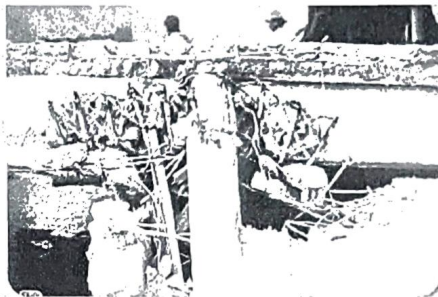
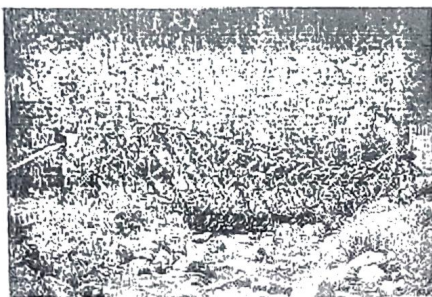


A BRIEF REPORT ON RELIEF WORKS UNDERTAKEN
IN
EARTHQUAKE-1991 AFFECTED AREAS OF
DISTRICT- UTTARKASHI



Source- District Collectorate, Uttarkashi
Compiled by- DDMA)
2013

- **Villages where TATA Relief Society has constructed the Earthquake Resistant Houses during Utarkashi Earthquake 1991**

Sn	Name of Village
1	Ginda
2	Kishanpur
3	Maneri
4	Bhela Tipri
5	Dikhtol
6	Heena
7	Aungi
8	Netala

Note: These are the houses made by using Tin & woods. The traces of these houses are still there in the mentioned villages.

- **Villages who are badly affected by the 1991 Earthquake and whose Village Disaster Management Action Plan was also prepared under DRM program**

Sn	Village	Near by Villages	Distance from District Headquarter
1	Agora	Naugaon, Bhankholi, Sikku, Dharda	22 kms
2	Baunga	Mateura, Thalan, Mustiksaud, Kankradi, Kuroli, Mastari	4 kms
3	Ganeshpur	Netala, Nald, Gangori	5 kms
4	Raithal	Bandhrani, Kyark, Barsu, Nateen	38 kms
5	Jamak	Kamar, Maneri	16 kms
6	Malla	Latta, Pahi, Bhela Tipri	27 kms
7	Mastari	Bagori, Sherpur, Kamradi	12 kms
8	Kishanpur	Ginda, Manpur	18 kms
9	Dhidsari	Aungi	18 kms
10	Sangrali	Tihar, Salang	12 kms
11	Bhukki	Churi, Sarang	47 kms

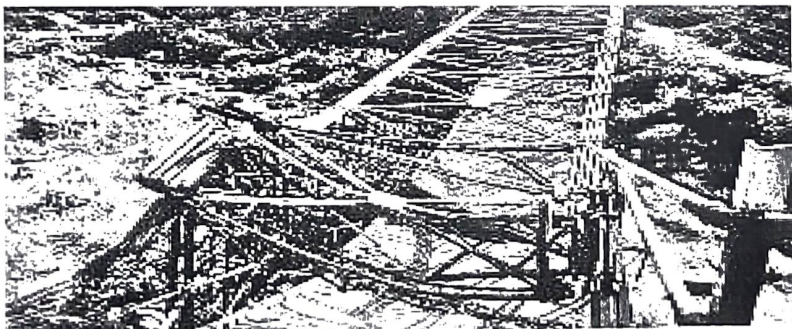
Note: These are badly affected villages and sensitive as well from the Disaster point of view

THE REPORT

Uttarkashi district has a total population of 2,37,000 as per 1991 census. It has 4 tehsils and 6 blocks at the time of Earthquake 1991. A severe earthquake which has been measured as 6.6 on Richter scale was experienced in the district in the early hours of 20-10-1991. Epicentre of the earthquake was located near Pilang gad in Bhatwari block and consequently Bhatwari and Dunda Block suffered heavy losses. Remaining blocks also suffered losses to life and property but intensity was less as compared to Bhatwari and Dunda.

