Repair, Restoration & Retrofitting of
Subhashnagar Govt. Primary School, Gopeshwar, Chomoli Dist., Uttarakhand
Project Completion Report

Background
The Subhashanagar Government Primary School in Gopeshwar town of Chomoli district of Uttarakhand was damaged in the rains of June 16 and 17, 2013. It was damaged earlier in Chomoli Earthquake of March 1999. The earthquake had caused several large cracks in the stone walls of two rooms that were built in 1977. In the months of November and December 2013, and January 2014 the school was repaired, restored and retrofitted to reduce its vulnerability in future disasters and bring additional safety to the children studying in the school. The work was carried out by Ahmedabad based NGO called National Centre for Peoples'-Action in Disaster Preparedness (NCPDP) with local support from Dehradun based NGO called Technology and Research Network (TARN). All the work was carried out with the financial support from BCAS Foundation and Bombay Chartered Accountant Society of Mumbai. The project was conceptualized and executed with the encouragement of the district administration under the guidance of DM Shri Murugesan and the District Education Department under the guidance of CEO Shri Negi, as well as the local office of United Nation Disaster Management Team under the leadership of Ms. Divya Gupta.

Existing Condition
The two storey building has seven rooms with built area of 1,920 square feet in addition to a kitchen and toilets. In 1977 two rooms were built using stone masonry in mud mortar with pitched Corrugated Galvanized Iron (CGI) roof. Later one more room was added adjacent to it having walls made of stone masonry in mud mortar supporting a RC slab roof. Next a covered passage consisting of RC slab supported on columns was added in front of these rooms, followed by a kitchen at one end and a two storey structure at the other end, all made of brick and concrete block masonry in cement mortar. The first two rooms were properly connected to each other. The rest of the additions have no integral connection with the adjoining rooms. The interfaces between the parts done at different times have been very poorly sealed from the outside. As a result major rain water leakages through these interfaces as well as through poorly maintained CGI roof and badly executed RC slabs have been causing much inconvenience to the occupants of the building.

Although, the total student strength is 35 at this school with Grade I to V, the building is being used not only as a school, but also as a polling station for elections and among other things, for polio vaccination. Based on the information from the education department English sections are also planned and there is a possibility that an *anganwadi* also may be started.

Work Carried Out
The school was visited on two occasions by the NCPDP team in September and October to document the existing structural and non-structural aspects of the building. Based on this a design was evolved, and material quantity and cost estimates carried out. Official permission was secured from the District Education Department.

Based on this certain materials including galvanized Weld Wire Mesh bundles, reinforcing steel rods, CGI sheets, GI sheeting, hardware, timber, chemicals for

grouting of cracks and repairs of RC slab etc. were procured in Dehradun. Some equipment including power tools were brought from the Ahmedabad office of NCPDP. All the items were carted from Dehradun to the site situated more than 250 kilometres in the hills by truck. The NCPDP and TARN teams arrived on the site on November 22, 2013, and after carrying out all the final planning on November 23, the work was started on November 24. Local masons and labourers were put to work after some initial orientation and much hand holding during the first several days. It took several days and help from various quarter including a Gujarati speaking local contractor to build up the labour force to attain the speed necessary to complete the work within four weeks as planned. It was easy to get cement but not as easy to get sand and aggregates. Everything had to be hand carried from the road side to the site. Water availability had been a major bottleneck in maintaining the work speed. Much time had to be spent to ensure adequate water supply from the local network on day to day basis. Class rooms were made available to the team as required to take up work in a manner that the school operation does not get interrupted.

Vulnerabilities in Building:

Based on the documentation carried out as well as detailed observations of the building, all the major weaknesses (vulnerabilities) were identified in the **class rooms** in accordance with relevant building codes **IS 13827 and IS-4326**. These could be listed as follows along with the damage that could result in the event of an earthquake.

