7.3 Manila North Super Highway, Three Main Routes to Bagio and Soil Liquefaction (Road 2 group)

7.3.1 Role of the Road 2 Group and the Route of its Reconnaissance

The role of the Road 2 group:

(1) To grasp the condition of damage situation to the following roads: from Tarlac to San Fernando on route No.3 which leads to Aparri in the northern extremity of Luzon Island via the west coast, route No.13 to Lingayen Gulf, branching off from Tarlac, and the three main routes (Naguilian Road, Marcos Highway, Kennon Road) to Baguio.

(2) To grasp soil liquefaction conditions centering on Dagupan City and its outskirts, and

(3) On the basis of the above findings, to make the technical suggestions and recommendations necessary for rehabilitation.

For this, a reconnaissance with a four-night stay itinerary from July 30th to August 3rd was originally scheduled; two nights in Dagupan, one night in San Fernando and one night in Baguio. However, since an airplane of the Philippine air force back from Baguio to Manila was not confirmed, lodging at Baguio was changed to lodging at S. Fernando due to time restrictions of going by land. Furthermore, for the Marcos Highway and Kennon Road routes, since sections which could not be approached from the ground remained, these sections were investigated again by helicopter on August 5th. For this reason, the period of the field reconnaissance was prolonged by a half day. Details are given in Chapter 3, and the route of reconnaissance is shown in Figure 7.3.1.

7.3.2 Results of the Reconnaissance

(1) Damage state along the investigated routes

1) Manila to Tarlac (North Super Highway, Route No.3)

In the roads of this section, the damages thought to have been caused by the earthquake were limited to a part of the viaduct (length: about 5km) of the Manila North Super Highway crossing the Panpanga river. The substructures of the viaduct are pile bent type piers, and the superstructure is a 10-span continuous PC girder bridge. The short span (span: about 1.5m) girders connecting the continuous girders were moved about 0.8m in the transverse direction of the bridge (to the east side). (see Photos 7.3.1 to 3). It is said that this movement was greater in the direction heading away from Manila. At the low-bank section near KM 110 between Capas and Tarlac, 1 to 2cm wide cracks were observed running in a direction parallel to the road, at the joints between the asphalt pavement of the shoulders and the concrete pavement of the near side lane. The surroundings are paddy fields. Whether or not these cracks were caused by the earthquake is underlain.

2) Tarlac to the San Isidro Bridge (Route No.3)

In Tarlac City, cracks obliquely crossing the external wall of the second floor of the Vilmar Hotel (three stories) and broken window glass were observed. (August 3rd evening). (see Photos 7.3.4 to 5). During travel through the section located about 10 to 15km to the north of Tarlac, open cracks about 10cm wide near the center line of the asphalt pavement and cracks at the shoulder parts were observed. Though the length of this is uncertain, it is probably about 500 to 1,000m. (see Photo 7.3.6). From the state of the deformations, it is presumed that liquefaction phenomena occurred in the ground under the road.

The San Isidro bridge, located at the KP149+511 position near the northern extremity of Pangasinan Province, is a 7-span PC simple girder bridge. Though cracks and spouted out sand were seen on the ground surface near the abutments, the extent of the damage to the bridge seemed to be slight (see 7.4 for details about damage to bridges). At this position, since the approaching fill on the left bank of the bridge (the south side of the bridge on route No.3) has sunk about 1.5 to 2m and the right bank approach has also sunk a fair amount, traffic can pass through only one lane of the two lanes (see Photos 7.3.7 to 7.3.10). Figure 7.3.2 shows a sketch of the area. The settlement of the approaching embankments of the S. Isidro Bridge was definitely caused by soil liquefaction. Not only at the approach banking but also at the left bank side downstream of the bridge, the stone masonry revetments are sunk to the degree that they have sunk below the water surface. Further, both the inland slaughterhouse and the neighboring ground sank to the degree that flooding above the floor boards occurred.

3) Tarlac to Dagupan (Route No.13)

In the section from Tarlac to Dugallon deformations thought to be damaged by the earthquake were not observed. There is a bridge showing a weight limit of 10 t at KM200 (370 on the old kilo-post) shortly before entering Lingayen, and a depression was observed on the road surface at a low banking section on its Tarlac side; however, the degree of depression was slight (Photo 7.3.11).

It was impressive that the condition of the pavements in Lingayen city and on to Binmaley was good; there was nothing abnormal although it is close to severely damaged Dagupan. During travel near Dagupan, settlement of the shoulders was observed in part of a 2 to 3m banked section located between some fish ponds on both sides.

4) Dagupan City

In Dagupan city, a great deal of damage was caused by liquefaction of the ground by the earthquake; the settlement of roads and buildings, leaning and destruction of buildings, and damage to drainage facilities. According to materials of the Task Force Office of Rehabilitation established in the city, an outline of the city and the damages is as follows.

Dagupan city is one of the early developed cities (another such city is: S. Canlos) in Pangasinan Province (capital: Lingayen). By 1590, Augustin missionaries had entered the district, and they named the district Bacnota. After a riot in 1660, the reconstructed town was renamed Nandrugupan, and Nandrugupan was further shortened to Dagupan in 1720. Dagupan became a city, based on Republic Act 170, established on July 20th, 1947.

The city area, situated at lat. 16°01′ to 16°07′N and long. 120°18′ to 120°23′E, is about 210km from Manila, at the mouth of the Dagupan river facing Lingayen Gulf, and has an area of 43.64km^2 (0.81% Pangasinan) and 31-barangays.

The developed area, that is, housing, commerce, industries and transportation, is about 6.5km^2, or 14.9% of the city area, 27.1%, or 11.84km^2, is cultivated lands, and the remaining 58% is damp grounds, salt farms, fish farms, rivers, and beaches. The population of the city is 111,716 persons (1989), the population density is 2,536.45 persons/km^2, and the number of households is 17,323 (6% Pangasinan). The main products are fish, salt, rice and fruits. According to statistical data on the city as of September 1988, there are 2,998 companies registered as enterprises in the city; of these, 1,670 companies (55.7%), are in commerce while 1,183 companies (39.46%) are manufacturing industries. The city budget revenues for fiscal year 1988 were 26,780,000 pesos (about 187.5 million yen).

The ground of Dagupan city is composed of soft alluvium thickly deposited at the flood periphery of the river mouth of the Dagupan river. There are seven rivers in the city: the Mangueragday river, the Anolid river, the Bayaoas river, the Paogeawen river, the Calmay river, the Dawel river and the Tanap river, Pantal river. The elevation is one meter above sea level, and the ground is almost flat (gradients are 0 to 3%).

The main city infrastructures are as follows.

Roads-bridges:	length of roads; 92.06 km (national roads: 22.30km, city roads: 17.80km, Barangay roads: 51.96km) Road density: 2.475km/km^2 Number of motorcars owned: 112 units/ 1,000 persons (registered motorcars in 1987: 12,226 units)
Harbors:	Satellite harbor of Sual fishery harbor; facilities are poor.
Information facilities:	Four telephone offices, one post office.
Generation of electricity:	Power is supplied to 16,391 households (91% of all households) by the Dagupan electric company (December, 1987)
Water supply:	Supplied to 108,865 persons (98% of the total population) from a deep well by the Dagupan City Water District (end of 1987)
Flood protection:	17,070m of concrete revetments, stone levees, earth levees and catch drains, and 11,960m of drainage gate. Length of the sea wall: 2,544m

Public buildings:	167 school buildings, 576 elementary school class rooms.

The real properties liable to taxation are estimated at 33,664 sections and 374,527.58 pesos, and the properties free from taxation are estimated at 1,066 sections and 58,127.04 pesos.

The sum of the damages to all of the Pangasinan area by the earthquake are estimated at 4,284 million pesos as of July 28th, 1990; most of this is 2,022 million pesos for private enterprises and private houses. It is officially reported that the dead person in all of Pangasinan reached a total of 81 lives (as of July 31st), 3,130 families are refugee households (as of July 24th) and other estimated damages were 4,104 totally collapsed houses (as of July 24th) and 15,836 partly-collapsed houses (as of July 24th).

As shown in Table 7.3.1, damages to public facilities in Dagupan city were as follows: 20 sections on the roads, 8-bridges and 25-buildings. (as of 17:00 July 26th).

The damages and the necessary rehabilitation budget for the centeral area of Dagupan city are estimated as shown in Table 7.3.2 (as of July 27th).

Since these materials mention about recommendations, they are included together here in this chapter. The measures taken after the earthquake are shown in Table 7.3.3.

Next, the results of the on-the-spot investigations in Dagupan performed on July 31st and on August 3rd are described below.

Figure 7.3.3 shows the midtown area of Dagupan city. As shown in the figure and in Table 7.3.2, the damage observed to the midtown area was concentrated in the trapezoid shaped part surrounded by Fernandez Blvd., Perez Blvd., Rizal St. and Urdaneta Juction Dagupan Lingayen Rd. In this area, Fernandez Blvd. sank 1.5 to 2m (the amount of the settlement was not measured; this is informed from DPWH local engineers) and the road surfaces were covered with water. Therefore, to raise up the road, earth and sand mixed with cobbles was temporarily spread. Since Perez Blvd. was closed to traffic due to a falling bridge, midtown traffic became one-way in a counter-clockwise direction. For buildings along the four streets described previously, not only damages, such as inclination, settlement and breakdown occurred; they were also flooded above floor level due to the land subsidence after the earthquake. Further, since the gutters lost drainage functions due to settlement of the whole neighborhood, many things went wrong with drainage as well. Underground tanks dug out of the ground are placed at all the gas stations facing the street; this shows that the tanks came to the surface.

The areas in which land subsidence was produced spread not only in the midtown area; it also occurred at Barangay Pugo in the south of the city and further on, to the hatched part of Figure 7.3.3. Though the amount of settlement was 1.5 to 2m, according to local engineers, concrete data was not obtained. During the reconnaissance, since the implementation of level surveying was glance at, accurate settlement amounts will probably be clarified by the Philippine government.

Since the collapse of and damage to the Magsaysay Bridge will be described in Chapter 7.4, the sketch drawn during the investigation is just shown (Figure 7.3.4)

The liquefaction damage in Dagupan city was mainly severe damage on the left bank area of the Pantal river, while the right bank area was only slightly damaged in comparison. However, since spouted-out sand was observed even in right bank areas, it is definitely clear that liquefaction phenomena occurred. Nevertheless, the reason why the degree of damage on each bank area of the Pantal river varied considerably is probably because the thickness and the depth of the liquefied layer varied. Therefore, interview to residents in both the right and the left bank areas was made to determine how long they felt the spouting out sand and water after the earthquake. (Conducted August 3rd). The interviewed locations are shown by marks I-1 to I-6 in Figure 7.3.3. The results are as follows.

I-1 A watch repairman on Fernandez Blvd. (32 years old, man)

He felt vibrations three times. During the second vibration, cracks opened on the ground, and sand and water gushed up to about one meter in height. The gushing continued for about two hours; the thickness of the gushed sand was 50cm.

I-2 The owner of a restaurant on Fernandez Blvd. (47 years old, man)

Water and sand gushed up to about 50cm in height. He thought that the gushing continued for about 30 to 45 minutes. But, he did not know when it finished because the gushing was covered by water gathering from the surroundings. When one hour passed after the earthquake, the water depth became about one meter both the inside and outside the restaurant.

I-3 The owner of a vegetable store on Fernandez Blvd. (35 years old, woman)

After 20 seconds passed since the vibration began, cracks occurred in the ground, and water gushed out there. The height of the gushing was about 30cm.

Since the surroundings were covered by the gushing water and sand, she did not know when the gushing stopped. The deposited thickness of the sand was about 20cm.

I-4 The owner of an electric appliance store by the Magsaysay Bridge on Perez Blvd. (52 years old, man)

The height of the gushed sand was about 40cm. He thought that the gushing continued for about 30 minutes. The height of the deposited sand was about 50cm. He felt that the up-and-down vibrations were stronger than the laternal ones.

I-5 A Barangay employee on Nable St. on the right bank (43 years old, man)

He felt vibrations twice. The height of the gushed sand was one meter. The gushing continued for about 20 seconds.

I-6 A boy playing on Tabacalera St. (7 years old, man)

The gushing continued for about five minutes.

I-7 The manager of an icecake factory on Liberation Rd. (54 years old, woman)

Cracks about 5cm wide occurred on the mortar floor, and then sand gushed out. The gushing continued for about ten minutes. The thickness of the deposited sand was about 7 to 10cm.

In the interview from I-1 to I-4 on the left bank area of the Pantal river, the gushing continued for 30 minutes to two hours, while in the interviews from I-5 to I-6, the gushing continued for 20 seconds to 10 minutes. The reliability of visual observations selected randomly may not be high; depending on conditions at the locations of the eyewitness, accurate durations may not have been observable due to the water and sand pouring in from the surroundings for these reasons, there is a range in the values of the eye-witnesses as to the duration in both areas.

However, a remarkable difference of duration definitely existed between the two areas; on the left bank area the gushing continued for a long time: that is, the thickness of the liquefied layer was serious on the left bank area.

After the earthquake, a standard penetration test was performed by four boring machines. It is reported that the investigation will be expanded from the badly damaged areas to the non-damaged areas. (according to the City Engineer and the director of Region-1 in S. Fernando)

By August 3rd, the boring at the B-2 to B-5 positions as shown in Figure 3.3.3 was underway (expected depth: 30m).. Though the work had not reach the final target depth, intermediate penetration test results were provided.

The particle size distribution of the spouted-out sand and the particle size distribution at a 16.5m depth at the B-3 boring are shown in Figure 7.3.5. The results of standard penetration tests from B-2 to B-5 are shown in Figure 7.3.6 and Figure 7.3.7. Further, F_L-values (liquefaction susceptibility index) are calculated according to the specifications for Highway Bridges in Japan as shown in Figure 7.3.6 and 7.3.7 in the cases where surface accelations of 200gal and 250gal are assumed.

The results of the estimated liquefaction susceptitility shown in the figures should take the following matters into consideration: boring data after the earthquake are used (the loose sand layes tends to become denser by liquefaction during earthquakes): N-value obtained intermediately are used without energy correction: according to past experience in Japan, the number of repeating strong earthquake motions is supposed to be about 20 cycles. According to observations at the actual location, control of the weight drop height for the standard penetration test is not always correct; energy correction is supposed to be necessary; with a adequate method, it is necessary that the density of the ground before the earthquake is estimated; as for the eye-witness evidence, it may well be that the duration of the strong earthquake motion was longer than that of experiences in Japan; the F_L-values are temporary values requiring further examination.

The damage in Dagupan city are shown in Photos 7.3.12 to 7.3.36.

5) Dagupan to Urdaneta

On the route from Dagupan to Calasiao, rising up of gas stations beside the roads, spouted-out sand and slightly inclined houses were observed at a position parallel to the Pantal river on the south of Dagupan city; since distance marks (milage stone) are unknown, their acculate location is not clear.

On the way to S. Barbara, branching off from Calasiao, crosswise cracks, differences in level of the pavement surface, and settlement at the shoulders were observed (see Photo 7.3.37 to 39). The section is located in a swampy area and the structure of the road is low embankment of 1 to 2m high. The cause of this portion was considered to be liquefaction.

The route between S. Barbara and Urdaneta was not apparently damaged.

Further, on route No.3 going southward from Urdaneta, no deformations were observed. Since the damage to the collapsed Carmen Bridge is described in Chapter 7.4, only some photographs of liquefaction are shown (Photos 7.3.40 to 44).

6) Dagupan to San Fabian (Route No.313)

There is a route, one of the roads form Dagupan to San Fabian of route No.3, along the Lingayen Gulf going northward from Dagupan city, although the route is not laid out in old topographical maps. At the outskirts of the urban districts of Dagupan city, there is a continuous 3-4m-high banked section where fish ponds on each side of the road can be seen. It is reported that the damage as shown in Photo 7.3.45 occurred in a part of that section (according to DPWH materials). Since the damaged positions had been temporarily filled up by soils when we passed, the conditions shown in the photograph had disappeared. In part of the section by the Lingayen Golf course near KM217+500, cracks were observed at the shoulders and beside the road (Photo 7.3.46). However, the road surface was not damaged.

At the Mangueragday Bridge (through truss bridge, two spans), the approach bankings sank, and the abutments on both sides seemed to be pushed out towards the river side; horizontal cracks occurred on the one of the eight 400mmϕ steel piles of the abutment foundations; the bearing shoes on the left abutment slid about 10cm in the horizontal direction, and the end of the girders collided with the concrete of the abutment.

Also, at the Longas Bridge (KM222+866, about 25m long, one span PC simple girder bridge), the banking for the access on both sides sank, and some oblique hair cracks were observed on the ends of the PC girders. The route merges into route No.3 in the KM223 neighborhood, and after merging, the 1 to 2km section up to the Cayanga

Bridge is a bank of 1 to 2m high. In this section, cracks in the shoulders, differences in level, and damages to parts of the pavement were observed (Photos 7.3.47 - 7.3.49).

For the Cayanga Bridge (9 continuous spans, concrete girder bridge with a total of 11 spans), the P1 pier of the end span on the left bank has rubber bearings; the girders and the shoe sheets slid about 3cm in the bridge axis direction and about 5cm in the bridge axis right angle direction. In the neighborhood of the concrete pile (octagon, dia: 50cm) heads, horizontal cracks occurred. Both abutments seemed to be pushed out to the direction of the river center. A 58-year-old man who lives near the left bank abutment observed that the center part of the river swelled and puffed upwards at the time of the earthquake.

The damages described above all supposed to have been caused by liquefaction of the ground.

7) San Fabian to San Fernando (Route No.385 and Route No.3)

The access part of the right bank of a bridge about 25m-long (bridge name: unknown) near KM228 sank, and cracks occurred on the road surface. The ridges between rice fields on the gentle slope on the east side near KM235 of the province boundary with La Union had collapsed.

Since the approaches to a single span bridge at Rabon (near KM236) sank, detailed investigation was felt to be needed. At KM239 and the surrounding neighborhood, a bridge about 25m-long was supposed to need detailed investigation.

The foundation piles of the right bank abutment of the Cupang Bridge were damaged, and temporary timbering using wood piles is underway (It is reported that this construction started on July 28th.). A private house (one-story-house made of wood) by the road near KM230 was completely destroyed. However, damage to the roads was not observed.

In Agoo city, the city hall, made of concrete, in the city center was completely collapsed, and buildings made of concrete and two-story wooden houses were badly damaged.

On the northern outskirts of the center of Agoo city, a small river flows from east to west. In the urban districts on the left bank side of the river, damage due to liquefaction, such as rising up of gasoline tanks, traces of spouted-out sand and damages to two-story private houses were observed.

Among the damages to Agoo city, the collapse of a bus stop made of RC beside the road of route No.3 stands out. Since the degree of damage to each bus stop structure varied place by place where their structures were the same, it may be useful to investigate the distribution of their damaged location and their degree of damage, in order to estimate the distribution of the intensity of the earthquake motion. A rice mill near KM241 (San Engenio?) about 5km north of Agoo city was completely collapsed.

At the Sta. Rita Bridge, the left bank abutment was pushed out ahead, the bearing support parts of the end of the girders were chipped off by about 10cm; therefore, a difference of about 10cm in level occurred between the abutment and the bridge surface (Photo 7.3.50).

Peeling of the walls of a church beside the road near KM248 (Caba town) was observed. In that neighborhood, subsidences occurred at parts of the shoulders, and also the access part of a small bridge sank.

The collapse of a silo made of concrete block near KM249, the collapse of a stone masonry retaining wall (height: 2 to 3m) beside the road near KM253 and a difference in level at the pavement on the north side of the 8-span truss bridge near the fork of the Naguilian road were observed; though the damage was slighter than that in Agoo city, this indicated that considerable earthquake motion acted in this area.

A difference in level occurred near the center line on the road surface between Bauang and S. Fernando near KM264 (Photo 7.3.51).

8) Kennon road

Kennon road is the name given to the road which runs from the outskirts of Rosario to Baguio along the Buedo river. Since the route of the on-the-spot investigation was from Damortis on the west coast at the fork with route No.358 via Rosario to Kennon road, damage in this area is also mentioned a little.