A brief outline of Rescue/relief and rehabilitation works undertaken in the wake of Earthquake is given below-

1-RESCUE OPERATION:- Earthquake claimed 653 lives in the district and approx 6000 people were injured. Various medical teams were mobilized immediately to provide first aid to the injured and to retrieve the dead bodies. As the bridge near Gavana had collapsed, rescue parties had to move on foot to the affected villages and helicopters were used to evacuate the injured to various hospitals. Local army units, ITBP and SSB played a crucial role in this task. Considering the emergency, first priority was given to provide tarpaulins, tents and blankets to the families whose houses had collapsed. In addition 20 kg of free ration was distributed per affected family. Government enhanced the standards of relief considering the gravity of damage. Government norms for distributing relief have been given in **Annexure 1**



(Bridge near Gavana)

2-RESCUE MEASURES:- As per government directions, survey of affected areas was conducted on priority. There are 673 revenue villages in the district, of which damage has been recorded in 601 villages. There are approx 65 villages where almost the

entire village has been devastated and will have to be fully reconstructed. As per survey reports, houses belonging to 14,544 families have been fully damaged while houses belonging to 21,221 families have been partially damaged in 601 villages. Almost 1300 cattles lost their lives. Almost 1300 cattles lost their lives and as mentioned above more than 6000 people were injured due to earthquake. Details of personal losses are presented at **Annexure 2**

A- DISTRIBUTION OF RELIEF SUPPLIES

Relief operations were undertaken on a war footing and relief was distributed to affected families. It may be mentioned here that:-

1. Lists of injured people had to be collected from 70 different medical teams which operated in the district during initial 20 days. These lists have only now been finalized and distribution is being made.
2. As per govt. norms house subsidy has to be paid only for one house even in cases where more than one house of the same family has been damaged. Although 35,000 families have been identified, relief has been given in 32,450 cases.
3. As far as material distribution is concerned tin sheets were provided to all the identified cases by Dec/Jan. Due to inclement weather and as reconstruction work did not begin in winter, distribution of cement and saria has been initiated in the month of Nov and distribution is continuing through depots established at 5 places.
4. As per Govt decision, Free wood rights have been released for two years and so far 5300 cum of wood has been supplied.
5. First instalment of housing loan/Indira Awas grant has been distributed to 10,800 families.
6. It may be reported here that inspite of the fact that almost 32,450 families have been provided house subsidy more people have applied recording their claims. Inquiry is being conducted by SDM's/Tehsildars to verify the claims. It may be added here that in large number of cases, claims have been filed for a house for which one or more of the family members has already obtained house subsidy and such cases have to be scrutinized carefully to ensure that unjustified claimants do not get relief.

B. OTHER RELIEF MEASURES

Apart from providing cash/material relief under different categories, following steps were taken to mitigate the sufferings of the affected families during last three months:-

1. As sowing of Rabi crops was badly affected in Bhatwari & Dunda block it was decided to distribute seeds and fertilizer free of cost to the affected families so as to help them overcome the crisis. Accordingly 436 Qt. seed and 872 Qt fertilizer totaling Rs 6.00 lakhs were distributed in Nov & Dec 1991. Further, Govt have decided to distribute free potato seed worth Rs 7.5 lacs in affected areas and accordingly 1500 Qt of potato seed is being distributed and arrangements are being made for mini-kits of vegetables also so that affected families can undertake the sowing operation.
2. As most of the affected families were living in tents/other temporary structures it was likely that severe cold may cause problems during winter months. 70 worst affected villages were identified and mobile medical teams were constituted to provide regular medical aid for these families. Various voluntary groups working in the district helped the District administration in this regard and sufficient medical cover was provided during winter season. It may not be out of place to mention here that there has been no report of deaths due to exposure in this area during winter.
3. Another problem was related to cattle. Although villagers had made temporary arrangements for cattle also but considering the extent of damage it could not have been adequate. During the months of Jan and Feb govt. posted additional veterinary doctors who were assigned 2 or 3 villages each. These teams regularly visited the allotted villages and provided medical care to cattle. Apart from 78,676 vaccinations which were conducted by these teams, medical and mineral food supplement was also distributed. In a few villages located at high altitudes extra tarpaulins were supplied to help villagers put up temporary sheds for cattle also. **SSB** also detailed 16 teams consisting of Jawans and Veterinary assistants and these teams also provided medical attention in allotted villages.
4. In order to provide extra nutrition to women and children **ICDS** centers were provided with extra food grains by State govt and extra allotment of Soya/Soya oil was also made through **CARE**. In total 2200 Qt. of Dalia and 115 Qt Gur and 119 Qt Soya was allotted for distribution which has been reached to the various centres for distribution.
5. Even though most of the families had constructed shelters for themselves immediately after earthquake it was felt that there may still be families without proper shelters. Accordingly Govt. decided to construct 450

community sheds in various villages so that any family who has not been able to construct a proper shelter may use them. Design prepared by CBRI Roorkee was found suitable from the point of view of ease of construction and also as it was designed to be earthquake resistant.

In spite of the fact that it was a tough task transporting structures to villages, 400 of these shelters have been erected in various villages. This work has been undertaken by **PWD/UPRNN and DGBR**.

