building. The weight of this overhang, combined with the sudden lurch of the ground toward the rear of the building (i.e. northwest) caused the shearing failure of the masonry filler walls and collapse of the columns in the third floor level. At the curve of the L the fourth floor columns collapsed as well. Other views of the collapsed structure are shown in FIGS. 50 and 51.

Fig. 50. Sud Building from the Southwest, Note How Third Story Has Collapsed Toward the Right (SE)

Fig. 51. Sud Building from NE, Overhang of Balcony Is Visible

Fig. 49. Sud Building from the Southeast, Third Story Has Collapsed

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