At the outskirts of Amlang near KM222, in a section sandwiched between a cut slope about 10m-high and a river, subsidences and cracks on the roads were observed. The height from the riverbed to the road surface may be about 10 to 15m. In that neighborhood, the side of the route on the riverbank side had been washed away by heavy rains before the earthquake; the collapsed positions seemed to have been expanded in scope by the earthquake.

According to the Report of the Disaster-Prevention for Roads in the Philippines by JICA on June 1984, past disasters on Kennon road are described as follows.

"The Kennon road, a 34km-long, 6m wide two-lane asphalt pavement, is the shortest route from Manila to Baguio. For this road, having a shoulder of 0.5 to 1.0m, there are many curves and sharp grades, since the route runs along the meandering Buedo river, and passes through sharp mountainous areas. The slopes are composed of conglomerate, andesite, diorite, etc. Since its completion in 1937, it is thought that many road disasters would have occurred over its forty seven year lifetime. However, we cannot obtain the reports on disasters in the past other than two disasters which caused long-time roadblocks in 1979 and 1980. These two particular cases were caused by the embeded debris in the Buedo river which came from the huge land slide at the opposite side mountain slope. With the exception of these special two disasters, disasters occurred at other places on a twice-yearly average; one-week to three-week roadblocks occurred.

Up to about 30km from the urban districts of Rosario, there are mountainous areas along the Buedo river, and after that the route leads to Baguio city through sharp gradients having hair pins turns.

There are a total of 46 danger points, made up as follows: falling stones in 31 locations, bank slope failures in 9 locations, cut slope failures in five locations and landslides in one location.

The stone in these areas is mainly composed of conglomerate, limestone, andesite and diorite. Though these stones are relatively hard, there are many falling stones at the cut slopes due to the existence of numerous cracks.

The bank slope failures were caused mainly by the scouring arising from the flow of the Buedo river and the concentration of surface water flowing down from the road surfaces and the cut slopes. A large-sized bank slope failure occurred at the KM227+500 position in August, 1983; it was mainly caused by the inundation of spring water to the bank. In the neighborhood of Baguio city, at the end of the Kennon road, large-scale landslides occur. It is reported that here the road surfaces have sunk about 10cm every year."

In addition to the cut slopes along the roads and the shoulders of half-banked and half-cut sections which were damaged by the earthquake, landslides also occurred due to sliding of the surfaces of the hills. Also, pieces of rock caused serious damages. When the party started the on-the-spot investigation of August 1st to 2nd, it was still impossible to reach the 14km section in the area from KM224+500 to 238.

Slope failures occurred on the hillside slopes along the Kennon road and also on the hillsides of Baguio city and its outskirts. Collapsed earth and sand caused river-beds to rise up along with the accumulation in the valleys; in some places, the rivers are blocked in the form of small-scale natural dams. (Photo 7.3.52 to 53)

The conditions downstream of the impassable section during the survey are as follows.

The slopes along the road from Camp 1 Bridge (KM216+150) to the KM218 neighborhood were not badly damaged. However, earth sloughed off from the slopes has accumulated on the road. Though the earth-and-sand seems to be being removed by graders, there seems to be no end of the supply of this earth and sand from the damaged slope and the valleys due to the rain during the rainy season (the sections KM218+900 to 219+100, 219+700 to +950, 220+600 to +900, 222+600 to +850 are the same as this). In the KM218+0 to +200 neighborhood, earth from the shoulder collapsed by the mountain stream and the collapse of the hillside are accumulated on the lane on one side; therefore, traffic can pass only on one side of the road.

In the KM221+200 neighborhood, a huge rock 10m wide and 4.5m high fell on the center of the road. Since the rock cannot be removed by heavy machines, small holes were drilled in it for blasting. However, the rock remains as it was, since blasting needs the permission of the military.

In the KM222+500 neighborhood, since a culvert for passing the valley water of the Buedo river was blocked, the water now flows on the road.

In the KM224+500 neighborhood, the last area which can be reached from the Rosario side, a large-sized bus which fell into the ravine remains. Damage from this position to the upperstream end of the impassable section (KM238), are shown in Photos 7.3.52 to 53.

The damage state in the KM238 neighborhood which can be reached from the Baguio side are the same as the above conditions. Examples of these damage are shown in Photos 7.3.54 to 59. Also, a straight line diagram compiled by the DPWH Baguio office, is shown in Figure 7.3.8. However, quantitive data, such as the volume of collapsed earth, is not available.

9) Marcos Highway

The Marcos Highway, between Agoo and Baguio, is a new two-lane concrete pavement road (width: 6.7m, shoulder: 2 to 2.5m). Generally the Baguio side is in a steep mountainous section, while the Agoo side has relatively gently sloping topography. The slopes of the mountainous section are mainly composed of seriously weathered clay rock, conglomerate, tuff, etc.

For the Marcos Highway, as a point of the on-the-spot investigation, the 5.5km section between KM272 and KM277+500 was also impossible to survey, since the section was cut into pieces by collapsed earth and sand.

For the section which could not be surveyed from the land, investigation by helicopter was tried on August 5th; however, the investigation remains unfinished due to bad weather.

For the section between the town of Agoo and the KM240 neighborhood, settlement of bridge access parts and cracks in the road surface were observed; however they were not serious damages. From KM240 to 262, shoulder subsidences on the valley side stand out, and there are scattered sections covered by collapsed earth and sand form the slopes. However, the volume and number of damaged positions are not serious as on the Kennon road.

There is a reservoir at the upper part of the slope of the impassable section near Baguio, and it is damaged. It is reported that its rehabilitation has run into trouble due to rainfall and affluent from the reservoir; this information remains as yet unconfirmed. Photos 7.3.60 to 7.3.65 show the conditions of the damages, and Figure 7.3.9 shows damage conditions along the route. Table 7.3.4 is a list of collapsed conditions obtained at the actual sites. As shown in the Table, there are 39 damaged positions. The impassable sections are between No.32 and No.38.

10) Naguilian road

The Naguilian road, a 2 lane asphalt pavement 47km long and 6m wide, is the northernmost access road from Manila to Baguio city. The pavement is badly damaged and the shoulders are narrow. The road runs through hilly areas for about 17km from Bauan via the steep mountainous areas and leads to Baguio city. Generally the slopes are composed of sand stone, shale, tuff, etc.

Among the three main routes to Baguio, this road has been used for the longest time. The slopes on the road sides are more stable than those of the other two routes. On the day after the earthquake, work for removing the collapsed earth and sand had been started, and the road was reopened for service on July 19th. However, since the road was intermittently open only on one side due to damages such as the collapse of half-banked sections or large amount of failured earth from the road side slopes, traffic has been forced to run on only one side of the two lanes in many sections. For this reason, uni-directional traffic control has been instituted: with traffic running up to Baguio until noon, and from Baguio from noon until evening. Photos 7.3.66 to 71 show the conditions of damage to the road.

Table 7.3.5 and Figure 7.3.10 show the conditions of damage along the road compiled by the local office.

In Baguio city, not only the damages to high buildings but the slope failures and collapsing of stone masonry retaining walls were also observed in many places. Slope failures in the city are shown in Photos 7.3.72 to 77.

Also, settlement at the landslide spot in the neighborhood of the Baguio side starting point of Naguilian road seemed to be progressing.

Since there are dwelling houses near these failured slopes, monitoring are necessary to prevent possible damage caused by secondary collapsing of these slopes during the coming rainy season.

(2) Summary of the reconnaissance

The forms of damage to the roads on the survey route are summarized as follows.

(1) Damages to bridges
(2) Damages to embankments and pavements
(3) Slope failures on the roadsides

Among the above, (1) and (2) occurred mainly at locations with soft ground. (3) occurred along the three routes to Baguio.

When plotted the damaged portions on the Manila north road and the neighboring roads (only in the investigated sections) described above on a topographical map (1/50,000), it is indicated that the damaged sections were located at river crossing areas, at locations parallel to rivers, or in marshy areas as shown in Table 7.3.6. That is, damages included under (1) and (2) can be supposed to be concentrated in areas with soft alluvial ground.

When empirical equation in Japan relating the maximum acceleration and the epicentral distance of the earthquake is applied to the case of M=7.7, Figure 7.3.11 is obtained. That is, at the location of the Carmen Bridge, the value is about 180 to 200 gal, and at Dagupan, which was badly damaged by liquefaction, the value is about 100 to 160 gal. Considering the past damages in Japan caused by such a maximum acceleration, the damage this time is much severer.

There are the amplification of earthquake motion by soft ground and the length of its duration as the possible reason for this severer damage which can be pointed out at this moment. It is apparent that liquefaction of the ground particularly caused disasters, since most spots of the damages in categories (1) and (2) left clear traces of spouted-out sand in and around the damaged structures.

For the liquefaction of the ground, longer duration of input motion or the situation where the ground is exposed to the successive earthquake motion before the raised pore water pressure in the ground by first motion has vanished is a particularly severe condition. In the future, more detailed examination on this point will be necessary.

Next, damages to the three places, 1) the Manila north road 2) the three main roads to Baguio and 3) Dagupan, are summarized, from the point of view of the mission of and the standpoint of disaster relief.

1) The Manila north road

Fallen bridges, such as the Carmen Bridge and some other bridges, caused inconvenience to users and a decline in economic activities.

Some bridges could have been avoided from falling. However, some of these bridges were badly damaged. Substructures were damaged, such as in breaking of foundation piles, cracks in the abutments, and damages to the foundations, etc. It is thought that liquefaction of the foundation ground had the greatest effect.

Due to the impassability of the Japan-Philippine Friendship Highway and the collapse of the Carmen Bridge, the road leading to northern Luzon by detouring through Lingayen is the only important route left which runs from Manila to northern Luzon. Considering the possibility that damages to the damaged bridges may progress, taking the emergency measure of temporary support to prevent bridge collapse is necessary for these bridges.

2) The three main routes to Baguio

Among the three main routes leading to Baguio city, traffic can now pass through the Naguilian Road.

Though the Naguilian Road can be passed through, some sections still have only one passable lane. The large quantity of collapsed earth and sand from the failured slopes and the settlement of road surfaces on banked sections have caused this one lane traffic. In the areas of KM267+700 and KM261+000, collapsed earth and rocks of more than 5,000m^3 remain. The total amount of collapsed earth and rock is now supposed to exceed 50,000m^3.

It is difficult to remove this large quantity of collapsed earth, rocks and huge fallen rocks, and further, rehabilitation work is prevented by rainfall.

For the Marcos Highway, the section between KM272+000 and KM277+500 cannot still be opened. Since this 5km section was inaccessible, investigation by helicopter was attempted, but was in vain due to bad weather conditions. Though the features of the damage are similar to those on the Naugilian Road, the scale of the slope failures is much larger than that on the Naguilian Road. The obstacles which cover the inaccessible sections are supposed to exceed 164,000m^3.

The Kennon Road, one of the three main routes leading to Baguio city, was the most extremely damaged.

The damage to the Kennon Road differs from the Marcos Highway, in the point that the large quantity of earth and rocks fallen from the slopes along the road includes huge fallen rocks.

On every route, even if the accumulated earth is removed, newly-fallen earth and sand and further erosion of the shoulders may cause more damage to the functions of the roads due to the rain. Therefore, measures to provide sufficient drainage facilities are necessary.

The mountain slopes on both sides of the Buedo river were failed due to the shaking of the earthquake, a large quantity of debris were supplied to the extent that which raised the bed of the Buedo river. When the rehabilitation plan for Kennon Road is formulated, the partial realignment of the road must be considered in sections beginning with the locations where the water collides due to lift-up of the river bed.

Also, for this route, investigation and inspection by helicopter was required. The aerial photographs will provide useful information for future rehabilitation.

In Baguio city, slopes as well as buildings were damaged; the damage to slopes in Baguio was not large in scale as in the mountainous regions along the Bued river. However, since the damaged slopes are inside residential areas, the places where sliding occurred should be monitored so that residents living at the lower parts of slopes will be able to evacuate in the case of secondary slope failure.

3) Dagupan and its outskirts

The damage to Dagupan city was a typical one caused by liquefaction of the ground. Many buildings inclined and sank, and underground gas tanks were raised to the surface by the liquefaction of the ground. Even low banks about 1.5m to 2m high lost the strength of their ground foundation, and cracks and sinking of road pavement occurred. The Magsaysay Bridge fell down due to displacement of the right bank abutment towards the river center caused by liquefaction of the ground.

At Barangay Pugo, it is reported that the ground surface sank 1.5m to 2m causing the difficulty of the surface water drainage; however, quantitative data of settlement has not yet been obtained.

Most of the large damages produced in the city by liquefaction phenomena occurred on the left bank side of the Pantal river, while on the right bank area damages were relatively slight, though traces of spouted-out sand can be seen.

It is thought that the thickness of the liquefied layer composed of a loose sand layer varied between the two areas.

In fact, according to interviews to residents living on the both sides areas, on the right bank, spouting phenomena of 20 seconds to 10 minutes were observed, while on the left bank, the spouting seemed to continue for about 30 minutes to two hours.

Because of the collapse of the Magsaysay Bridge, the roads in the city are limited to one-way traffic, and the bypass function of the Manila north road is limited due to the resulting traffic congestion.

Furthermore, regarding the health of the city residents, damages to drainage functions are causing great inconvenience.

These obstacles should be removed as soon as possible.

7.3.3 Recommendations

On the basis of the findings summarized in 7.3.2 (2), the items to be taken are listed up as follows along the surveyed route.

<u>Manila north road</u>

<u>Temporary rehabilitation</u>

(1) Ascertain the remaining strength of the substructures of the bridges, by investigating the damages, and evaluate the degree of the damage.

(2) Badly damaged bridges, which have a possibility of collapsing though they have not yet fallen, should be quickly supported by temporary timbering.

<u>Intermediate-term rehabilitation</u>

(1) By introducing past experience in Japan, guidelines to evaluate the damage to and the earthquake resistance of the bridges in the Philippines should be compiled.

(2) Based on the above guidelines earthquake-proof reinforcement of the bridges should be done.

The three main routes leading to Baguio

Temporary rehabilitation

(1) The Marcos Highway should be reopened without delay.

(2) The inundation from the cut slopes should be drained off with drainage facilities installed at proper intervals. The drainage facilities must have the sufficient drainage capacity.

Intermediate-term rehabilitation

(1) The alignment of the Kennon route should be examined.

(2) The following points should be considered for the above examination.

a) Slopes collapsed by the earthquake may easily be eroded by rainfall.

b) Partial damming-up of the Bued river has occurred due to collapsed earth, sand and rock at several places.

c) To evaluate the stability of the slopes in mountainous regions, aerial survey is indispensable.

d) The introduction of bridges in some unstable slope areas cannot be unavoided.

(3) The removal of and countermeasures to the unstable earth, sand and rocks on the upper slopes of the roads is indispensable.

(4) Monitoring of dangerous slopes in Baguio city.

Dagupan city

Temporary rehabilitation

(1) Boring should be conducted for the investigation of the ground in damaged and non-damaged areas.

(2) A survey for drainage design should be conducted.

Intermediate-term rehabilitation

(1) A drainage system should be designed.

(2) Redevelopment of the urban areas of Dagupan, which includes the relocation of Barangays, should be done.

When the above countermeasures are further arranged, the followings are recommended.

(1) Guidelines for properly evaluating the degree of damage to structures should be introduced.

1) For that purpose, the "Manual for Repair Methods of Structures damaged by Earthquakes" compiled by the Ministry of Construction in Japan will be helpful. In particular, for civil engineering structures, the "Manual for Reapir Methods of Civil Engineering Structures damaged by Earthquakes" has been translated into English (by the US National Center for Earthquake Engineering Research) and has been published. (One volume was presented as a gift to the director of DPWH.)

2) By using the methods described in the "Manual for Repair Methods of Civil Engineering Structures damaged by Earthquakes," the degree of the damage to bridges has been evaluated by the bridge group of the expert team.

However, due to time limits and to the shortage of data, we should take heed of the fact that this judgement was done for a limited number of bridges.

3) Also, the Manila north road, and bridges on its bypassed route, which were not evaluated, should be judged in the same way. On the basis of the results, necessary temporary support should be carried out.

(2) Introduction of earthquake-proof diagnostic methods and execution of earthquake reinforcements.

1) The "Earthquake disaster prevention for road" (Japan Road Association, in Japanese) will be a good guide with this as the object.

(3) Reexamination of the alignment of the Kennon Road and strengthening of disaster-prevention measures on the Naguilian Road and the Marcos Highway.

1) For the Kennon Road, even if it is rehabilitated with the present alignment, the road will be susceptible to natural disasters, such as slope failures and falling rocks due to rainfall.

2) At the slopes of hillsides collapsed by the earthquake, we should take heed of the fact that the slope failures are apt to occur continuously, due to rainfall, permeation and the promotion of weathering, since there are cracks on the surfaces of the slopes close to the collapsed slopes due to the earthquake shaking.

(4) Examination of rehabilitation methods for Dagupan city, considering the relocation of a part of the area.

1) In a part of this area, the ground has subsided excessively, and drainage has become impossible.

2) Also, it has been observed that the degree of damage is very different in different localities in the city. It is thought that this was caused by a difference in the ground conditions. Therefore, a soil type investigation and a level survey to correctly determine the settlement conditions should be executed.

3) For this soil exploration, whether or not soil which is apt to become liquefied exists between the ground surface and a level 20m - 30m deep should be correctly grasped. Further, the accumulation condition of soft ground which affects the amplification of earthquake motion should be grasped. Considering the above two goals, boring surveys should be conducted not only in damaged areas but also in non-damaged areas.

(5) Monitoring of the slope failure positions in Baguio city

1) In Baguio city, slope failures occurred even within residential areas.

2) To guard against secondary progress of slope failures due to rainfall, monitoring the changes in the slopes is necessary for making judgments about residential evacuation.