It may be mentioned here that the worst sufferers of the earthquake have been school buildings. Almost 50 % of schools/colleges buildings have collapsed beyond repair. This was kept in mind while sitting the community sheds and many of these sheds have been erected near school premises so that educational activities, which were hampered during Nov- Jan could be reactivated. But for these community sheds, it could not have been possible to conduct various board examinations in the district.

6. As a result of earthquake 30 women were widowed and 12 children were orphaned. Of these 20 eligible widows have been sanctioned widow pension. As far as orphans are concerned many individuals have come forward for adopting such children and also many missions /ashrams have shown interest in providing education to these children in their ashrams.

3. REHABILITATION PROGRAMME:

1. In spite of the fact that huge amount has been distributed to the affected families by way of house subsidy, it was felt that unless knowledge about earthquake resistant buildings is disseminated, faulty construction may again lead to damage in future. PWD, in consultation with CBRI Roorkee, has prepared a booklet which has been circulated. In addition training programmes at Nyay panchayat level have been conducted at 15 places in the district in the last week of March, 1992. Public participation in this programme have been very encouraging. It is felt that in severely damaged villages closure supervision and guidance will be required. Accordingly the whole district has been divided into 47 sectors consisting of 2-3 villages each. Junior Engineers have been made in charge of these sectors and have been given responsibility of organizing training programmes at the village level and also providing technical guidance to villagers/Masons during the construction over next 2½ months. 14 Assistant Engineers have been assigned the responsibility of supervising works of sectoral teams.

Many voluntary groups have also undertaken this work and publicity material prepared by these groups is also being made available to the villagers.

2. Extra allotment of Rs 3.7 crores has been made under JRY. It has now been clarified that this allotment is not covered by existing set of guidelines and it may be used as per local requirement to undertaken earthquake relief work. Schemes have been prepared an work is being initiated. It may however, be mentioned that local wage rates are far in excess of stipulated Rs 18/- per man day and would hamper the progress under this scheme.

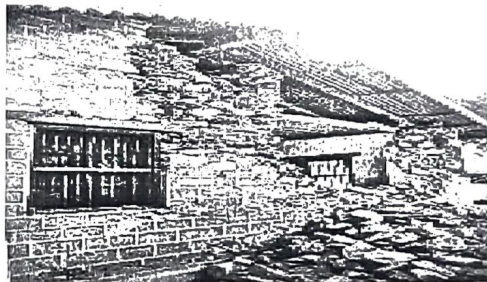
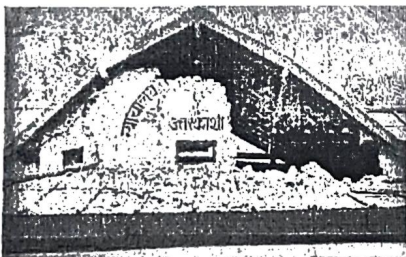
3. Affected families who can be benefited under **IRDP** have been identified and in villages where cattle losses have been significant, additional loaning has been made to replace cattle. **CAPART** has also decided to benefit eligible families through voluntary groups working in this district.

4. Non availability of skilled masons was anticipated as early as Dec and accordingly **HUDCO** has sanctioned 4 building centres which were expected to undertake mason's training and also propagate better use of local materials. However, these centres have yet to be operationalised. In the absence of these centres it is proposed to organize mason's training programme under **TRYSEM** with the help of voluntary agencies in the third week of April.

4. LOSSES TO INFRASTRUCTURE AND GOVT.PROPERTY

Govt buildings have suffered sever damage due to earthquake with losses amounting to almost Rs 63.50 crores. The most crucial sector that has been affected is education where majority of the buildings have suffered heavy damage. Government residences have also been very badly damaged and employees as well as officers residences have been badly affected.

As far as infrastructure is concerned losses has been approx Rs 30 cr. Funds have been allotted to PWD and Jal Sansthan for repair works.



(Building of District Court)

5. ROLE OF VOLUNTARY GROUPS:

Relief works of Govt work were supplemented by individuals/organizations that came in large numbers and distributed blankets/tarpaulins/tents/CGI

sheets/medicines/foodgrains etc. in affected areas. Most of these supplies were distributed directly by them. In few cases supplies were received and distributed through administrative machinery. Efforts were made to direct these voluntary groups in most affected areas by giving them guidance at Central Control Room. However, distribution of relief by voluntary groups has been uneven due to the difficult geography of the district.