- Absence or inadequacy of interlocking between wythes (two faces) of stone walls which could result in to delamination of the wythes, or even wall collapse
- Absence of seismic bands at sill, lintle and gable top levels which could result in to vertical, horizontal and diagonal cracks in walls
- Absence of encasement of wall openings for doors and windows which could result in to diagonal cracking from opening corners
- Absence of vertical reinforcement embedded within masonry at wall junctions which could result in to failure of walls at wall junctions
- Absence of anchoring of principal supports of roof to walls which could result in to failure of walls
- Poor wall to wall connections between construction done at different times which could result in to damage to walls
- Major cracks from Chomoli Earthquake of 1999 which could result in to more serious damage to walls

In addition the water leakage problems were also identified based on leakage marks, corrosion related damage in RC elements, and information provided by the school staff. All these weaknesses can result in to major damage in the event of an earthquake.

Measure Carried Out:

The remedial measures were taken up as per IS-13935 for reducing or eliminating these weaknesses. These measures were implemented, as mentioned above, to tackle the **structural weaknesses that were visible or were assumed based on the knowledge of the construction trends as well as the past experience in the region**, and to tackle non-structural problems such as water leakage that could have structural implications in long run.

Structural Vulnerability Reduction Measures:

- **Seismic Belts**: Since in the main three rooms the seismic bands are absent in the walls, in lieu of them the Seismic Belts made of Welded Wire Mesh (WWM)

encased in 1:4 cement mortar are installed at sill and lintle levels. In addition since two of these rooms have pitched two sided Corrugate Galvanized Iron (CGI) sheeting roof seismic belts are also installed just little below the top of the gable walls. All these belts are installed on both faces of the walls. In some rooms where lintle level belt is present, then only the sill level belt is installed. All the belts are securely attached to the walls.

- **Vertical Reinforcement**: Adjacent to the junctions of walls vertical belts similar to the above mentioned belts are installed in the absence of vertical reinforcement embedded within masonry. These belts are integrally connected to the horizontal belts.
- **Opening Encasement**: All openings are encased with belts similar to those mentioned above, in the absence of Reinforced Concrete encasing. This is done only on one of the two faces.
- **Stitching Elements**: In case of the stone masonry (random rubble) walls, the two faces of the walls are stitched using cast in situ RC stitching elements in the absence of regularly placed through stones.
- **Roof Anchor**: The CGI sheet roof, being light should be anchored to the walls. In the absence such anchors, anchors are installed. The major elements in the roof under-structure such as the ridge beam and the roof trusses have been anchored using brackets made of 50x5 MS flats.
- **Crack Repair**: The cracks repair consists of grouting them with non-shrink or expansive grout, plus splicing across with WWM encased in 1:4 cement mortar. In some cases the loose masonry units like stones are removed and re-installed.
- **Strengthening of Room 1 Entrance**: The beam supporting the passage slab next to the front wall of Room 3 at the junction with Room 1 appeared to be resting on the lintel of the door of Room1. The lintel in turn does not appear to have adequate support in the wall of Room 2, is sitting squarely on the steel door frame. In other words the roof slab of the passage and the beam that it is sitting on appears to be resting on the door frame. Hence, a new heavier frame was installed as a supplemental support to the passage beam. The new frame was anchored to the walls with 6" long nails.

Non-structural Measures:

- In the third room with RC slab there was evidence of leakage through the roof slab in the form of spalling of concrete in many locations. All the loose concrete from the underside of the slab was removed and patches were finished by re-plastering with the help of a popular bonding agent. On top of the roof slab the old plaster was removed, surface was thoroughly cleaned, three coats of Pidicrete 301 water proofing were applied, and the water proofing was covered with waterproof cement plaster consisting of Pidiproof LW plus.
- The cracked old concrete placed over the junction of (a) Rooms 5 and the covered front passage, (b) Room 5 and Kitchen, and (c) Kitchen and front passage was removed after extensive breaking, and replaced with Galvanized Iron flashing anchored under a layer of bricks.
- The concrete placed on top of the roof at the junction between the gable wall of Room 3 and the wall of two storey building consisting of Rooms 1,2 and 7 was removed, and replaced with GI flashing anchored in a groove on the face of the wall of the two storey building with an overlap of approximately 8" over the CGI roof.