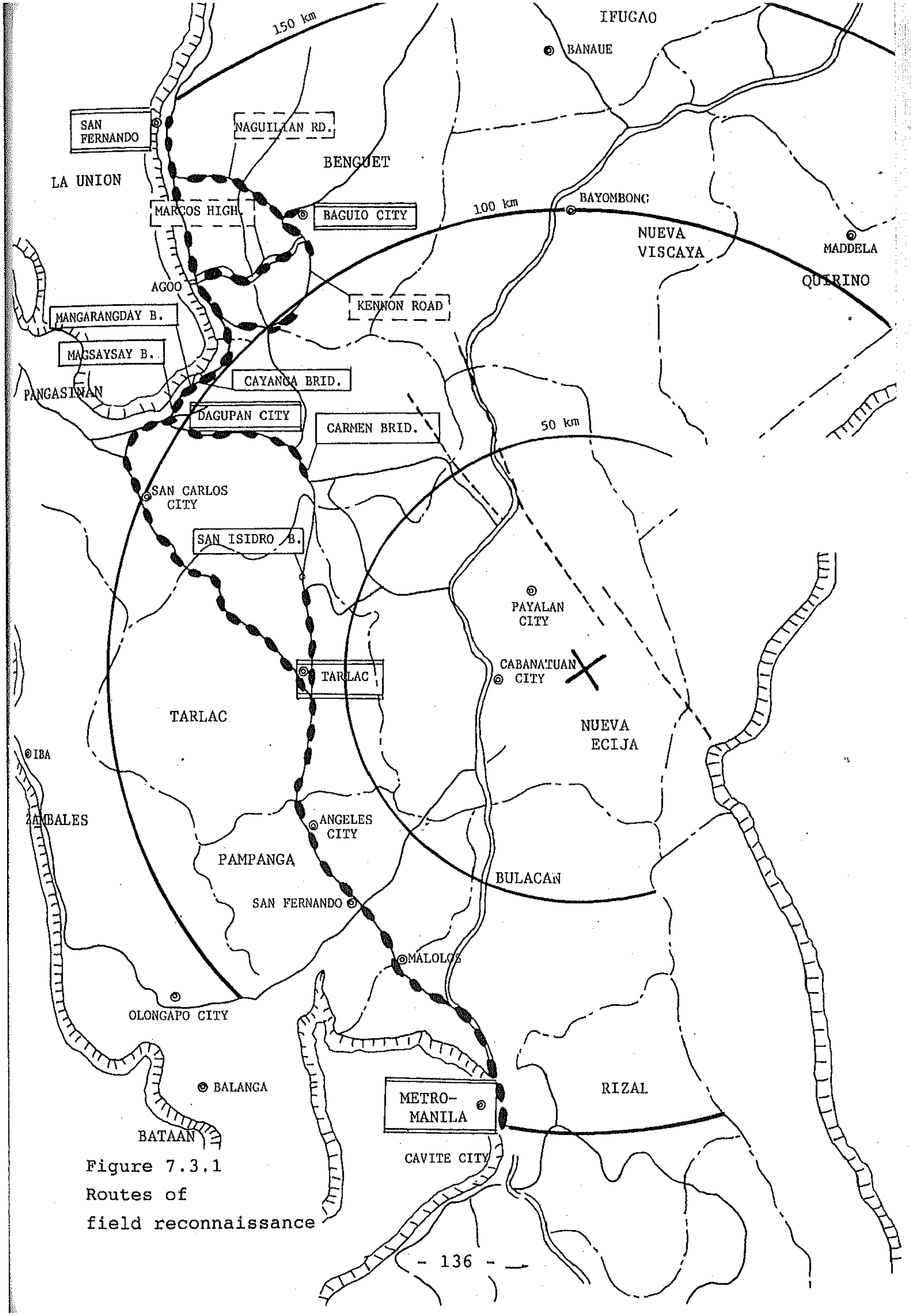


Figure 7.3.1
Routes of
field reconnaissance

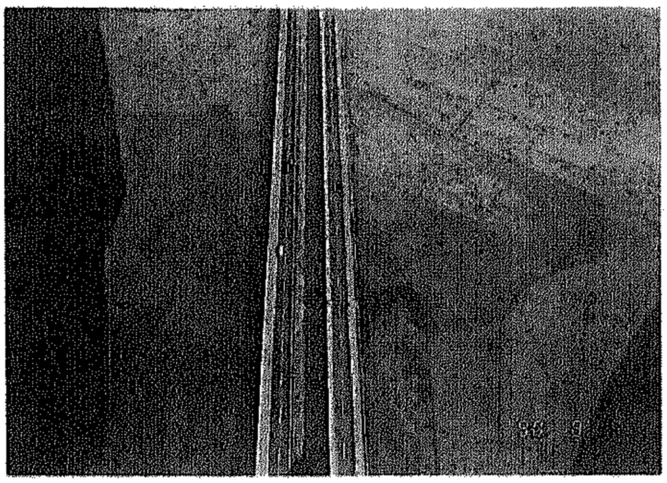


Photo 7.3.1 Elevated bridge of North Super Highway (lateral slip of floor slab visible)

Photo 7.3.2 Lateral slip of floor slab of elevated bridge of North Super Highway

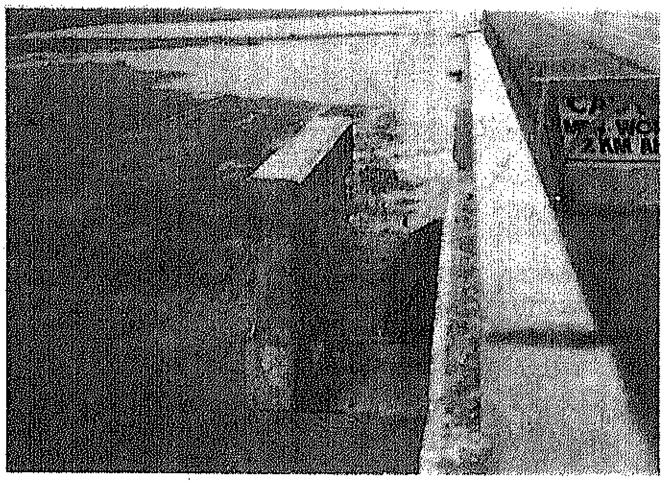


Photo 7.3.3 Lateral slip of floor slab of elevated bridge of North Super Highway; A close up view of the lateral slip

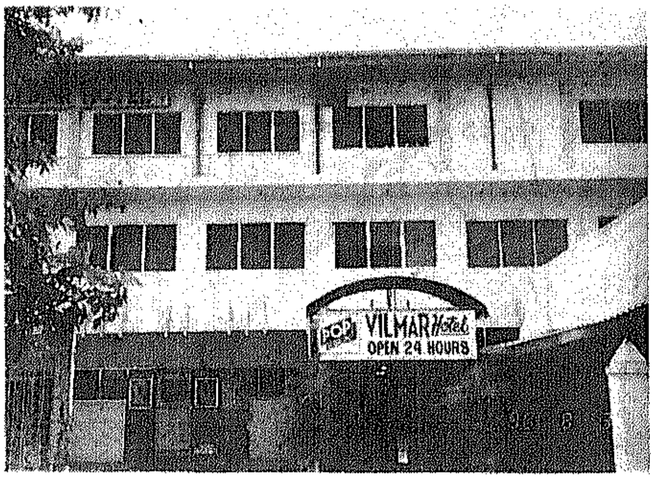


Photo 7.3.4 Vilmar Hotel in Talac City (cracks in wall)

Photo 7.3.5 Cracks in wall of Vilmar Hotel

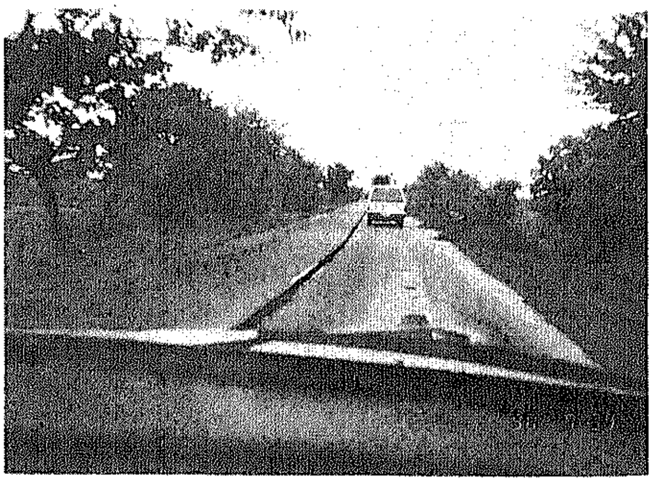


Photo 7.3.6 Cracks along center line near 135km (?) spot on No. 3 Line

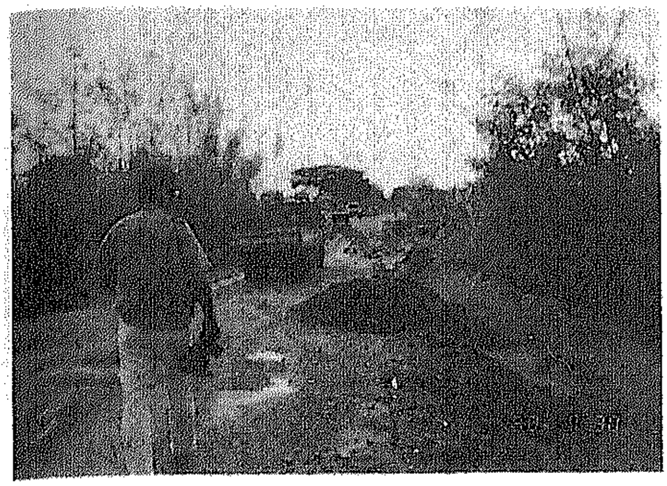


Photo 7.3.7 Sinking of approach to left bank of S. Isidro Bridge

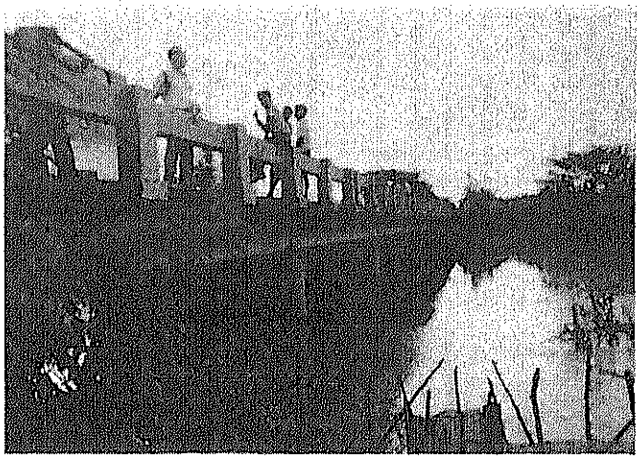


Photo 7.3.8 S. Ishidro Bridge

Photo 7.3.9 Collapse of approach to railroad bridge parallel to S. Isidro Bridge

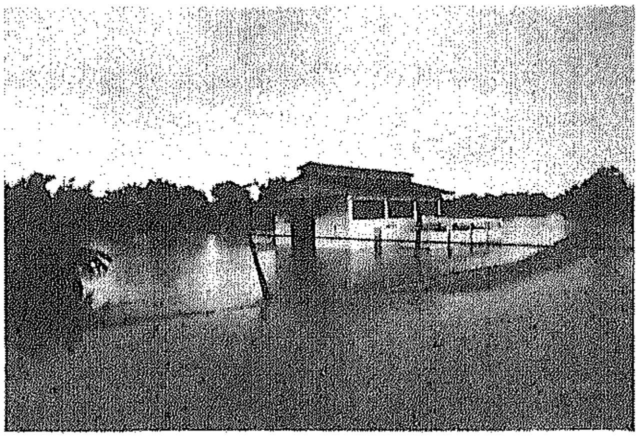


Photo 7.3.10 Sinking of ground inside revetment and embankment on downstream left bank of S. Ishidro Bridge

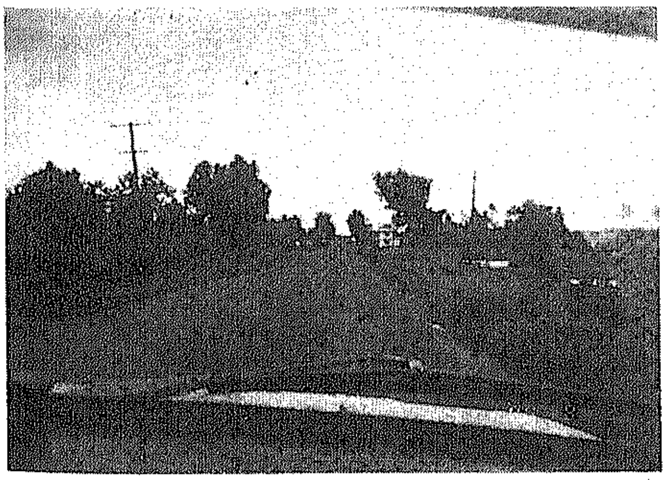


Photo 7.3.11 Depression of surface near the 200km spot on No. 13 Line

Photo 7.3.12 Task Force Rehabilitation Office in Dagupan City

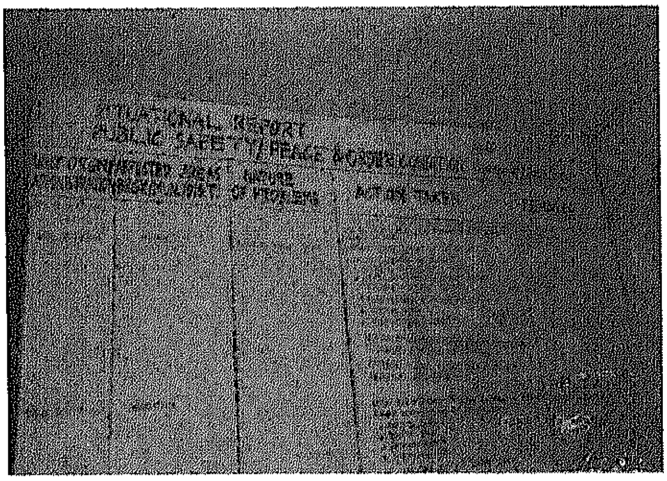


Photo 7.3.13 Billboard in Task Force Rehabilitation Office

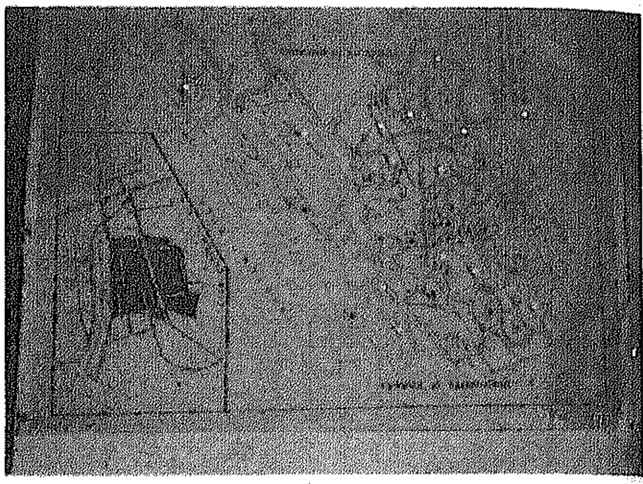


Photo 7.3.14 Billboard in Task Force Rehabilitation Office

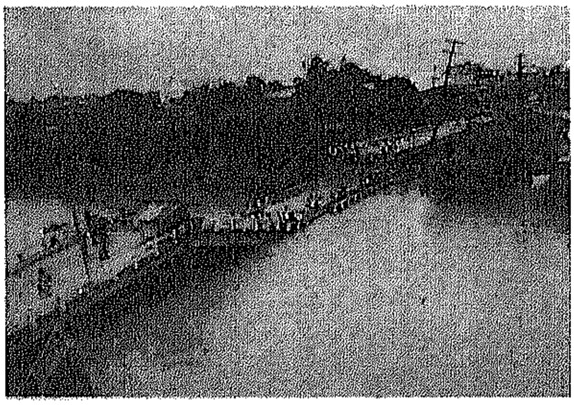


Photo 7.3.15 Magsaysay Bridge (from right bank)

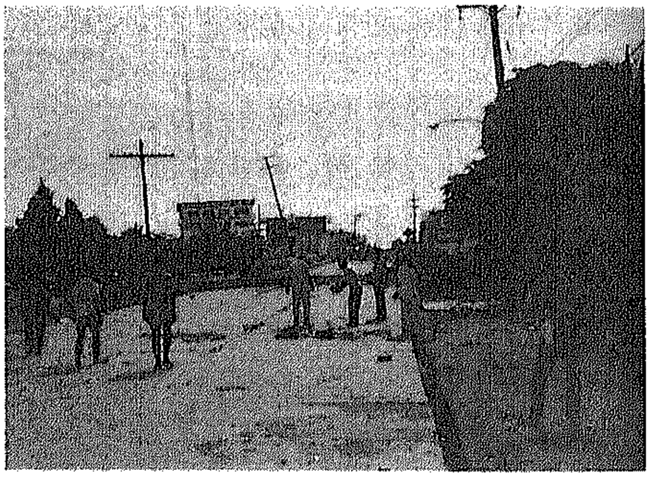


Photo 7.3.16 Approach to left bank of Magsaysay Bridge

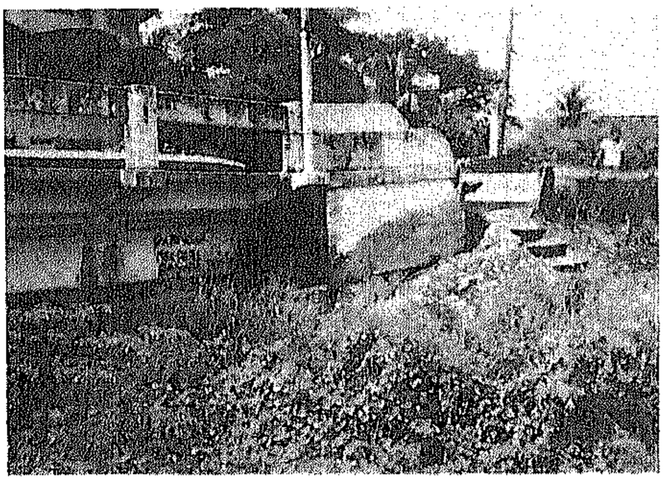


Photo 7.3.17 Abutment on left bank of Magsaysay Bridge

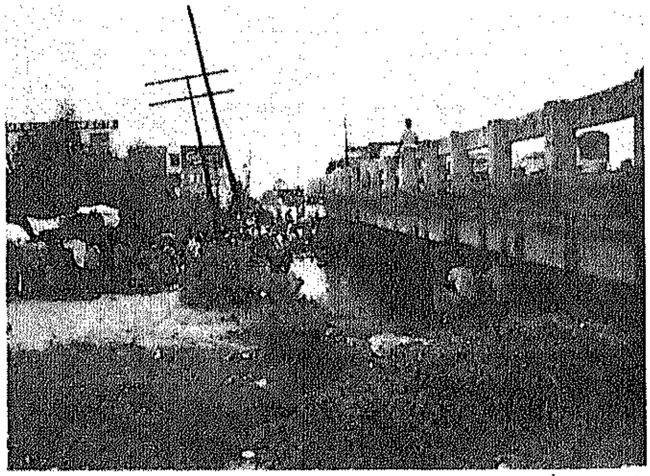


Photo 7.3.18 Magsaysay Bridge; passage is provided for pay by forming an emergency bridge using boats arranged side by side

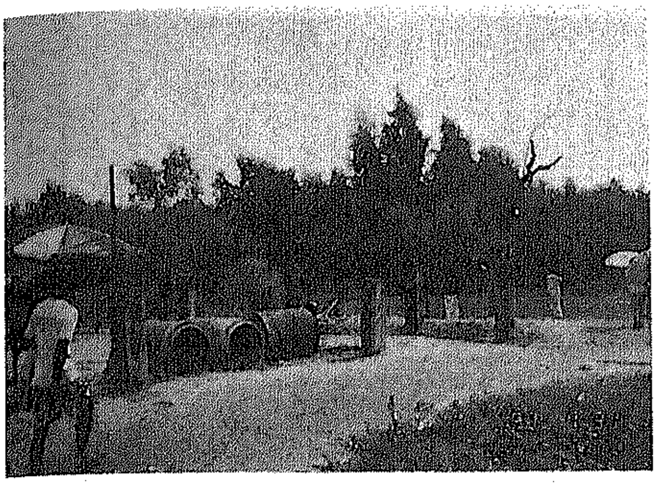


Photo 7.3.19 Substructure for widening of Magsaysay Bridge

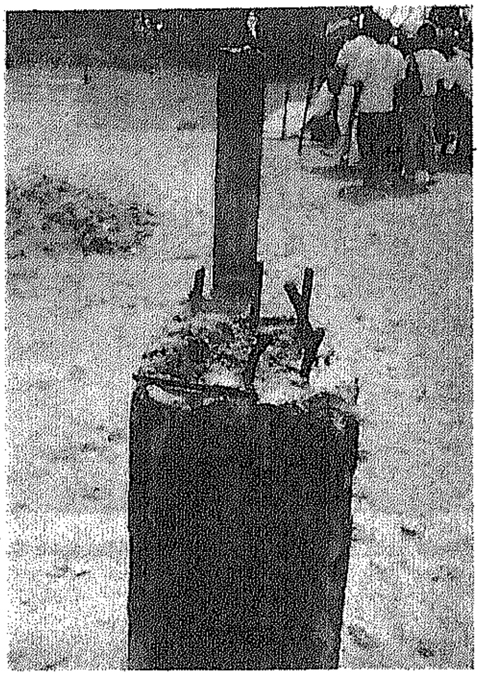


Photo 7.3.20 Substructure for widening of Magsaysay Bridge; Closer view

Photo 7.3.21 Damage to building at approach to right bank of Magsaysay Bridge

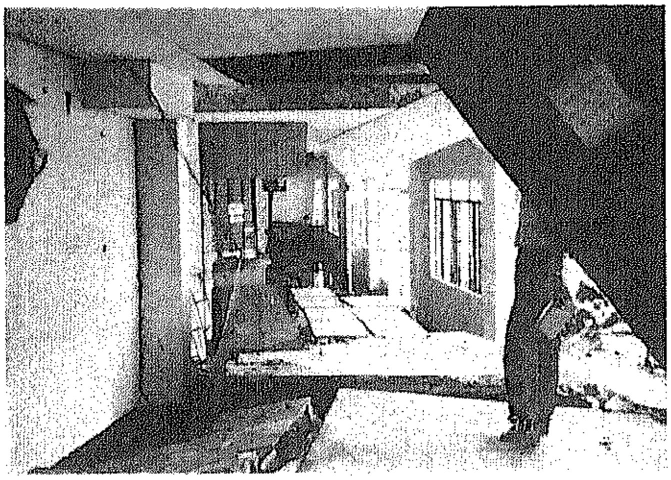


Photo 7.3.22 Damage to building at approach to right bank of Magsaysay Bridge; Inside the buildng