Apart from distributing immediate relief, many NGOs have decided to contribute in long term rehabilitation. Some groups have undertaken to construct houses in adopted villages viz:-

Sn	Name of the organization	Houses
1	<i>Uttaranchal Bhukamp Rahat Samiti</i>	360 houses in 6 villages
2	<i>Tata Relief Society</i>	206 houses in 1 village
3	<i>Himalayan Trust</i>	40 houses in 1 village
4	<i>ADRA</i>	70 houses in 1 village
5	<i>CASA</i>	70 houses in 1 village

In addition six NGOs viz: **VIKALPA, RUCHI, SAMTA, DISHA, SUTRA & SBMA** have adopted approx 35 villages. With a view to help in long term rehabilitation and development. They plan to initiate income generating activities in the affected villages and are also engaged in imparting technical training to villagers in Earthquake Resistant House building technology. The groups are funded by **CAPART**. A district level committee has been constituted to co-ordinate effort of all voluntary groups engaged in rehabilitation work in the district.

Annexure 1**A. EX- GRATIA PAYMENT**

Sn	Details	Amount
1	For every death	Rs 30,000 subject to maximum Rs 90,000 per family
2	Injuries - Grievous	Rs 5,000
	Simple	Rs 2,000
3	For Cattle death- Big	Rs 1,250 (Subject to Maximum 2 animals)
	- Small	Rs 300 (Subject to Maximum 2 animals)

B. GRATUITOUS RELIEF

Rs 3,000/- per affected family.

- It includes supply of blankets, tarpaulins & tents etc,
- It includes supply of free food grains.
- Ration money @ Rs 300/- per unit for 3 months (Nov to Jan) for affected families.

C. HOUSE SUBSIDY/ASSISTANCE

1	For fully damaged house	Amount(Rs 35,000 consisting of)
A	Grant of	Rs 10,000/-
B	Material worth (CGI Sheets-22 nos; Cement -17 bags Saria - 145 kgs	Rs 10,000/-
C	Housing loan	Rs 15,000/- for non SC/ST family; OR
	IAY Grant	Rs 15,000/- for SC/ST family
2	For partially damaged house	Rs 5,000/-
3	For nominal damage	Rs 500/-
4	Considering the requirement of wood for reconstruction, Govt. have decided to release 'free rights' for two years. In addition, wood is being supplied under petty demand (PD) at concessional rates.	

Annexure 2

**STATEMENT OF PERSONAL DAMAGES SUFFERED BY THE PEOPLE OF
UTTARKASHI DURING EARTHQUAKE**

Sn	Name of Tehsil	Affected Population	No of Human casualties	Completely Destroyed Houses	Partially Destroyed Houses	No of Cattle Died	No of Injured Persons
1	Bhatwari	47,000	562	8496	2051	1152	4065
2	Dunda	83,000	90	4843	9628	234	1520
3	Barkot	40,000	1	1007	7251	00	38
4	Purola	15,000	00	198	2291	00	40
	TOTAL	1,85,000	653	14,544	21,221	1386	5663

RELIEF DISTRIBUTED UPTO 31-03-1992**A. EX-GRATIA PAYMENT-**

Sn	Detail	No	Amount(in Crores)
1	For Deaths	613	1.84
2	For Injured	1369	0.31
3	For Cattle	432	0.04
	TOTAL		2.19

B. GRATUITOUS RELIEF-

Sn	Detail	No	Amount(in Cr)
1	Relief given as cash	1,69,608	5.09
2	Rupee value of material distributed		6.76
	Material-Blankets 1,02,277		
	Tarpaulins 31,621		
	Tents 1,483		
	Foodgrains 703 MT		
	TOTAL		11.85

C. HOUSE SUBSIDY-

Sn	Detail	No	Amount(in Cr)
1	FOR FULLY DAMAGED HOUSES		
A	Cash Subsidy	14,042	14.04
B	Hosing Loan/IAY Grant	10,835	8.13
C	Value of Material Supplied		
a	CGI Sheets	2,88,000	7.92
b	Cement Bags	23,000	0.29
c	Saria	109(MT)	0.11
	TOTAL		30.49
2	FOR PARTIALLY DAMAGED HOUSES	18,411	9.20
	TOTAL HOUSE SUBSIDY/ASSISTANCE		39.69

GRAND TOTAL OF RELIEF DISTRIBUTED	Rs 53.73 Crores
GRAND TOTAL of RELIEF DISTRIBUTED (excluding Housing Loan/IAY)	Rs 45.60 Crores

Q- Are the masses (in general) sensitive to earthquake issue?

A- Yes, the masses are sensitive to earthquake issue. But they consider it as a Devi Apda. With the ongoing program what we have told them with the slides they are now understanding it as a geological conditions. The attitude if it comes we will see is also there earlier now they want to learn how to save themselves. They wish know about the Earthquake safe design houses as well.