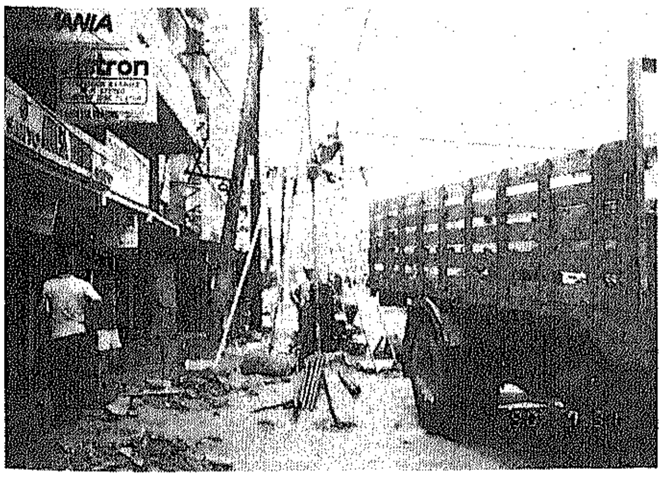


Photo 7.3.23 Boring, B-3 Site

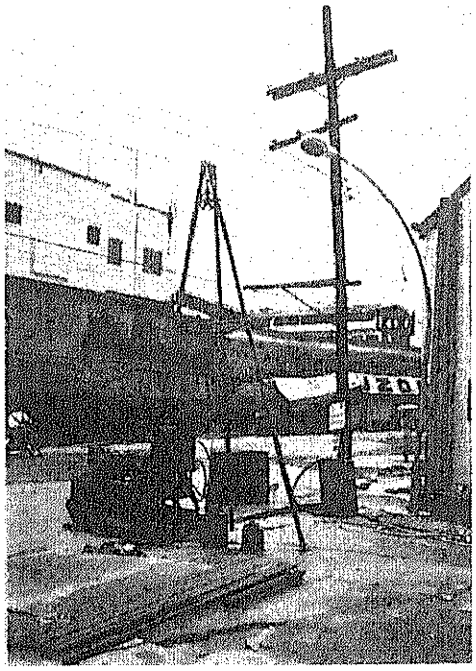


Photo 7.3.24 Boring, B-2 Site

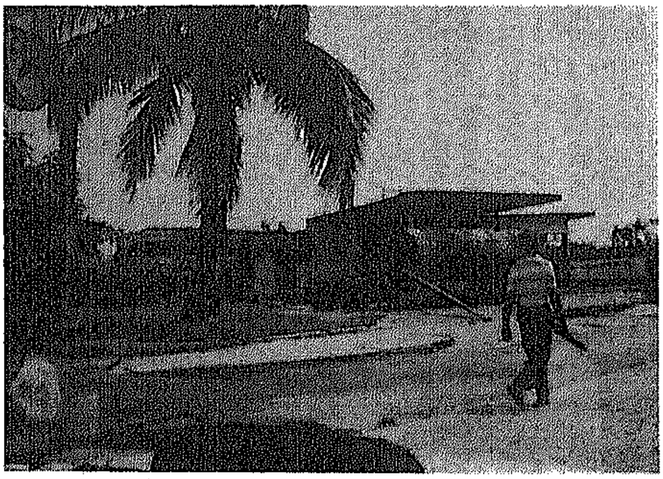


Photo 7.3.25 Gasoline stand in Dagupan City

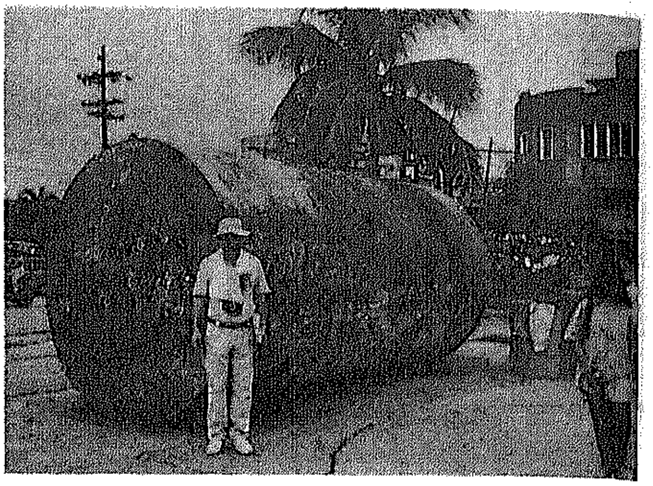


Photo 7.3.26 Excavated tank

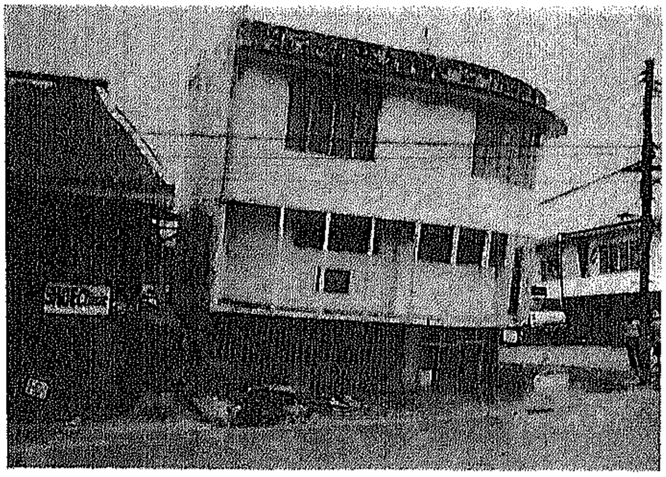


Photo 7.3.27 In Dagupan City

Photo 7.3.28 In Dagupan City (cobble stones on the surface are materials used for emergency repairing.)

Photo 7.3.29 In Dagupan City

Photo 7.3.30 In Dagupan City (there are some sections where puddles were left.)

Photo 7.3.31 In Dagupan City

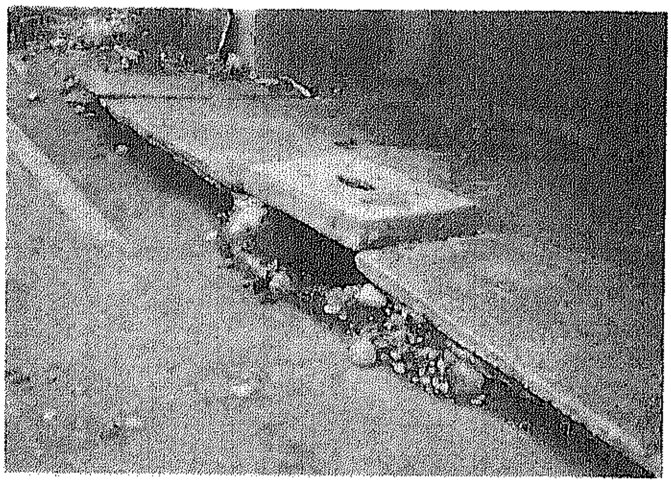


Photo 7.3.32 Damage to drain-ditch in Dagupan City

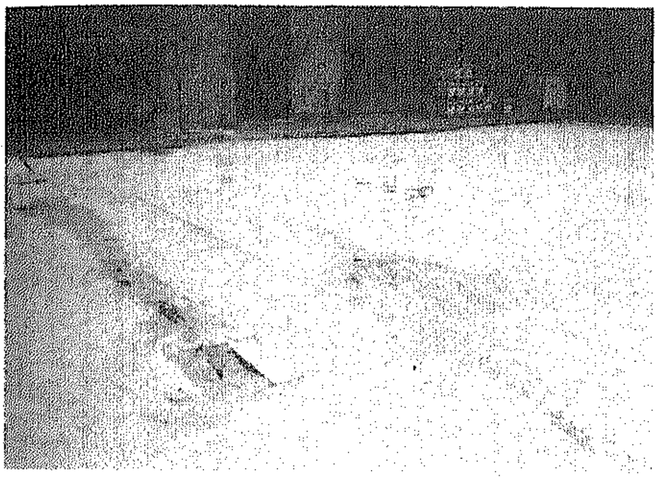


Photo 7.3.33 Sand gust marks on a factory on the right bank (spots 1 - 7) of the Pantal River

Photo 7.3.34 Road in Barangay Pugo

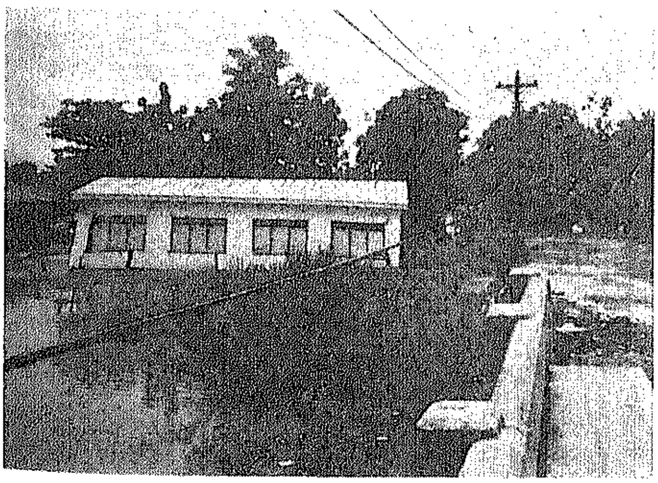


Photo 7.3.35 Road in Barangay Pugo (brought down to a level lower than the water level of the river due to ground sinking.)

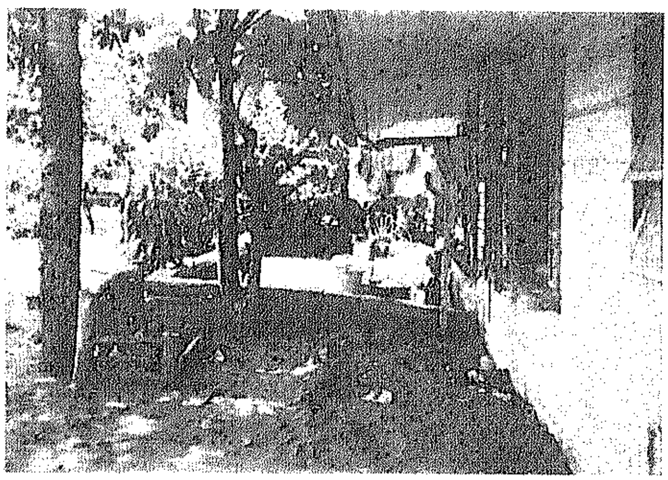


Photo 7.3.36 Damaged private houses in Barangay Pugo

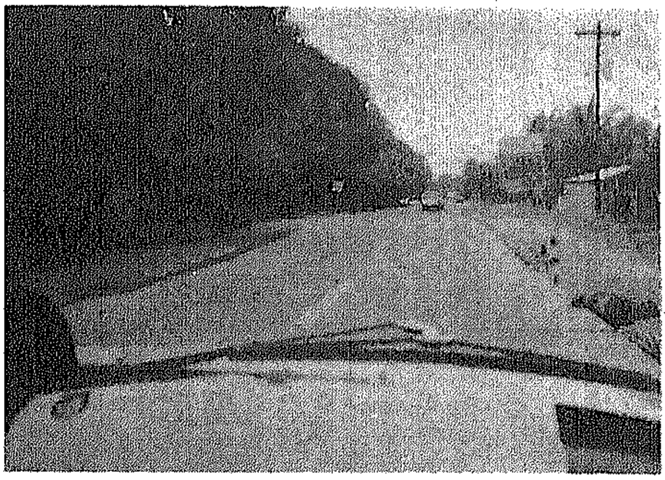


Photo 7.3.37 Depression of road from Calasiao - S. Barbara

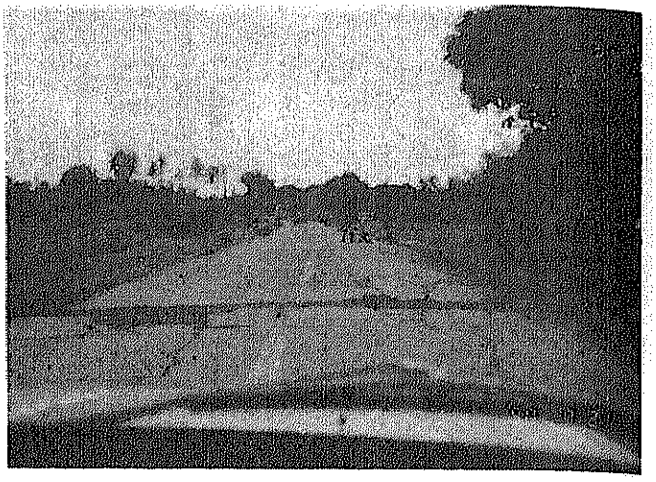


Photo 7.3.38 Depression of road from Calasiao - S. Barbara; Cross-cracking of pavement

Photo 7.3.39 Depression of road from Calasiao - S. Barbara; Sinking of roadside

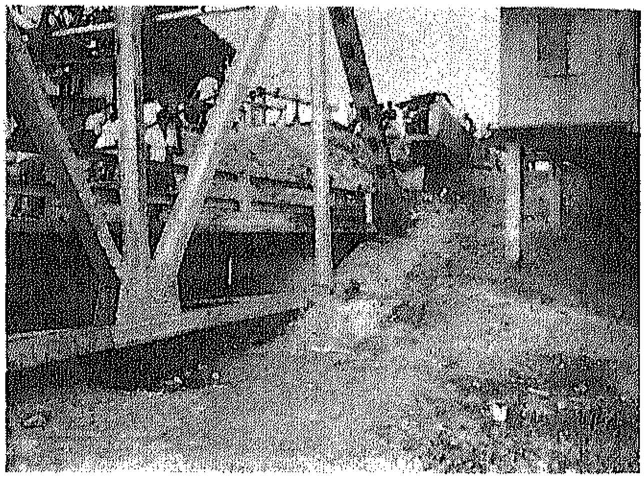


Photo 7.3.40 Left bank abutment of Carmen Bridge

Photo 7.3.41 Left bank abutment of Carmen Bridge; Closer view; side span is pushed out.

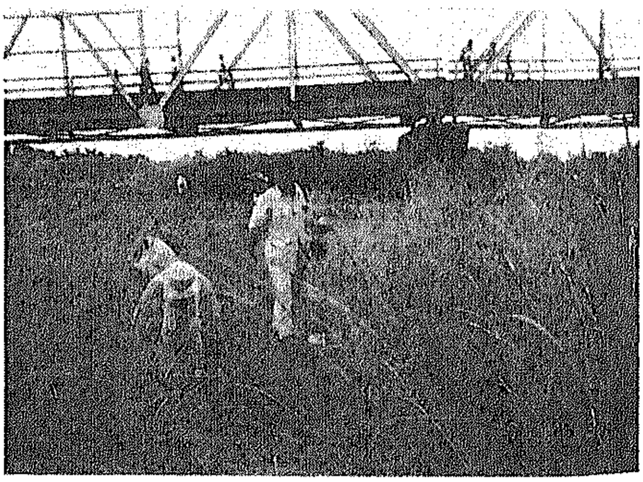


Photo 7.3.42 60cm wide crack seen on left bank side high riverbed

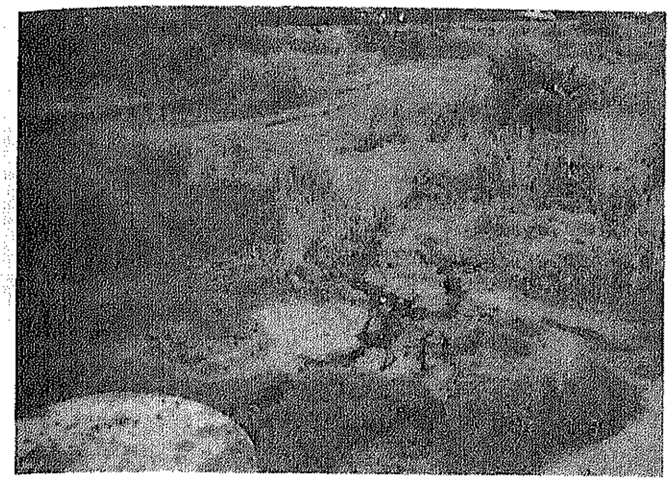


Photo 7.3.43 Crack seen on right bank side high riverbed

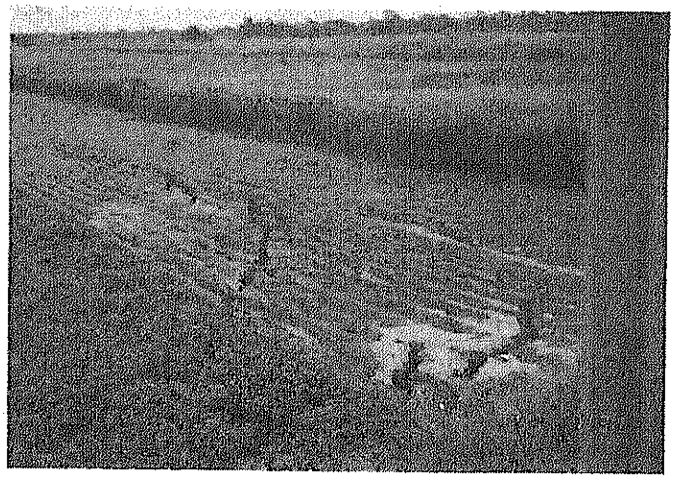


Photo 7.3.44 Crack on left bank down-stream side high riverbed

Photo 7.3.45 Crack in bank along No. 313 Line (Courtesy DPWH)

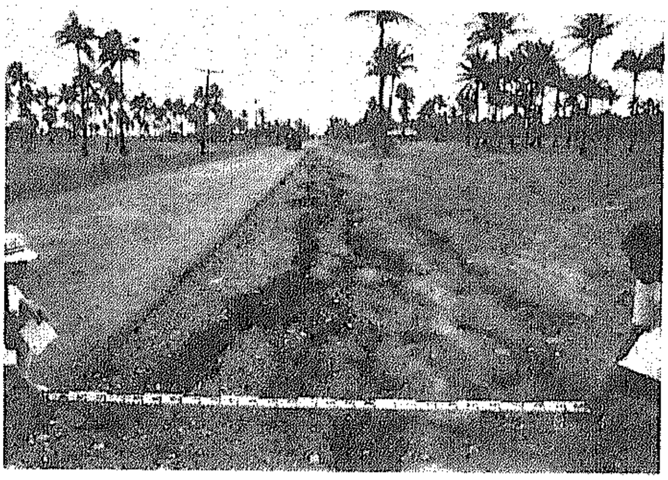


Photo 7.3.46 No. 313 Line, Crack at the side of the Lingayen Golf Link

Photo 7.3.47 Damage to the low bank section of Longas Junction

Photo 7.3.48 Damage to the low bank section of Longas Junction

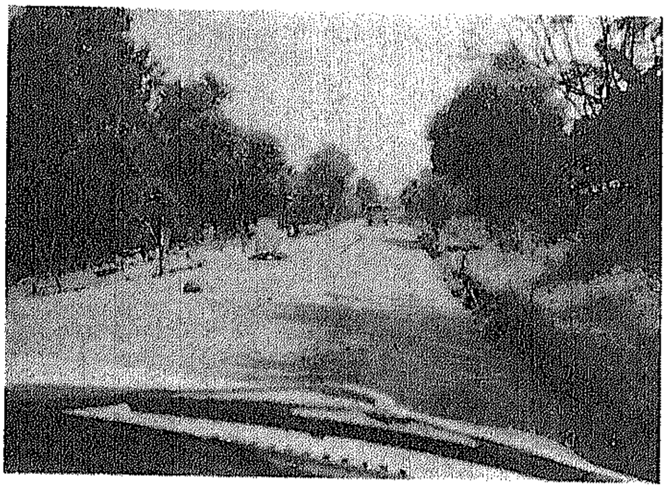


Photo 7.3.49 Damage to the low bank section of Longas Junction ; swelling of surface

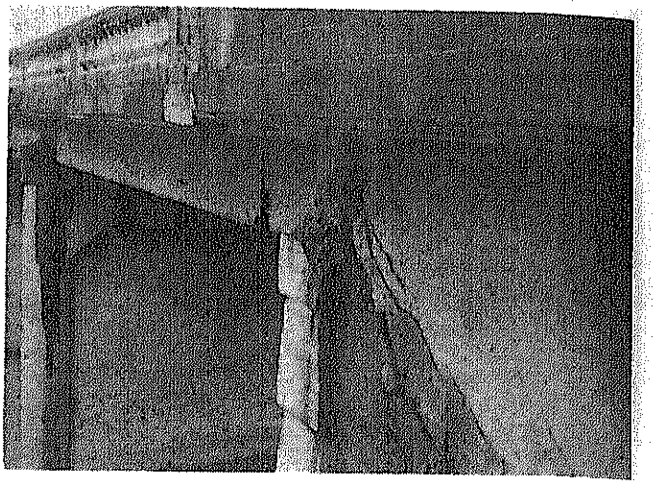


Photo 7.3.50 Damage to left bank abutment of S. Rita Bridge

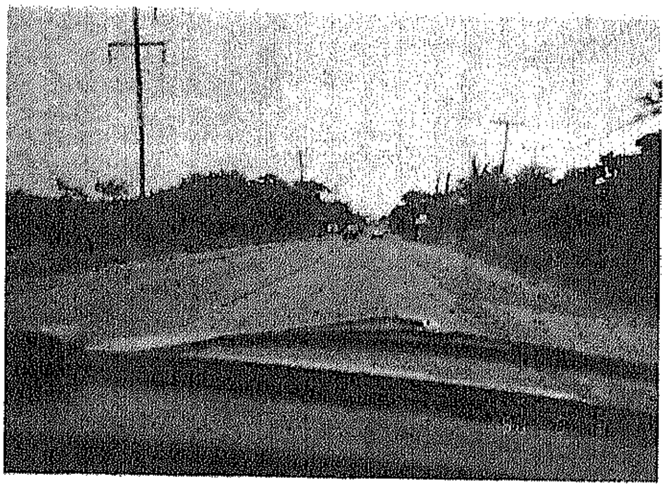


Photo 7.3.51 Stepped part at center of surface from Bauang - S. Fernando

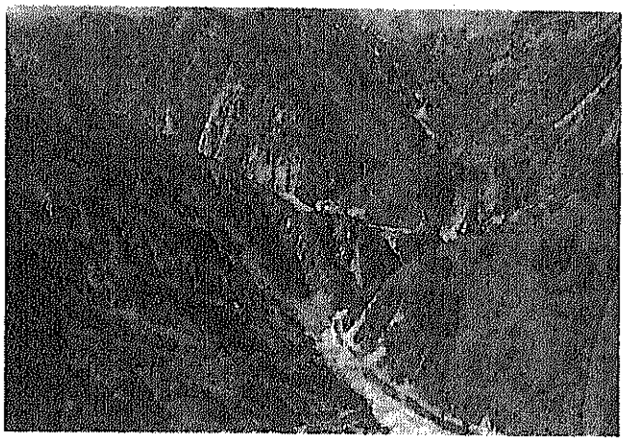


Photo 7.3.52 Shallow failues of hillside slopes along the Kennon Road

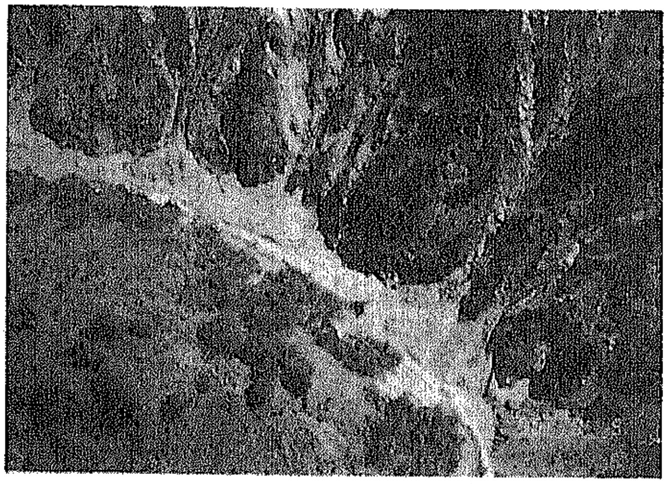


Photo 7.3.53 A large amount of collapsed and fallen sediment flowed out into the Buedo River.

Photo 7.3.54 Around 222 + 500km on Kennon Road

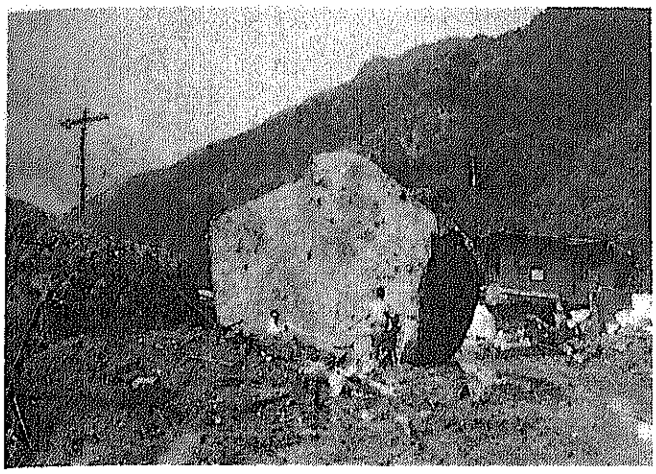


Photo 7.3.55 Large stones which fell at center of Kennon Road

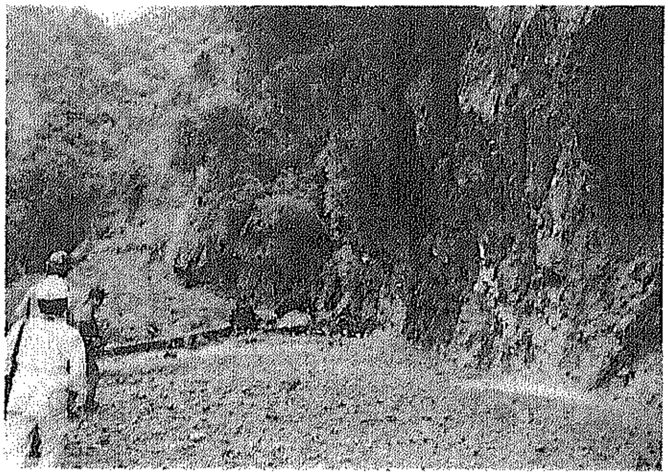


Photo 7.3.56 Around 224km on Kennon Road

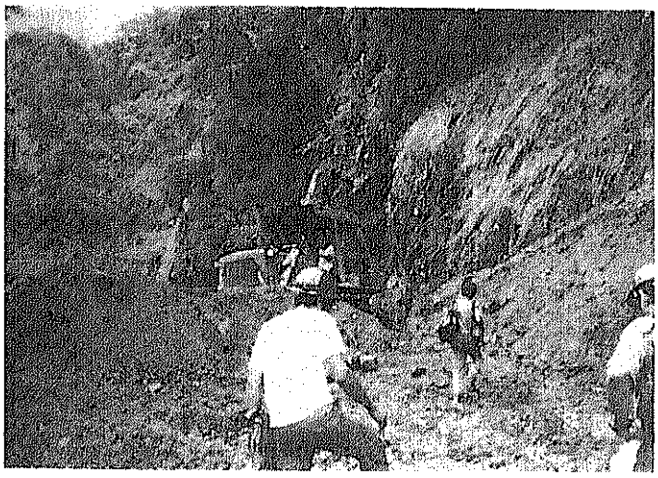


Photo 7.3.57 Around 224km on Kennon Road

Photo 7.3.58 Around 224km on Kennon Road; a bus which fell into the valley bottom

Photo 7.3.59 Masses of collapsed and fallen rocks along the Baguio side of the Kennon Road

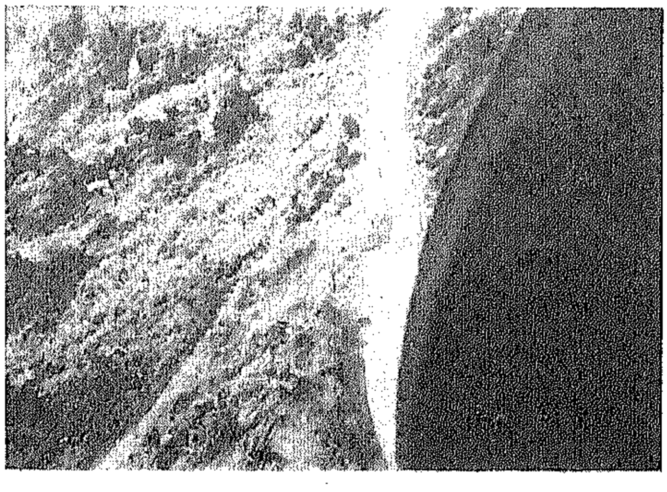


Photo 7.3.60 Settlement of the Marcos Highway

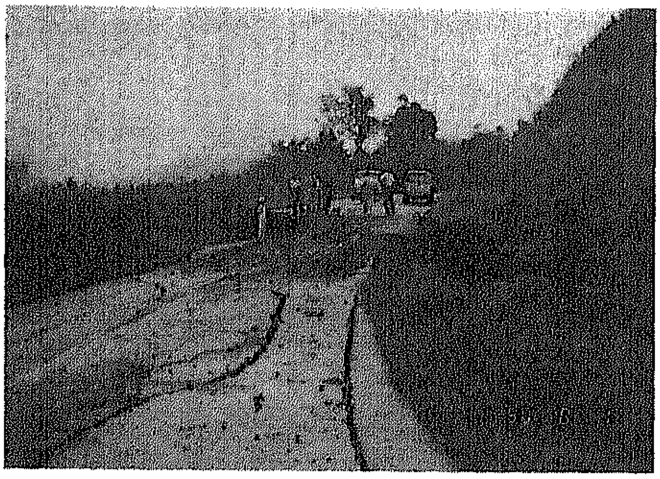


Photo 7.3.61 Collapse around 265km of Marcos Road

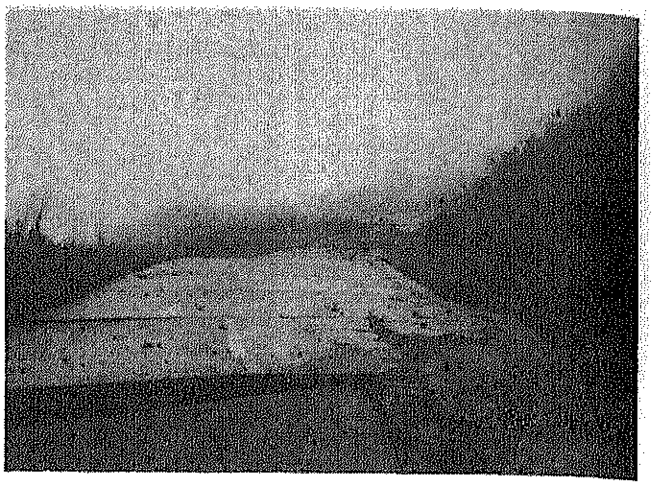


Photo 7.3.62 Collapse around 265km of Marcos Road

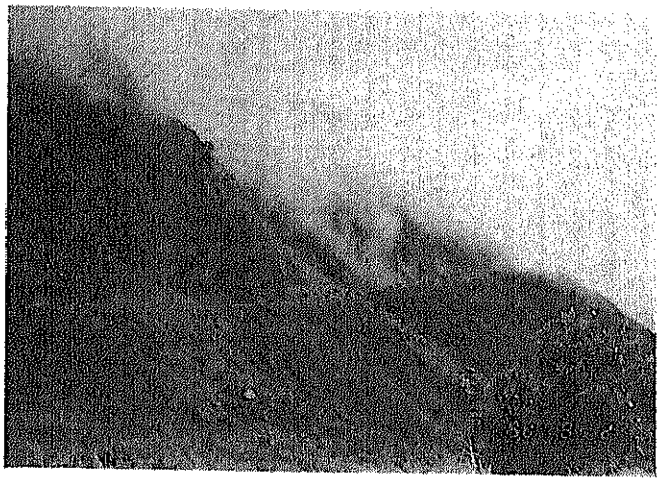


Photo 7.3.63 Collapse around 265km of Marcos Road; Collapse near 277 + 500km (a distant view)

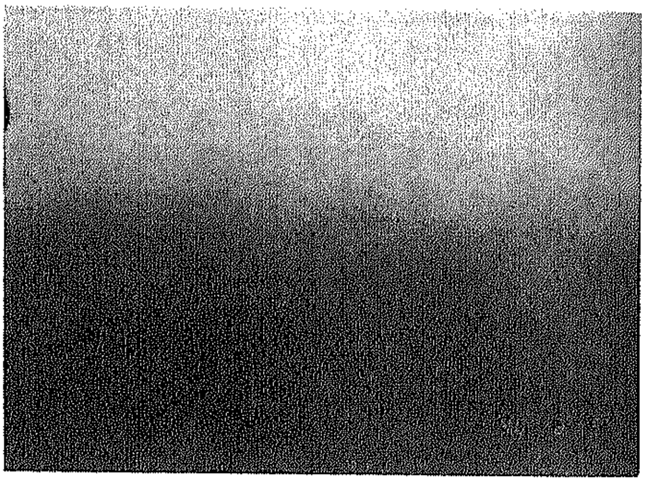


Photo 7.3.64 Collapse around 265km of Marcos Road; Collapse near 272km and recovery work

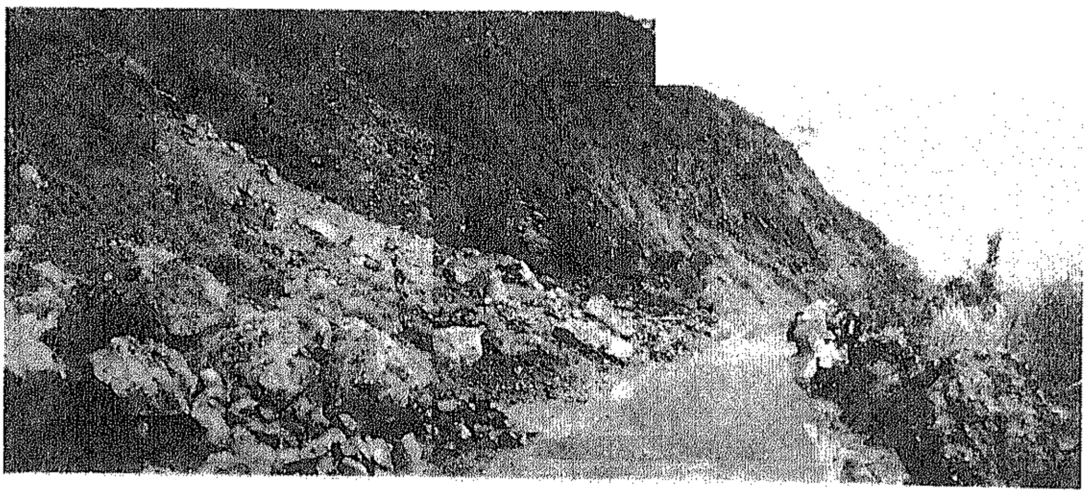


Photo 7.3.65 Collapse around 265km of Marcos Road; Collapse near 277 + 500km (a close range view)

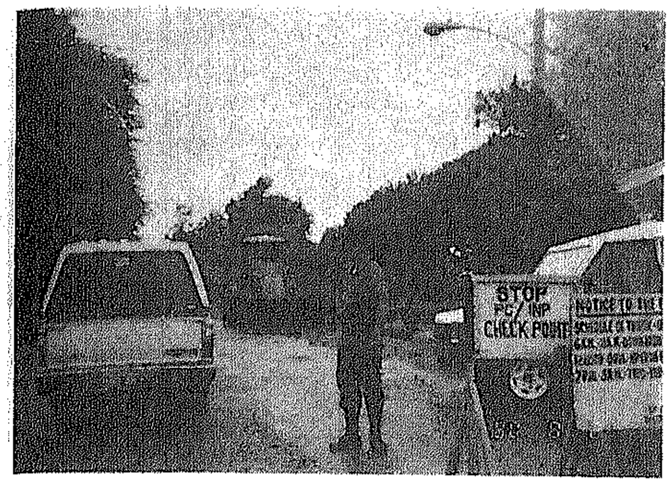


Photo 7.3.66 Entrance to Naguilian Road

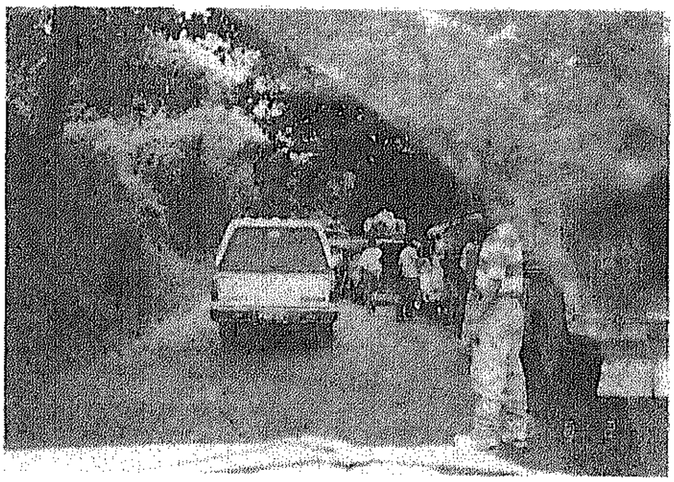


Photo 7.3.67 Entrance to Naguilian Road;
Waiting cars are forming a queue.

Photo 7.3.68 Entrance to Naguilian Road;
Aid materials are running in reverse.

Photo 7.3.69 Entrance to Naguilian Road;
Shoulder collapse

Photo 7.3.70 Entrance to Naguilian Road;
Rock slope collapse and fall

Photo 7.3.71 Entrance to Naguilian Road;
Sediment slope collapse and fall

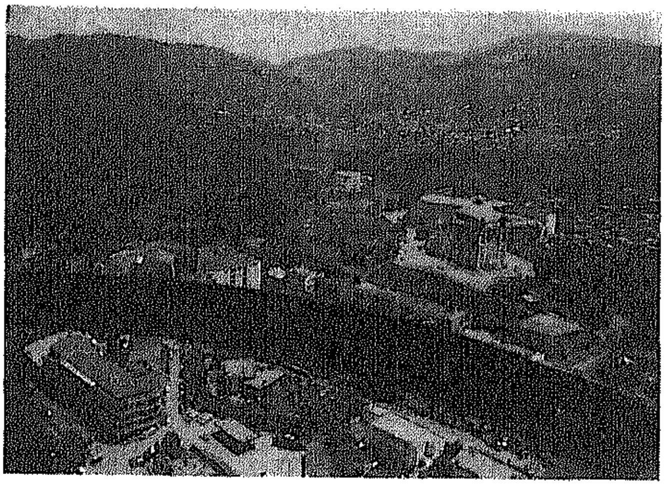


Photo 7.3.72 Colony at Baguio City

Photo 7.3.73 Colony at Baguio City; Slope collapse, even though of small scale, is distinctive.

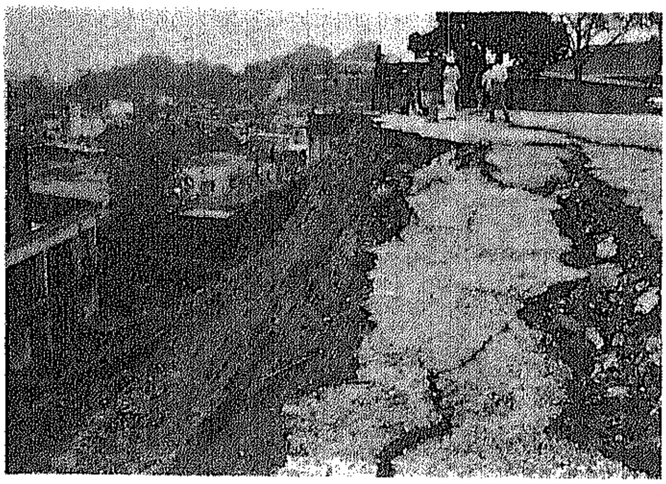


Photo 7.3.74 Collapse of site end of S. Mary Church

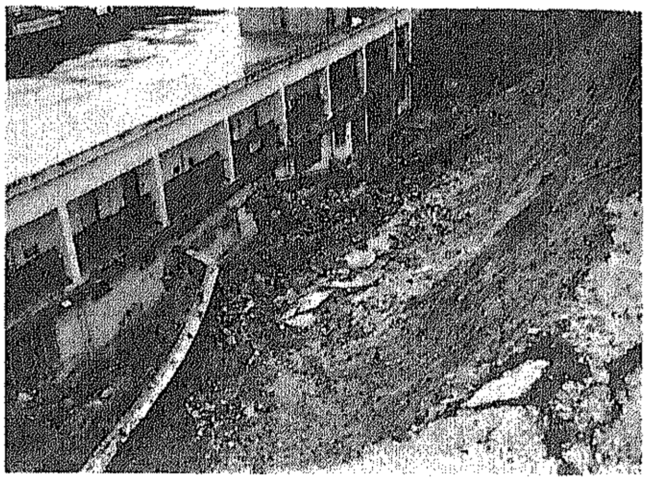


Photo 7.3.75 Collapse of site end of S.Mary Church; There is an RC apartment (?) under the slope.