Q- Are the memories of 1991 Earthquake fresh or have faded away?

A- When we discuss this issue with the masses in workshops, trainings, etc they recollect all the faded memories. The irony here is that in their daily chorus or in habit this seems to be that all the things of past has been faded away. The reason being is the pace of construction in the district shows the roadway.

Q- Are the masses receptive to modern precepts of building technology?

A- They are receptive but confused or they were misguided by the non professionals about the technology to be used. They feel that their budget will go up if they adapt this. Therefore there is a need of effective awareness drive in this regard.

Q- Are the new construction complying with earthquake safe construction practices?

A- Up to some extent, yes. Because the authority has made compulsory to have the designs earthquake safe. But practically people do whatever they desired to do. This is happening due to the toothless law and the monitoring part is very poor, even there is no compliance of any penalty as well. Otherwise in a place like Uttarkashi we are not able to see the three floor houses.

Q- Level of receptivity amongst rural and urban population groups?

A- Rural groups are more receptive than the urban groups. But now some very solid work has to be done so that they feel aligned with the program. Practical trainings are the need of time.

Q- What are the shortcomings of the ongoing awareness/sensitization programs?

A- Programs conceived and designed were very good in ideal situation. Main problems with these program is that is is were running ideal as some another government program. The biggest hurdle is the understanding of the common masses regarding Devi Apda is the CRF fund. They feel that by this program they will also be getting some sort of fund

The main shortcoming is lack of orientation of the Govt officials as well because they are the main person who have to take the baton forward to move this program especially the Officer Incharge. As in many aspects they consider it as a routine work instead that it is time bound activity and needs immediate attention. also the .

Q- What can bring forth change in attitude?

A- Orientation about the subject and their involvement in the program can go a long way. In the village level especially if the village level committees do have a legal status as there are already few committees formed under Panchayat Raj, if these committees do have the same status they will feel that they are the part of solution not the problem and they have to cope with the situation not to sit idle. This can be done by GO from the govt as well. Than these committees will be encouraged to have their own fund as well.

Garhwal Earthquake of Oct. 20, 1991

EERI Special Earthquake Report, EERI Newsletter, Vol.26, No.2, February 1992

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Introduction

On October 20, 1991, at 2.53 a.m. local time, an earthquake occurred in the Garhwal Himalayas in northern India. The earthquake caused strong ground shaking in the district of Uttarkashi, Tehri, and Chamoli in the state of Uttar Pradesh (*Figure 1*). Official information indicates that population of about 307,000 in 1,294 villages were effected; 768 persons died while 5,066 were injured. In addition the earthquake claimed 3,096 head of livestock. As many as 42,400 houses were damaged. The roads between Uttarkashi and Gangotri were disrupted. A four-member team from Civil Engineering Department of the Indian Institute of Technology, Kanpur conducted a survey of the significantly affected areas during October 27 to November 4. The team members were Dr. Sudhir. K. Jain, Dr. R. P. Singh, Dr. V. K. Gupta, and Mr. Amit Nagar.

Seismological Data

The magnitude of the earthquake was assigned as 6.1 by the Indian Meteorological Department (IMD) based on body wave data. The USGS assigned a surface wave magnitude of 7.1. There was confusion about epicenter of the earthquake, with preliminary estimates by IMD indicating its location close to Almora, about 170 km from Uttarkashi.

However, no damage occurred in and around Almora. Based on the damage pattern, the epicenter is believed to be located somewhere in the Uttarkashi and Bhatwari region. Calculations on magnitude and epicenter by IMD are under revision.

Uttarkashi lies in the main Alpine Himalayan belt, one of the most earthquake prone regions of the world. Crustal instability in this belt is ascribed to the movement of the Indian plate towards the Eurasian plate at the rate of about 50mm per year. Besides several local faults, two prominent thrusts tending northwest to southeast, from the conspicuous tectonic features.