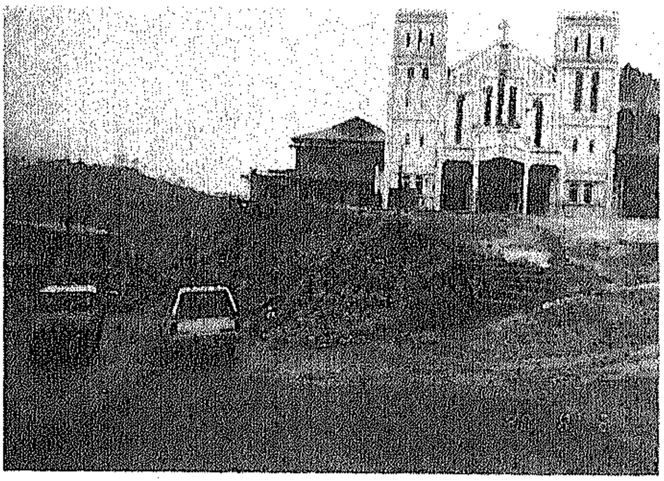


Photo 7.3.76 Collapse of faces of slopes in Baguio City

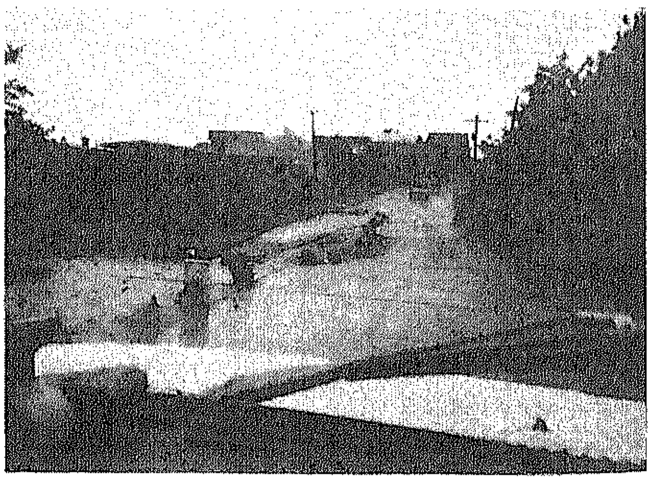


Photo 7.3.77 Depression of roads in Baguio City

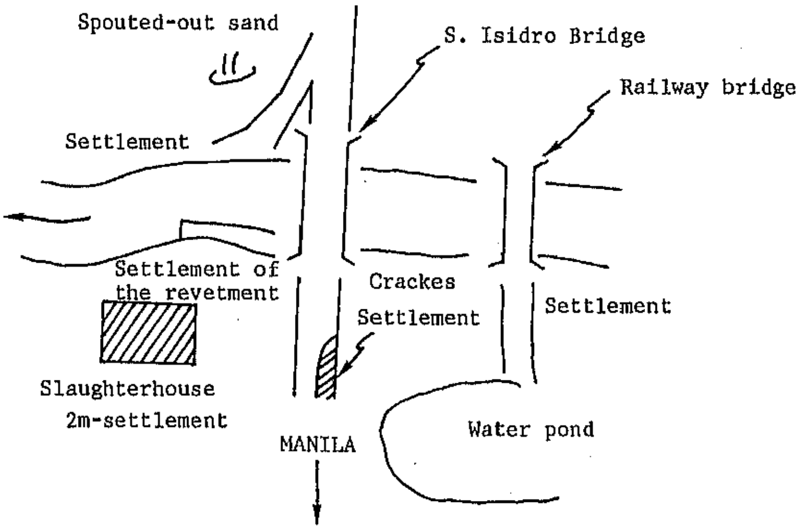


Figure 7.3.2 Sketch of the S. Isidro Bridge and Its Surroundings

Table 7.3.1 Summary of Damages/Losses to Public Infrastructure As of July 26, 1990 (5:00 PM) (Unit: Peso)

DAGUPAN CITY

ROADS:	NUMBER	ESTIMATED COST
National	4	28,450,000.00
City	16	52,750,000.00
Barangay	10	18,560,000.00
	Sub-Total	94,760,000.00
BRIDGES:		
National	2	26,800,000.00
City	1	2,250,000.00
Barangay	5	2,950,000.00
	Sub-Total	33,000,000.00
PUBLIC BUILDINGS:		
School Buildings	22	68,742,000.00
City Hall	1	50,000,000.00
Post Office/Telecom	1	7,000,000.00
Public Market	1	43,000,000.00
	Sub-Total	168,742,000.00
OTHER PUBLIC UTILITIES:		
Banks	3	25,000,000.00
Hospital (Government)		66,050,000.00
Other Gov't. Offices		327,000,000.00
Water System		100,000,000.00
	Sub-Total	518,050,000.00
	TOTAL	814,552,000.00

Table 7.3.2 Damage Report

Economic reconstruction group, Dagupan city

As of July 27th, 1990,
Pangasinan State

I. Estimated damage to society and the economy - Commercial areas of Dagupan city

Street	Damaged areas		Total damaged area (ha)
	Total (ha)	Partial (ha)	
1. A.B. Fernandez	7.2	1.8	9.0
2. Perez Boulevard	7.2	1.8	9.0
3. Fernandez Street	2.4	0.6	3.0
4. Rizal Street	2.4	0.6	3.0
5. Galvan/Gomez Street	1.4	0.4	1.8
6. Rivera Street	2.4	0.6	3.0
7. Others	1.0	0.2	1.2
Total	24.0	6.0	30.0

II. Estimated cost of damage

Street	Reconstruction cost (Peso)	Restoration cost (Peso)	Demolition cost (Peso)	Total (Peso)
	million	million	million	million
1. A.B. Fernandez	576	72	18	666
2. Perez Boulevard	576	72	18	666
3. Fernandez Street	192	24	6	222
4. Rizal Street	192	24	6	222
5. Galvan/Gomez Street	112	14	3.5	129.5
6. Rivera Street	192	24	6.5	222
7. Others	80	10	2.5	92.5
Total	1.92 billion	240 million	60 million	2.22 billion

Footnotes:

1) a. Area of commercial districts: 63.6ha
   b. Area of damaged commercial districts: 50ha
   c. Area of roads and open-spaces: 20ha

2) Based on visual investigation and previous inspection by the comp team group, consisting of consultants employed in private organizations, to decide on the safety and conditions of buildings in DPWH central offices, city engineering offices, Dagupan city and the stricken areas. (DPWH: Department of Public Works and Highways)

3) a. Affected commercial enterprises: 650
   b. Economically-affected stores-commercial space holders: 500

4) Government staff suffering indirect economic effects due to presumed shortages in the collection of revenues, such as local taxes: 600

5) Affected banks: 8 (PNB, Associated Bank, Prudential Bank, BPI Bank, China Bank, FEBTC, Red Planters Bank, Inter Bank)

6) At about 500 commercial enterprises, an average of 20 persons per enterprise suffered from economic disruptions.

7) The influence on secondary and tertiary industries is being estimated.

III. Recommendations from the commercial sector

Recommendation	Program
1. Hasty dispatch of building engineers, soil specialists and geologists.	Soil specialists arrived on July 24th, and are investigating. Building engineers arrived on July 26th.
2. Preparation of temporary movable facilities for shopkeepers and pedlars who have had to move.	The McAdore Hotel agreed to offer a place for shopkeepers and the offices of the government. An evaluation of necessary restoration is being conducted. Public Plaza agreed to offer a place to pedlars. Construction work commenced on July 30th, to be finished on August 8th. (The public market escaped damage.) The PNR location agreed to offer a place to pedrlars. Inspection has been finished. Pantranko Wash Rack location is studying the offer of places for medium to large enterprises.
3. Rapid use of low-interest reconstruction loans with long-term payments and free security requirements.	Under study.
4. Rapid construction of the revetments of the Pantal river.	So far, 7,000 gunny sacks have been donated; 1,000 sacks were donated by Agno river Control. To collect as many sacks as possible, PR is being conducted.

Recommendation	Program
5. Removal of earth and sand and obstacles on main routes.	Finished by the army construction party.
6. Rapid restoration of the main streets and the Quitos Bridge.	Restoration of the drainage facilities is being executed. The asphalt for the bridges and the roads is under study.
7. Rapid restoration of the waterworks.	Restoration materials for the pumps have been prepared. Restoration of distribution-supply facilities is being studied.
8. Deferment of bank expenses for checks and present loan payments.	Being studied, agreement is clearly indicated.
9. Assignment of positions to pedlars in the Public Plaza by the authorized pedlars related to ERG.	Agreed on.
10. Assignment of areas and positions in the McAdore Complex, which should be performed by ERG.	Agreed on.
11. Explanation of the terms of possession according to the merchants left in the McAdore Complex.	Under study.
12. Quick installation of street lamps on A.B. Fernandez street.	Under study.

Recommendation	Program
13. The relationship of ERG long-term urban planning to Dagupan city.	Agreed on , under study.
14. Organization of different industrial bodies for the unity and control of ERG.	Dagupan "Bangus" Jaycees made an equal effort.

Note: (1) PNR: (2) ERG:

Table 7.3.3 Report on Damage Conditions

Safety of public welfare, conditions of equability and public order

As of July 27th, 1990,
Pangasinan State

Party and administrative organization	Disaster areas BRGY/MPLTY/DIST.	Features of damage	Countermeasures	Comments
Pangasinan State head office, PC/IMP head-quarters	Pangasinan State	Great earthquake	Performance of IMPLAN.OPLAN 06/88 DAMAYAN.	In order to deal with the disaster, all PC/INP parties were mobilized.
			To make sure of a report on the scope of the disaster from AOR in four PC/INP districts, four investigation teams were dispatched from PHQ.	
			All PC/INP vehicles were mobilized for the evacuation of sufferers; general persons remaining were conveyed.	
			All COs/STN commanders were directed to give every aid to sufferers.	
			In order to aid in the disaster scope and the countermeasures plan, PC/PS had a discussion with the disaster control council at 20:00 on July 16th.	
			The report on the stricken area obtained by the survey team was telegraphed to HQS at 04:00 on July 17th.	At HQS, disaster information has been renewed.
			PS/PS had a discussion with governor Rafael Colet at 04:30 on July 17th, and a visual investigation of the stricken areas was conducted.	
		Safety and public welfare in the disaster areas.	PS/PS and governor Rafael Colet spoke on the radio on the disaster conditions at 08:30 on July 17th.	In order to cope with many administrative organs and other sections, a mobile REHAB troop was organized.
			In order to prepare drinking water for the residents in Dagupan city, 17 fire engine trucks from neighboring police stations were mobilized.	17 fire engine trucks and 52 persons from local fire stations, and 11 fire engine trucks and 79 persons from assigned parties were mobilized.
Dagupan police station	Dagupan city	Rescue of the earthquake disaster sufferers.	Evacuated sufferers took refuge in the east-central elementary school; the killed and injured were received into hospitals.	

Party and administrative organization	Disaster areas BRGY/MPLTY/DIST.	Features of damage	Countermeasures	Comments
		VIP safety	Proper security for President Aquino, Directors Ramos, Orbos and Leong, VIPs such as Senators Laurel and Shahani, and for Comnolcom, who investigated the disaster areas.	
Val Task Rice "Tulong" F	Dagupan city	Rehabilitation of damaged facilities.	At 10:00 on July 21st, arrival at Dagupan city to help sufferers; establishment of ACP.	
			<u>As of July 23rd</u> Pogo Lasip Grande street, Perez main street, Dagupan city, Rizal street.	Removal of obstacles on the roads/ leveling/compaction: 100%
			Rehabilitation of concrete drainage pipes along A.B. Fernandez street.	20%
			Removal of obstacles in the canals at Pogo-Chico/cutting of backfill and transportation of it to the site.	85% 10%
			Restoration of bridge access parts: Binloc Bridge Pogo-Chico Bridge Pogo-Lasip Bridge	 30% 30% 85%
PC/INP head-quarters	Pangasinan State	Traffic	Preparation of the traffic signals, safety of drivers on the main roads for Manila city from the north.	
Bantay	Dagupan city	Safety	Safety for the Philvocs team	Soil analysis.
Laison team			Coordination with the State disaster coordination center in Lingayen and Dagupan city.	
			Coordination of functions of the PHQ investigation party, collection of new damage conditions in the disaster areas.	
			Coordination with DSWD office a) West Pangasinan State branch b) East Pangasinan State branch c) Present rescue operations of the Dagupan city branch and a renewed disaster report.	
			Coordination of the possibilities of the helicopter parties of PHQ and DSWD (east Pangasinan State), at Brgy Malico, San Nicolas and Pangasinan.	The helicopter parties were organized at 12:30 on July 26th.

Party and administrative organization	Disaster areas BRGY/MPLTY/DIST.	Features of damage	Countermeasures	Comments
Tulong naval mobile	Dagupan city	Rehabilitation of the damaged facilities.	Rehabilitation report as of July 25th:	
			1. Filling of the roads/leveling	
			a. 2.5km from Perez main street (Burgos) to Malued	5%
			b. 2.5km from Perez main street (Zamora) to Pogo Grande	27%
			c. 2.0km from Burgos street to Lasip Grande	10%
			2. Filling in of bridge access parts/leveling	
			a. Mariposa Bridge 20m	90%
			b. Pogo Grande (culvert) 70m	13%
			3. Transportation of cement-aggregate: 21km from San Fabian to Dagupan city 450DPTS1350M.	5%
			4. Rehabilitation of sewer pipes along A.B. Fernandez street.	18%
Pangasinan State PC/INP	Main road network	Traffic detours	The president of the mobile REHAB troops directed the Pangasinan State PC/INP party to take a long way around to reduce traffic jams.	The order was enforced at 11:00 on July 28th.

Note)
(1) PC/INP: Personal Carrier/Inpersonal Carrier
(2) IMPALAN. OPLAN 06/88 DAMAYAN: Implementation Plan/Operation Plan
(3) AOR:
(4) PHQ: Pangasinan Headquarters
(5) COs/STN: Commanding Officers Station
(6) PC/PS: Personal Carrier/Police Station
(7) PS/PS: Police Station
(8) REHAB: The name of Task Force for Rehabilitation
(9) VAL TASK RICE: Task Force to supply Foods
(10) ACP:
(11) Philvocs: Philippine Institute of Volcanology and Seismology
(12) DSWD: Department of Social Selfare and Development

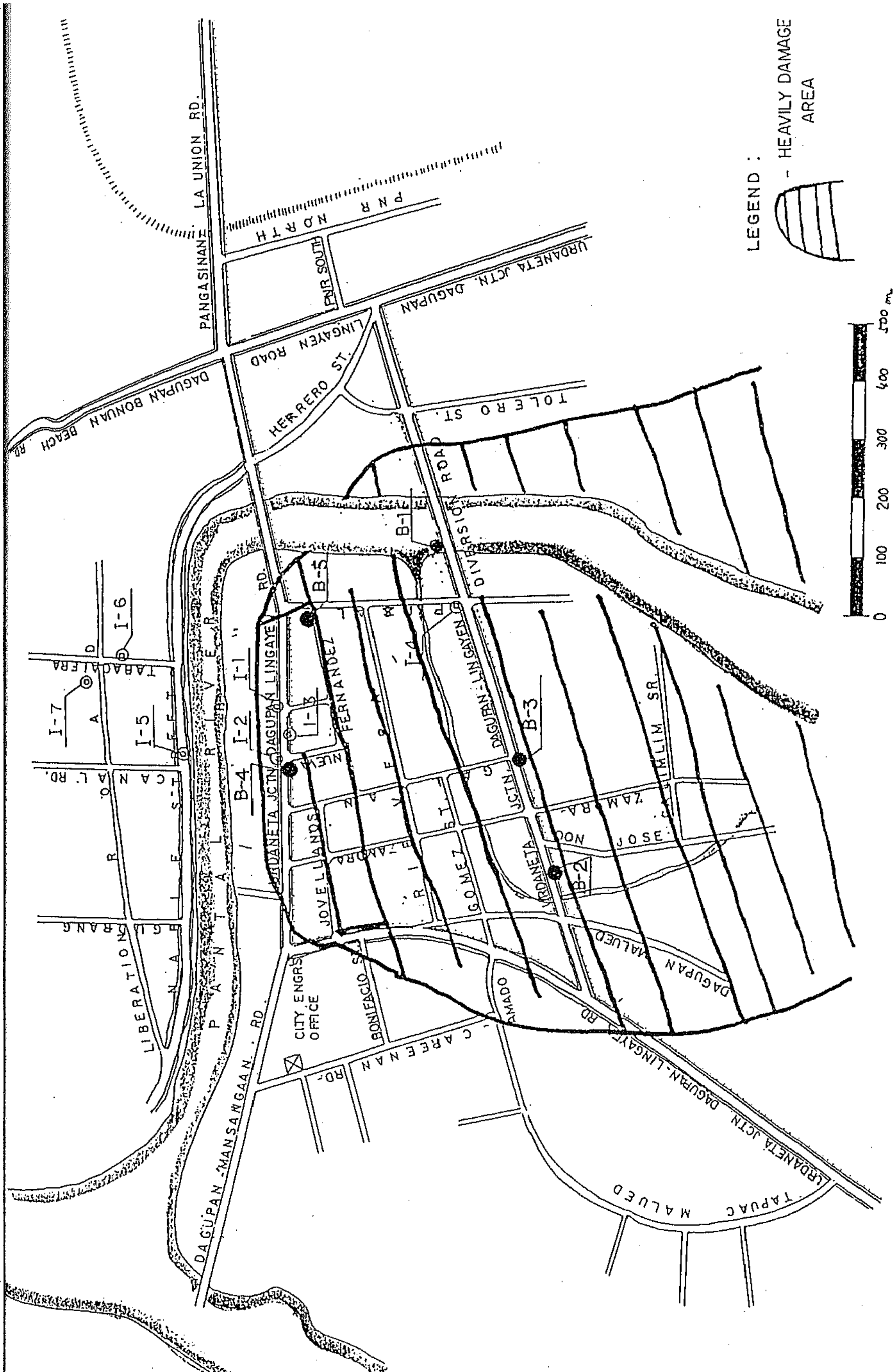
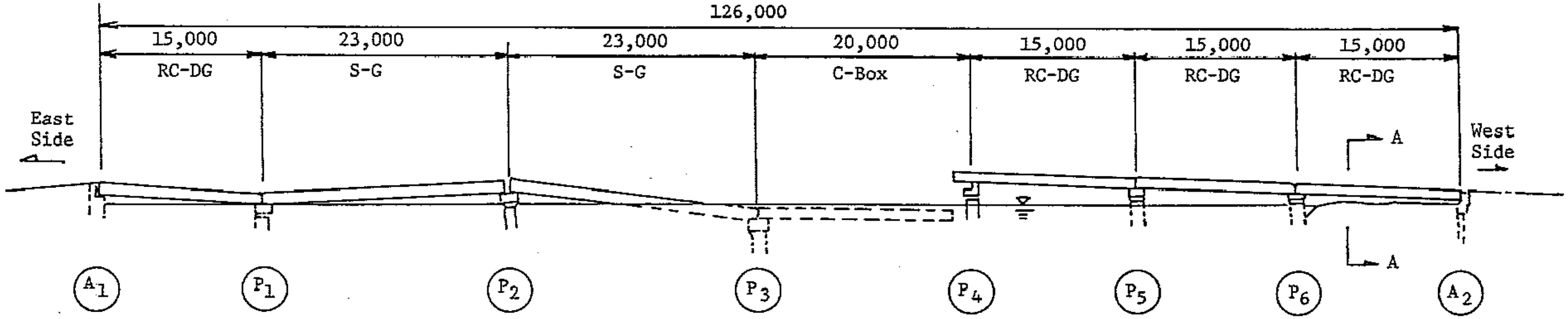
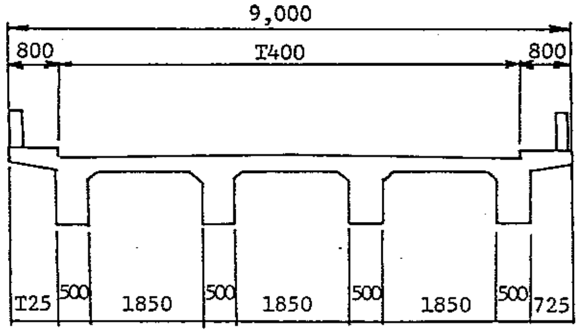


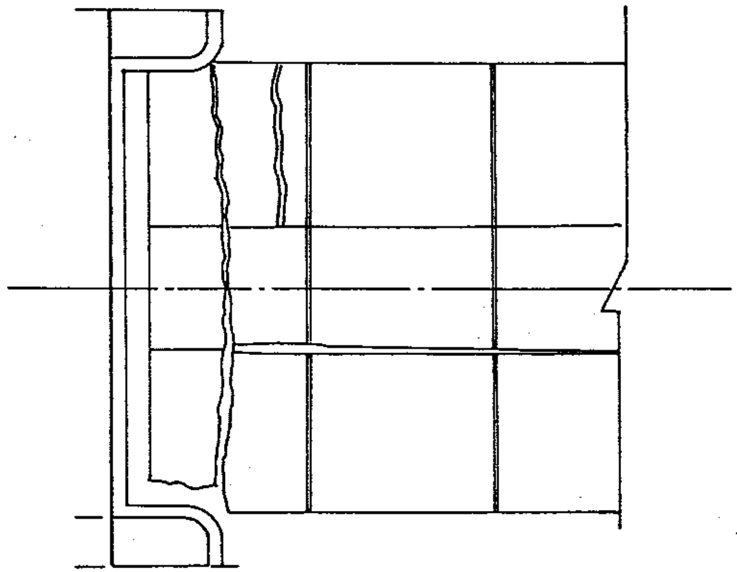
Fig. 7.3.3 The Midtown Area of Dagupan City



Profile



A-A Section



Crack Diagram at West Side Bridge Approach

Figure 7.3.4 Magsaysay Bridge in Dagupan City

Sample Name	Dagupa	Carmen Br. Left Bank	Magsaysay Br. Left Bank	Boring No. 3 16.5m
Particle size (mm)	Percentage of passed (%)			
4.76	100.0	100.0	100.0	100.0
2.00	100.0	100.0	100.0	99.8
0.84	100.0	100.0	99.9	99.7
0.42	98.7	94.4	70.4	99.6
0.25	59.5	36.8	40.9	98.6
0.105	8.7	8.2	6.9	82.5
0.074	5.4	5.6	5.0	41.5

Note: More than 0.084; shells

Sample Name	Dagupa	Carmen Br. Left Bank	Magsaysay Br. Left Bank	Boring No. 3 16.5m
Particle size (mm)	Percentage of passed (%)			
0.056	—	—	—	36.6
0.034	—	—	—	32.1
0.023	—	—	—	25.5
0.013	—	—	—	17.7
0.0092	—	—	—	15.5
0.0071	—	—	—	12.2
0.0042	—	—	—	6.6

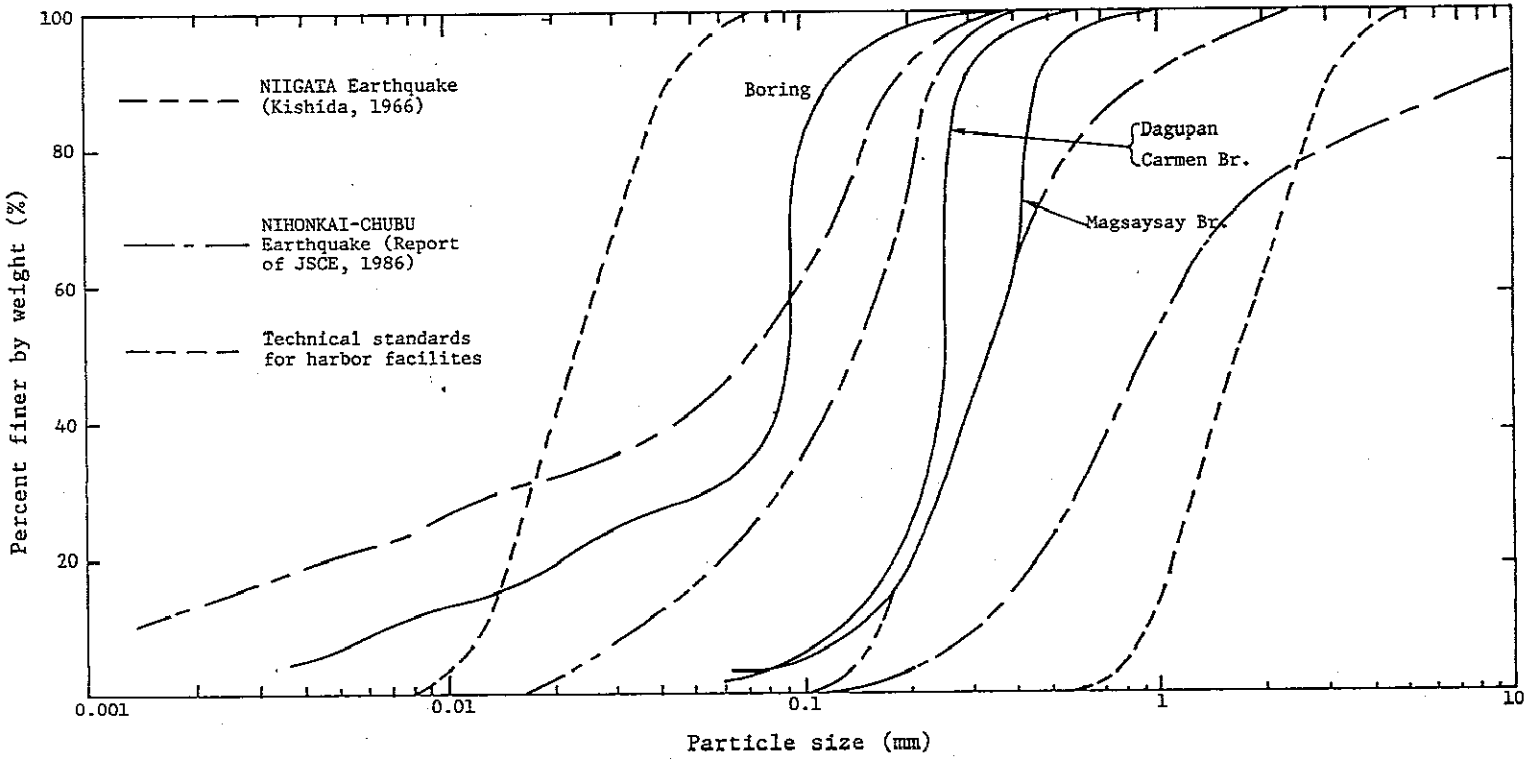


Figure 7.3.5 Results of the Sieve Analysis of Sand

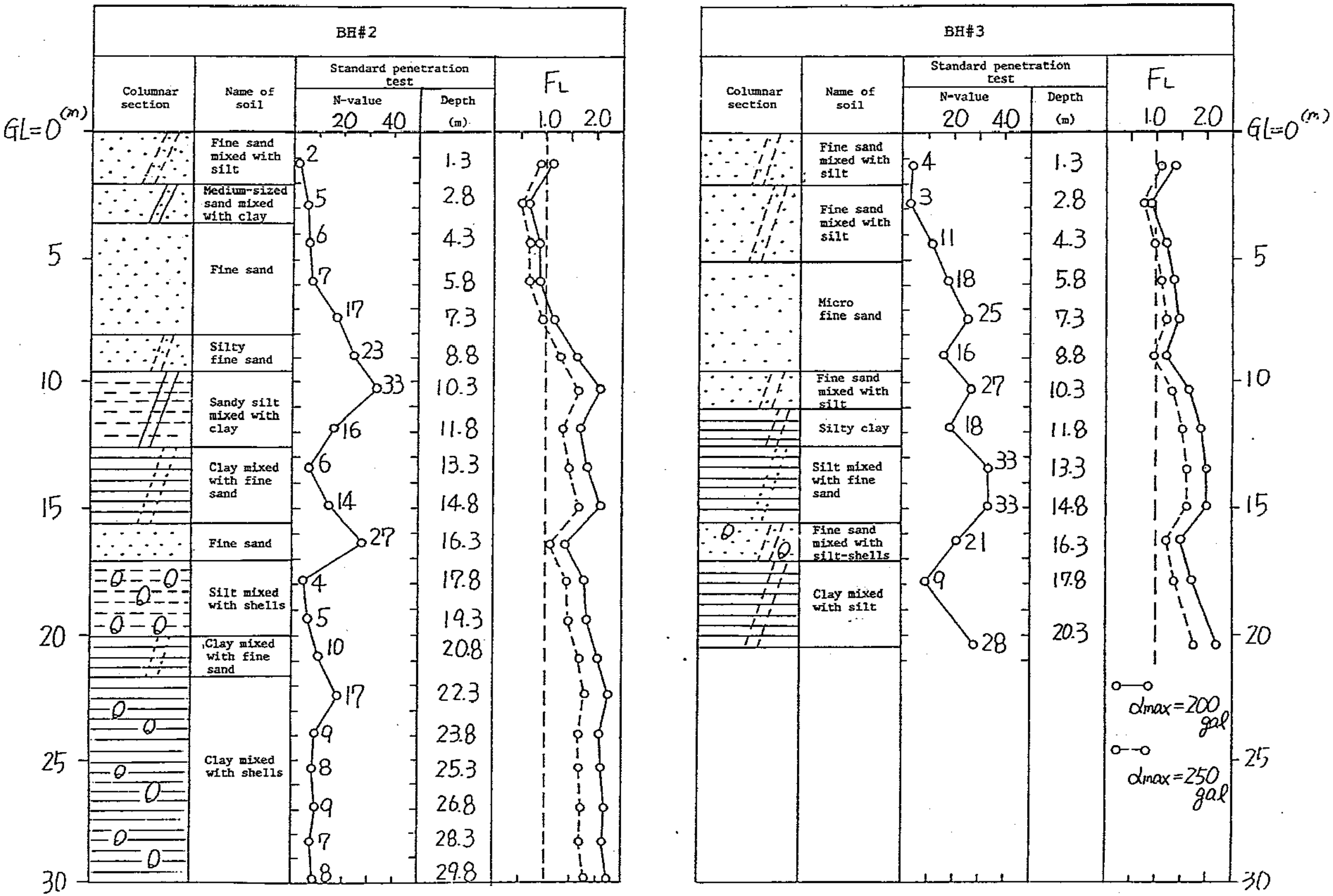


Figure 7.3.6 Boring log in Dagupan

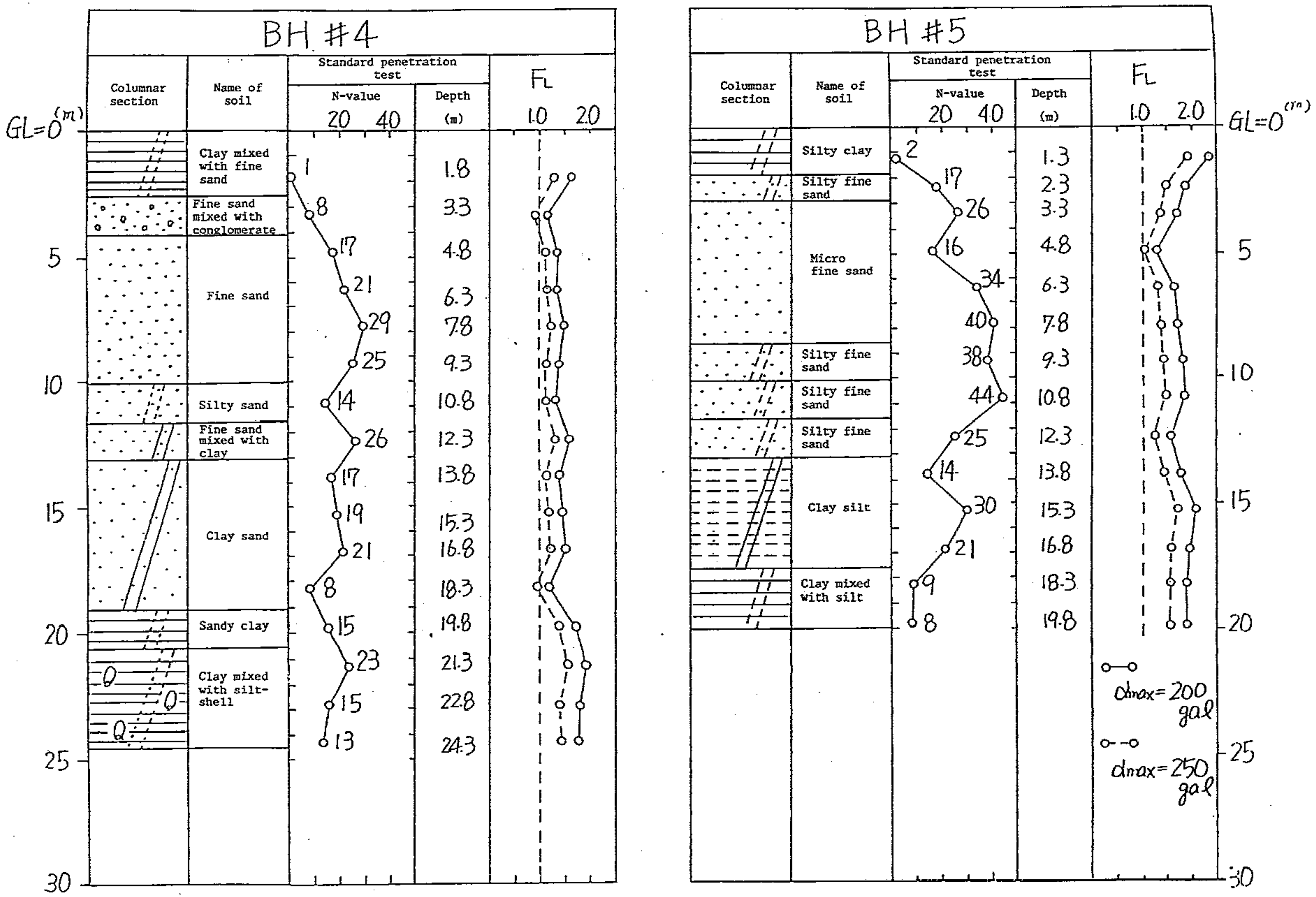
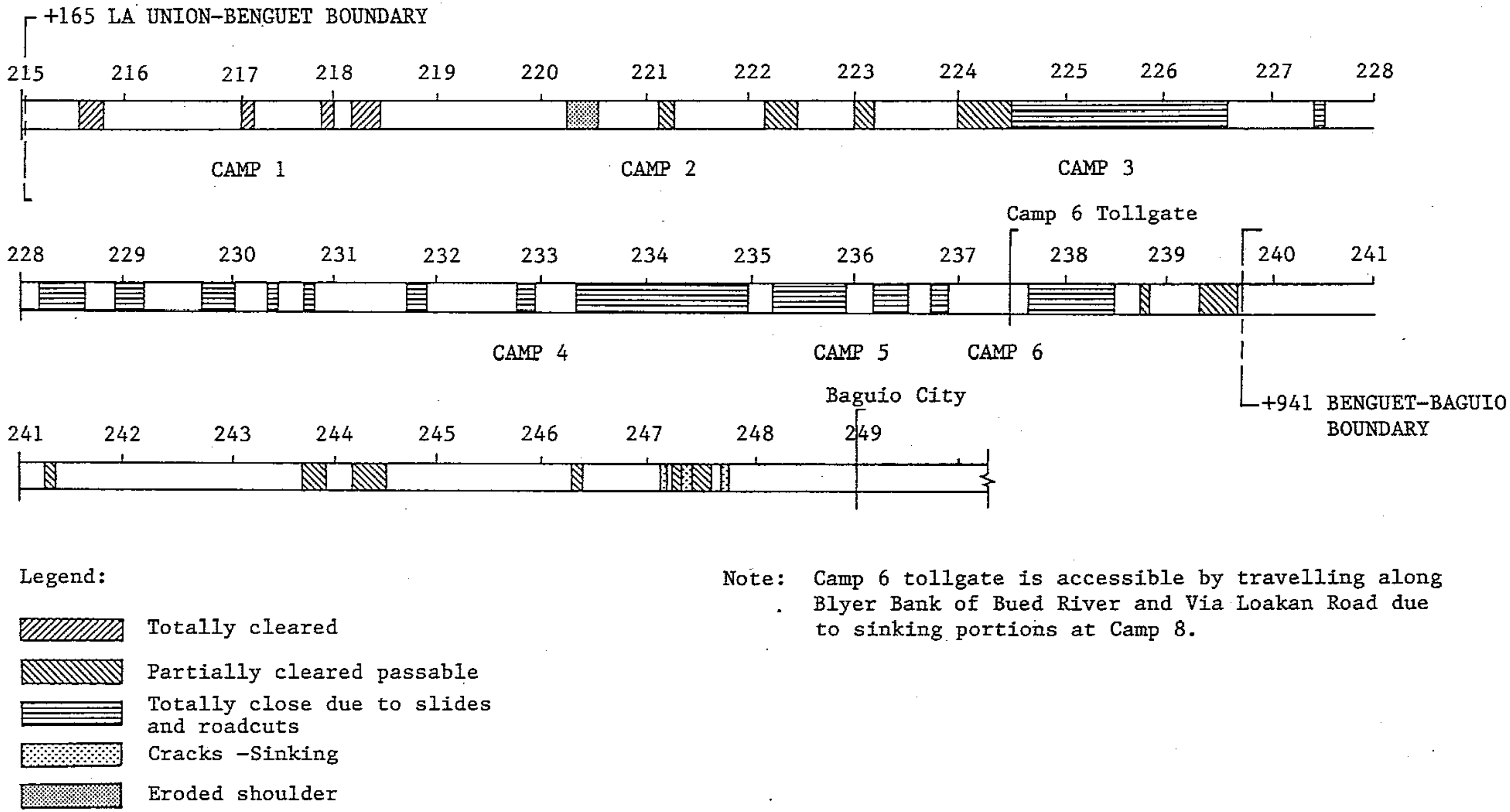


Figure 7.3.7 Boring log in Dagupan

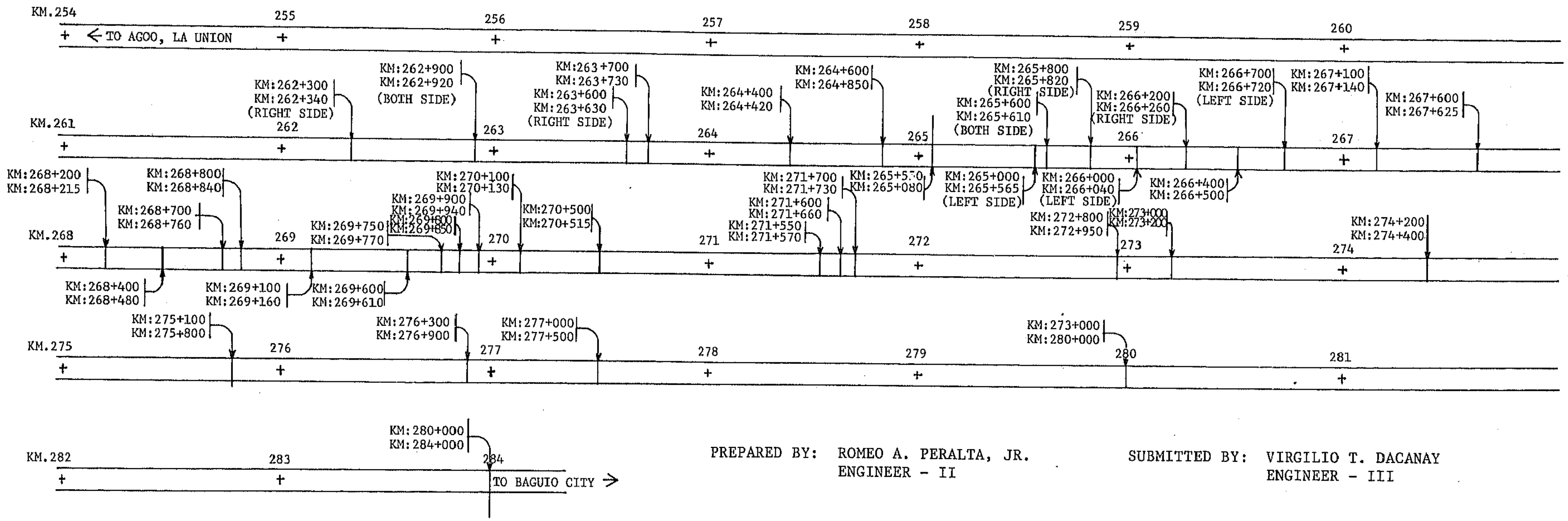
STRAIGHT LINE DIAGRAM ALONG KENNON ROAD
AS OF JULY 31, 1990



Note: Camp 6 tollgate is accessible by travelling along Blyer Bank of Bued River and Via Loakan Road due to sinking portions at Camp 8.