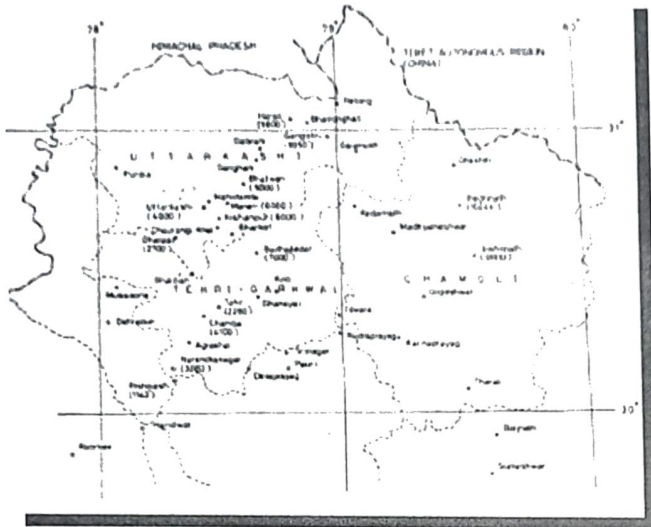


Figure 1: Map of the affected area

This earthquake has provided excellent strong motion records. The area is instrumented with a number of SMA's (photographic film type, supplied by kinematics) and structural response recorders (SRR) operated by the University of Roorkee. Maximum horizontal acceleration of 0.03 g and maximum vertical acceleration of 0.04 g were recorded.

Intensity of Shaking

The intensity of shaking was moderate. The maximum intensity was VIII on the Modified Mercalli (MM) scale at Budhakedar, Krishanpur, Maneri, Uttarkashi, Mahinanda, and Bhatwari. Tehri, Ghansyali, and Gongotri had a shaking of MMI VII. Information from other sources indicate that Pauri, Karnaprayag and Gopeshwar also experienced shaking of MMI VII.

The seismic code in India divides the country into five seismic zones (I to V). Tehri and Chamoli are in zone V and Uttarkashi is in zone IV. The preamble of the code suggests that the expected MMI broadly associated with zones I to V is: V (or less), VI, VII, VIII, and IX (above), respectively. Thus the Uttarkashi and its neighborhood experienced a design level earthquake.

Buildings

Damage to rural dwellings (random rubble stone masonry supporting a heavy roof) was extensive in areas of maximum shaking. Even in developed areas, most

privately owned buildings and older government owned buildings were build without seismic provisions.

Uttarkashi has a number of three and four story reinforced concrete (RC) framed buildings which sustained damage. Shear-cracks developed in the ground floor columns of two story Post Office Building in Uttarkashi built in 1985-86 by engineers of the Department of Post and Telegraphs. The strong floor beams in the frame forced the yielding into ground-story columns. The weaker roof beams sustain flexural hairline cracks while the supporting second story columns were damaged.

Figure 2 shows the State Bank building in Uttarkashi. During the earthquake, the upper two stories collapsed on the first story. Informations from the local residents revealed that the building was first constructed as one story only; the upper two story was added subsequently. The beams has only two normal rebars on the top face near the column joint and those were incorrectly placed.

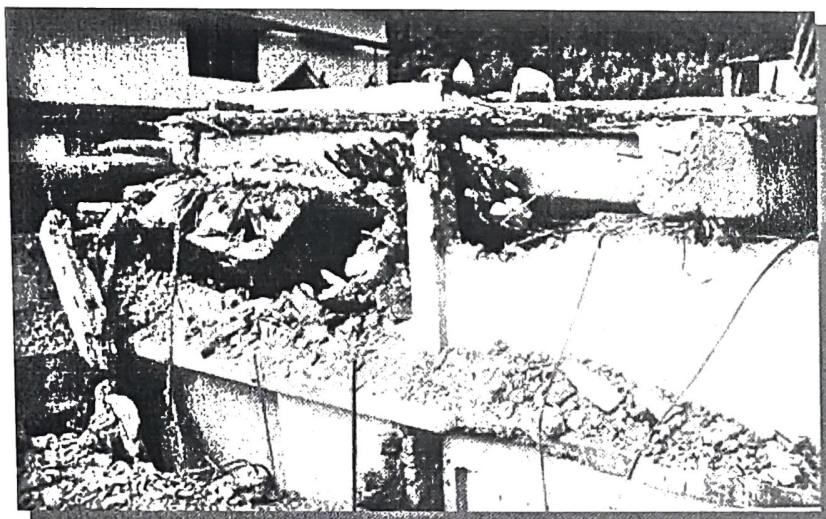


Figure 2: State Bank Building at Uttarkashi

Most government buildings, both offices and residences, are one or two story buildings with load bearing walls and sloping roofs. Older construction is of Unreinforced random rubble stone masonry which performed very poorly. The newer construction is of Unreinforced concrete block masonry and usually include a RC band at lintel level.

The ITBP Paramilitary Campus at Mahidanda consists a large number of two story residential buildings with load bearing walls of concrete masonry. All have

RC lintel bands, but no roof bands or gable bands. The construction is about 10 years old. The damage to buildings consisted of (i) diagonal cracks below window sills, (ii) damage at the connection between masonry walls and RC roof slabs, (iii) in buildings with corrugated iron sheet roofs, damage at seat of purlins on the gable end walls, and (iv) damage to walls supporting roofs at different heights at either end (*Figure 3*). Roof and gable bands would have prevented damage of types (ii), (iii), and (iv) above.