Figure 7.3.8 Damage to the Kennon Road

STRAIGHT LINE DIAGRAM ALONG
AGOO-BAGUIO CITY RD. (MARCOS HIGHWAY)
AFFECTED BY THE EARTHQUAKE



PREPARED BY: ROMEO A. PERALTA, JR.
ENGINEER - II

SUBMITTED BY: VIRGILIO T. DACANAY
ENGINEER - III

Figure 7.3.9 Damage to the Marcos Highway

Table 7.3.4 Agoo-Baguio City Road (Marcos Highway)

LOCATIONS AFFECTED BY EARTHQUAKE

No	STATION	DESCRIPTION ON DAMAGE	VOLUME	REMARKS
1	km. 262+300 – km. 262+340	Road cut @ right side	104= 240cu.m. 201= 56cu.m.	Passable
2	km. 262+900 – km. 262+920	Sinking conc. pavement on both sides	201= 70cu.m. 311= 122sq.m.	-do-
3	km. 263+600 – km. 263+630	Damaged conc. pavement @ right side	311= 105sq.m.	-do-
4	km. 263+700 – km. 263+730	Eroded shoulders right side	104= 450cu.m. 201= 40cu.m.	-do-
5	km. 264+400 – km. 264+420	Boulders to be blasted Loose rick slide	V = 36cu.m. VLR= 900cu.m.	-do-
6	km. 265+000 – km. 265+050	Loose rick slide	VLR= 2,100cu.m.	-do-
7	km. 265+530 – km. 265+565	Sinking conc. pavement @ left side	201= 30cu.m. 311= 55cu.m.	-do-
8	km. 265+600 – km. 263+610	Sinking conc. pavement on both sides	201= 70cu.m. 311= 70cu.m.	-do-
9	km. 265+800 – km. 265+820	Loose rock slide @ right side	VLR= 750cu.m.	-do-
10	km. 266+000 – km. 266+049	Earthslide right side Road cut @ left side	VE = 3,000cu.m. 104= 800cu.m. 505= 1,200cu.m. 201= 50cu.m.	-do-
11	km. 266+200 – km. 266+260	Earthslide	VE = 4,000cu.m.	-do-
12	km. 266+400 – km. 266+500	Road cut conc. pavement damaged	201= 1,050cu.m. 311= 670sq.m. 505= 1,500cu.m. 104= 1,200cu.m.	-do-
13	km. 266+700 – km. 266+720	Sinking pavement @ left side	201= 140cu.m. 311= 150sq.m.	-do-
14	km. 267+100 – km. 267+140	Road cut	311= 270sq.m. 104= 800cu.m. 201= 70cu.m. 504= 600cu.m.	-do-
15	km. 267+600 – km. 267+625	Damaged riprap	504= 150cu.m.	-do-
16	km. 268+200 – km. 268+215	Loose rock slide	VLR= 360cu.m.	-do-
17	km. 268+400 – km. 268+480	Solid rock with loose rock slide @ left side	VLR= 100cu.m. VLR= 2,000cu.m.	Unpassable
18	km. 268+700 – km. 268+760	Loose rock slide	VLR= 650cu.m.	Passable

19	km. 268+800 – km. 268+840	Sinking conc. pavement Loose rock slide	VLR= 670cu.m. 201= 380cu.m. 311= 268sq.m.	-do-
20	km. 268+900 – km. 268+960	Loose rock slide	VLR= 1,200cu.m.	Unpassable
21	km. 269+100 – km. 269+160	Loose rock slide	VLR= 2,700cu.m.	-do-
22	km. 269+800 – km. 269+610	Loose rock slide	VLR= 188cu.m.	Passable
23	km. 269+950 – km. 269+770	Sinking conc. pavement	201= 35cu.m. 301= 134sq.m.	-do-
24	km. 269+800 – km. 269+850	Sinking conc. pavement	201= 525cu.m. 311= 335sq.m.	-do-
25	km. 269+900 – km. 269+940	Sinking shoulder @ right side	104= 240cu.m.	-do-
26	km. 270+100 – km. 270+130	Sinking pavement	201= 170cu.m. 311= 201sq.m.	-do-
27	km. 270+500 – km. 270+515	Loose rock slide	VLR= 180cu.m.	-do-
28	km. 271+400 – km. 271+430	Sinking pavement w/earthslide	201= 105cu.m. 311= 201sq.m. VE = 360cu.m.	-do-
29	km. 271+550 – km. 271+570	Earthslide	VE = 90cu.m.	-do-
30	km. 271+600 – km. 271+660	Sinking pavement	201= 201cu.m. 311= 402cu.m.	-do-
31	km. 271+700 – km. 271+730	Sinking pavement	201= 100cu.m. 311= 201sq.m.	-do-
32	km. 272+000 – km. 272+950	Loose rock & Solid rock	VLR= 9,600cu.m. VSR= 806cu.m.	Unpassable
33	km. 273+000 – km. 273+200	Loose rock & Solid rock	VLR= 3,500cu.m. VSR= 2,500cu.m.	-do-
34	km. 274+200 – km. 274+400	Series of slides	VSR= 3,000cu.m. VLR= 7,000cu.m.	-do-
35	km. 275+100 – km. 275+600	Boulders	VLR=22,960cu.m. VSR= 9,840cu.m.	-do-
36	km. 276+300 – km. 276+900	-do-	VLR=21,000cu.m. VSR= 9,000cu.m.	-do-
37	km. 277+000 – km. 277+500	-do-	VLR=52,500cu.m. VSR=22,500cu.m.	-do-
38	km. 278+000 – km. 280+000	-do-	VLR= 3,500cu.m. VSR= 1,500cu.m.	Cleard by private equipment July 23-25
39	km. 280+000 – km. 284+000	Pavement failure, no slides		Passable, one lane

LEGEND ; VE : Volume of Earth
VCR : Volume of Solid Rock
VLR : Volume of Loose Rock

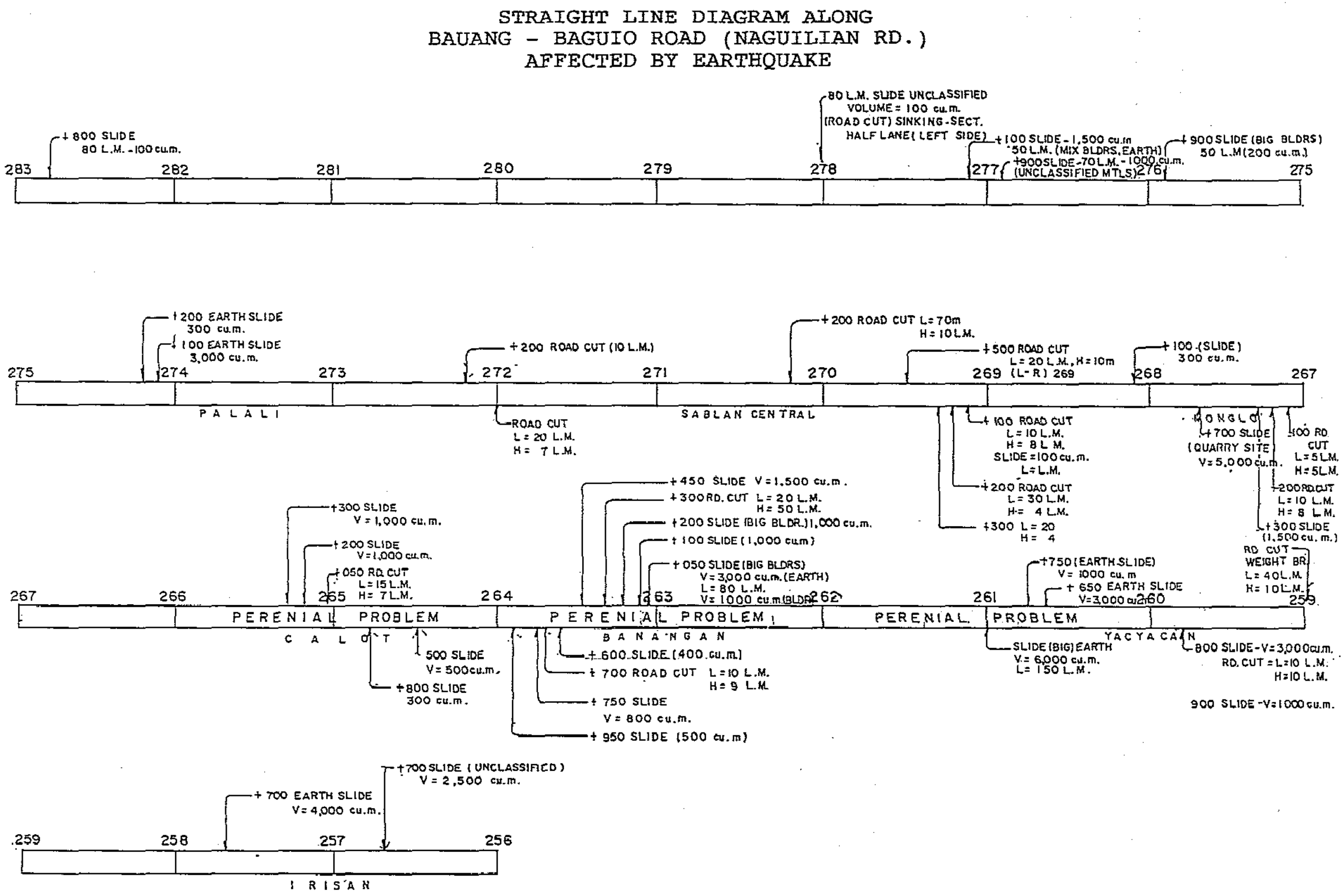


Figure 7.3.10 Damage to the Naguilian Road

Table 7.3.5 Bauang - Baguio Road (Naguilian Rd.)

SUMMARY OF QUANTITIES (VOLUME)

STATION	EARTHSLIDE	LOOSE ROCK	SOLID (BIG) ROCK	REMARKS
KM.282+800	100 cu.m.			
KM.278+000	50 cu.m.	50 cu.m.		
KM.277+100	900 cu.m.	100 cu.m.	500 cu.m.	
KM.276+900	600 cu.m.	300 cu.m.	100 cu.m.	
+600	2,500 cu.m.			
KM.275+900			200 cu.m.	
KM.274+200	300 cu.m.			
+100	3,000 cu.m.			
KM.269+100	100 cu.m.			
KM.268+100	300 cu.m.			
KM.267+900	2,000 cu.m.			
+700	5,000 cu.m.			
+300	1,500 cu.m.			
KM.265+300	1,000 cu.m.			
+200	1,500 cu.m.			
KM.264+800	300 cu.m.			
+500	500 cu.m.			
KM.263+950	500 cu.m.			
+750	800 cu.m.			
+600	400 cu.m.			
+450	1,500 cu.m.			
+200			100 cu.m.	
+100	1,000 cu.m.			
+050	3,000 cu.m.		1,000 cu.m.	

STATION	EARTHSLIDE	LOOSE ROCK	SOLID (BIG) ROCK	REMARKS
KM.261+500			2,000 cu.m.	
+000	5,000 cu.m.	1,000 cu.m.		
KM.259+900	1,000 cu.m.			
+800	3,000 cu.m.			
+750	1,000 cu.m.			
+650	3,000 cu.m.			
KM.257+700	4,000 cu.m.			
KM.256+700	1,500 cu.m.	500 cu.m.	500 cu.m.	
Total	45,350 cu.m.	1,950 cu.m.	4,400 cu.m.	

Table 7.3.6 List of Investigated Damage

Classification of Structures	Location	Distance Mark	Details of Damage
Panpanga river viaduct Manila North Super Highway			Slide of girdirs.
Vilmar Hotel	Tarlac city		Cracks in the walls on the second floor and breaking of window glass.
Road	10 to 15km north of Tarlac city		Open cracks of about 10cm at the center line of the road, shoulder cracks (0.5 - 1km).
The San Isidro Bridge (7-span continuous PC single girder bridge)	The northern extremity of Tarlac city.	KM149+511	Cracks and spouting-out sand at the ground around the abutments. The left bank access bank subsided 1.5 to 2m, also, the right bank access parts subsided considerably.
Bridges	Near Lingayen	KM200	Weight limit: 10t, subsidence of the road surface at the low bank section (slight).
Banks	Near Dagupan		Shoulder subsidence at part of a 2 to 3m banked section.
Fernandez Blvd.	Dagupan city		1.5 - 2m subsidences, flooding of the road surfaces (temporarily rehabilitated with filled in earth mixed with round cobbles).
Magsaysay Bridge	In Dagupan city, the Pental river		Collapsed bridge.

Classification of Structures	Location	Distance Mark	Details of Damage
Buildings	In Dagupan city		Turning over, subsidence, breakdowns, flooding above the floor.
Liquefaction damage	In Dagupan city, along the Pantal river		Serious damages on the left bank, slight damages on the right bank.
Other damages	Southern part of Dagupan city		Gasoline tanks rising to the surface, spouted-out sand at shoulders, inclination of houses.
Roads	Between Calasiao and S. Barbara		Cross-wise cracks and differences in level on concrete pavements, subsidences on shoulders.
The Carmen Bridge	Rosales	KM172+500	Collapsed bridge.
Roads	Beside the Lingayen golf course	KM217+500	Cracks at the shoulders and beside the roads.
Mangneragday Bridge (2 span through truss bridge)			Subsidence of the access banks, moving of the abutments, horizontal cracks at the pile heads of the steel pipe piles of the abutment foundations, crashing of girders and abutments at the abutments.
Longas Bridge (25m long 1 span PC single girder bridge)		KM222+866	Subsidence of access banks, cracks at the end of the girders.

Classification of Structures	Location	Distance Mark	Details of Damage
Road	Between Dagupan city and Cayanga Bridge		Cracks in the shoulders, differences in level and breakdown of the pavements at a 1 - 2m high banked section (1 - 2km).
Cayanga Bridge (9 span continuous, concrete girder bridge with 11 total spans)			Moving of girders, horizontal cracks at the pile heads of concrete piles, moving of the abutments.
Bridge (length: about 25m)		KM228 neighborhood	Subsidence of right bank access part, cracks in the road surface.
Bridge	Rabon	KM236 neighborhood	Subsidence of abutment access parts.
Bridge (length: about 25m)		KM239	
Cupang Bridge			Breakdown of foundation piles of the right bank abutment.
Building	In Agoo city		Complete collapse of the city hall (made of concrete), breakdown of a concrete building and two-story wooden house.
Other damages	In Agoo city		Gasoline tanks rising to the surface, spouted-out sand on the shoulders, breakdown of a two-story private house.

Classification of Structures	Location	Distance Mark	Details of Damage
RC bus stop	Urban area in Agoo city and along route No.3.		Collapse.
Rice mill		KM241 neighborhood	Complete collapse.
St. Rita Bridge		KM243 neighborhood	Moving of the left bank abutment, breakdown of the bearing supports of the end of the girders, differences in level on the bridge surface.
Other damage	Caba town	KM248	Peeling of the walls of the church, subsidence of the shoulders of the road, subsidence of the access parts of a small bridge.
Block silo		KM249 neighborhood	Collapse.
Masonry retaining wall (height: 2 to 3m)		KM253 neighborhood	Collapse.
Road	Near the fork of the Naguilian road	KM259	Differences in pavement level.
Road	Between Banang and S. Fernando	KM264 neighborhood	Differences in level near the center line of the road surface.

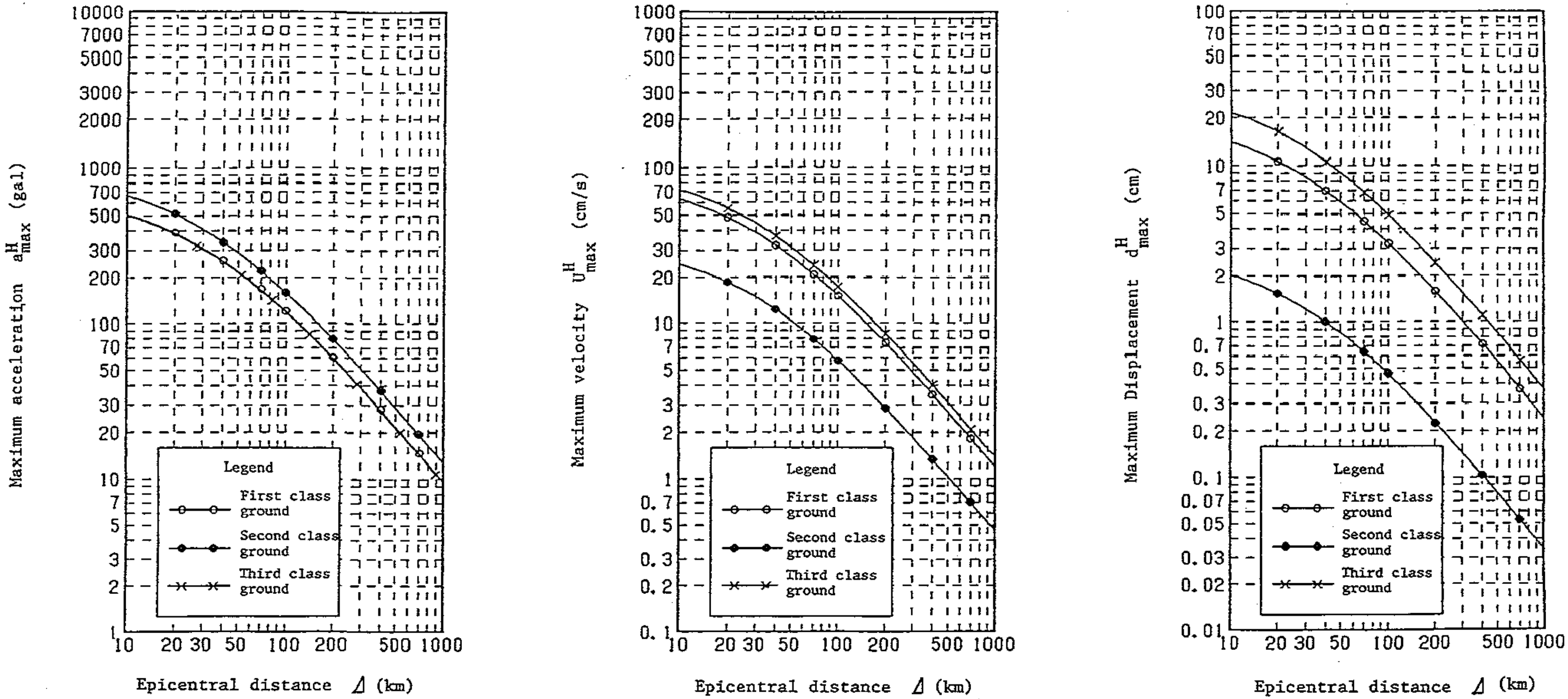


Figure 7.3.11 Maximum Earthquake Motion in the Case of M=7.7, by the Empirical Formula of the Specification of Highway Bridges