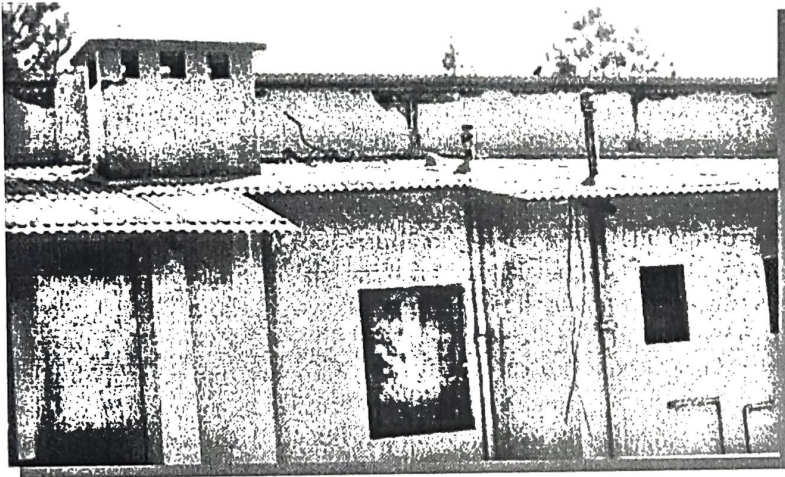


Figure 3: Damage to wall supporting Split Level roof - ITBP campus, Mahidanda.

The Maneri Hydel power project colony campus has two-storey buildings with concrete block masonry bearing walls, of poorer quality construction than that seen on the ITBP campus. Many buildings were damaged beyond repair. Damage consisted of (i) severe damage to gable walls (*Figure 4*), and (ii) diagonal cracks in ground story walls.

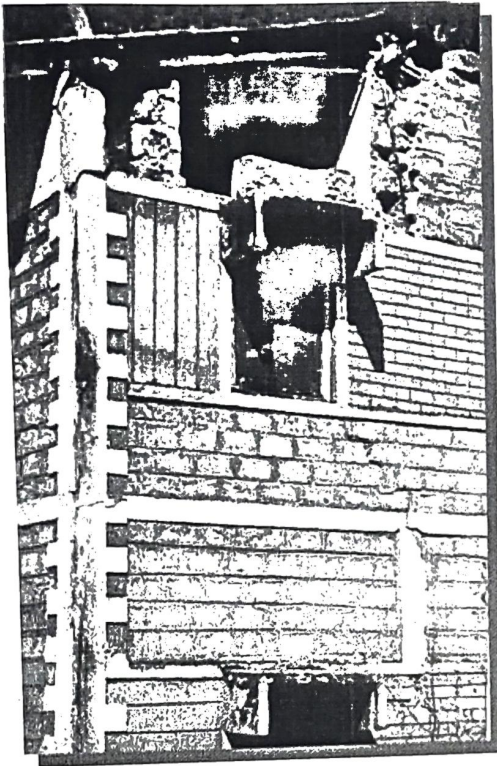


Figure 4: Damage to Gable Wall -Maneri Hydel Project Colony

Roads

Roads in the area were extensively damaged due to failure of slopes, retaining walls, and bridges. The Uttarkashi-Harsil-Nelong road link was completely disrupted for several days due to large number of landslides and the collapse of a major bridge. The Uttarkashi-Lumgaon road link was lost due to collapse of embankment on the approach road to the bridge at Kishanpur.

Numerous massive landslides took place on the Uttarkashi-Harsil road, particularly on a 42 km stretch between Uttarkashi and Bhatwari. The stretch is believed to be the area of most intense shaking. While landslides on this route are common in rainy seasons, many of the landslides caused by the earthquake were totally new. Deep fissures on the road caused by the earthquake pose a potential threat of slope failure in the near future. Fissures were most prominent on the Maneri to Bhatwari stretch. A few landslides also took place on the Uttarkashi-Lumgaon route and on Ghansyali-Koti road.

Retaining walls in the area consist of random rubble stone masonry. These are either "dry" with no mortar, or "banded" with horizontal and vertical bands of masonry in cement mortar at regular intervals in the otherwise dry wall. Many of

these walls collapsed on Uttarkashi-Harsil road. The number of such collapses was higher in the Maneri-Bhatwari segment.

On the Uttarkashi-Lumgaon route, the approach road to a bridge near the village of Kishanpur is on an embankment about 8.0m high with retaining walls in "banded" stone masonry. The walls on both sides of the approach road collapsed leading to failure of the embankment. The reduced road width was adequate only pedestrians. Vehicular traffic was disrupted for more than 10 days. The RC T-beam bridge at this location, spanning 18m, suffered shear cracks in the main girders near the support, the flexural cracks near the quarter span.

The Gawana Bridge is a 56.0 m span steel truss bridge build in 1974. It is located at 6km from Uttarkashi towards Maneri. The entire bridge came off the abutments and fell into the river (*Figure 5*) causing the entire area beyond Uttarkashi to be cut off from the rest of the country. Inadequate design of the bearings and anchor bolts as well as absence of any suitable means of preventing the span from falling off the supports were responsible for the damage.

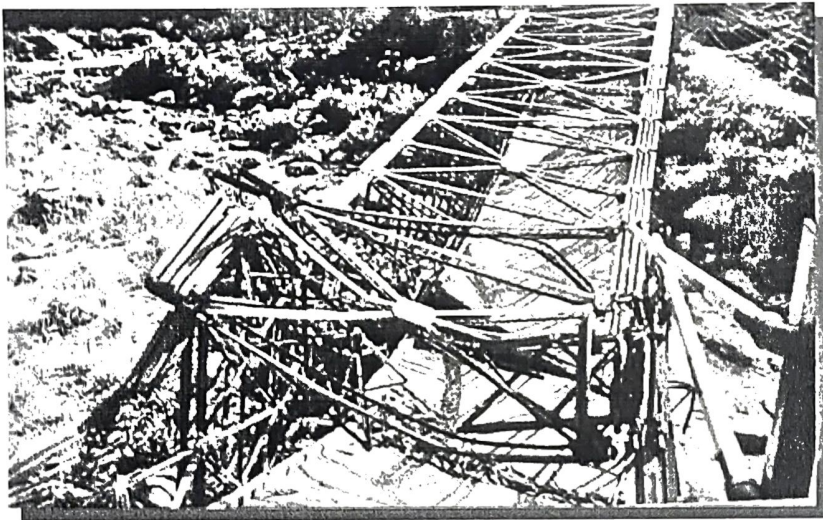


Figure 5: Collapsed Gwana bridge

The area has a number of pedestrian suspension bridges that cross the River Bhagirathi. The main tower and the anchors blocks are of Unreinforced stone masonry. Five of these bridges were damaged, four of them in the Maneri-Bhatwari region. Cracks in the tower and anchor blocks were typical of damage sustained.

The peak horizontal ground acceleration in the region was about 0.30 g. The Indian codes specifies the design seismic force for bridges in the range of 0.05 to 0.075 g for zone IV. This is obviously inadequate. It is hoped that the bridge failures caused by this earthquake will provide the necessary impetus to revise the code.

Other Lifelines

Landslides damaged numerous electric and telephone poles. The area beyond Bhatwari was still without power and without telephone link 10 days after the earthquake.

The diversion dam at Maneri which feeds water through a tunnel to the Tilot power house at Uttarkashi suffered no damage. However the telephone link between the dam and the power house snapped, and power generation had to be stopped.

Rescue and Relief

With the road network disturbed, rescue and relief became extremely difficult. Immediate rescue was provided by the army and paramilitary forces. The Border Roads Task Force did a very commendable job by clearing the Uttarkashi-Harsil road quickly. However the restoration of the Uttarkashi-Lumgaon road by the state Public Works Department was rather slow, and the work on restoration of approach road to the bridge at Kishanpur was still in progress on November 1.

During the initial response stage some relief material was air dropped to the villages. Once the road network was restored, the area was flooded by relief material. However, there are numerous villages accessible only on foot; the relief materials could not reach such villages and ended up being distributed amongst the villages on the roadside. There appeared to be a lack of appropriate leadership at the village level. While many administrators and politicians are experienced in the handling of flood relief work, it appears that earthquake relief poses a rather difficult task for which they have no prior experience or training.

Conclusions

The earthquake caused strong ground shaking over a large area with worst effects suffered in Uttarkashi-Bhatwari region. Damage was observed in Unreinforced masonry buildings as well as RC frame structures. Good construction performed much better than poor quality construction. The need for RC roof and gable bands in masonry buildings was clearly underlined by the performance of buildings at the ITBP campus at Mahidanda. The damaged Post Office building, which was designed and constructed in the formal manner, may

provide some useful insight after detailed analysis. There was enormous loss due to landslides and collapse of retaining walls. The failure of Gowana bridge needs to be studied. This may trigger revision of the Indian code.

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