- Roof gutter was installed at the eave level of the pitched roof over Rooms 3 and 4 along the rear wall to prevent splashing of rainwater falling off the pitched roof. In front, along a part of the eave of Room 3 adjacent to the Room 7 5' long roof gutter was installed to prevent water from the CGI roof over Room 3 to leak down at the junction between the passage roof slab and wall of the two storey building.
- Along the full front eave GI eave board was installed at the front end of the rafters to minimize rainwater splashing in to the joint between the passage roof slab and front walls of Room 3 and 4.
- In the CGI roof of Rooms 3 and 4 all the open holes and nails without tar-felt washers were sealed with a special Areldite sealant, all the J-bolts without washers were removed and replaced with washers, the ridge was resealed with a new layer of adequately wide GI sheeting.

All in all the retrofitting was quite straight forward. The junctions of the portions constructed at different times, however, did require proper understanding of the interface of those portions in order to decide the continuity of the retrofitting elements. Decisions for these had to be taken on the spot after the removal of the plaster for getting good understanding of the situation.

Although, all the structural repairs and most of non-structural repairs, plus retrofitting was finished before the Ahmedabad team left Gopeshwar to return to Ahmedabad on December 20 (4 weeks duration), some minor non-structural work including roof gutter and the paint job was done subsequently.

Side Benefits of Project

There are a number of benefits that this month long project has generated, directly and indirectly.

- First of all, there was a dire need to demonstrate the option of seismic retrofitting of an existing building since just because of ignorance buildings get demolished. Every year in Uttarakhand alone a large number of schools are demolished and rebuilt in the name of safety against earthquake.
- Several local engineers and masons, and a couple of contractors got exposed and trained at the site while the work was going on.
- Several local residents including leaders visited the site.
- The DM (Collector) visited the site several times generating much interest in the people.
- Along with the DM many media people also came. Some of them gave excellent coverage. A major TV channel also gave excellent coverage.
- Since an annual government teacher's training program was going on in the district the NCPDP team was invited to give presentation to several batches. All of them, adding up to nearly 200 teachers, visited the site. Teachers play very important role in the rural society in India. They are carriers of new ideas. In addition each principal (teacher) of primary school is responsible for the school that he/she is in charge of. He is involved in deciding how the Sarva Shiksha Abhiyan funds coming to the school are to be utilized. Being aware of the retrofitting option, the teachers will always have this option on their hand.

Cost:
The total expense of the work carried out is as shown in the table below. At this point in time the final bills and vouchers are still awaited from the field. But those numbers are included in the cost and await verification.

No.	Head	Expense	Subtotal	Comment
A	Overheads	84,597	84,597	Includes Room, board, travel
B	Retrofitting & Repair		5,49,041	
1	Technical manpower	154,500		Planning, designing, supervision & training.
2	Materials	2,21,128		Materials including carting
3	Labour	1,73,413		Labour only
	Retrofitting Expense		**6,33,638**	
	Misc. Expenses	1,885		
	Training Expense	3,066		
	Total Project Expense		**6,38,589**	
	Contribution from BCAS, BCAS Foundation		**6,00,000**	
	Contribution from NCPDP-CEDAP		**38,589**	
Note: The above expense as well as contribution does not include manpower cost of Rajendra & Rupal Desai at the site. These are borne by NCPDP-CEDAP.				

Please note that unlike new construction where overheads are rather small, retrofitting and repair entails much greater design role as also the on-site role of supervising staff. In case of this particular school the overheads are include the travel and room-board cost of the non local staff since it is not being done by local engineer. But in return for a retrofitting cost of Rs.5.49 lacs plus overheads cost of Rs.0.85 lacs adding up to Rs.6.34 lacs a large building that would cost approximately Rs.29 lacs, if rebuilt, is saved and put back in to use for many more years. It needs to be noted that if the government takes up such a program using local engineers, and local contractors, the total cost per school would drop dramatically.

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Photographs:

Few photographs have been received from the field as show below.

Retrofitted school exterior full view

Retrofitted school exterior view of two storey portion

Exterior of Room 1

Exterior of Room 1 and passage

Kids inside Room 4 of retrofitted school

Passage view with children in Retrofitted school

Room 4 corner

Roof rain water gutter in rear

Exterior of Room 3 in retrofitted school

Plaque for support rendered

Training of masons

District Megistrate and District Chief Education Officer visit to school

School teacher's orientation visit

Installing WWM belt

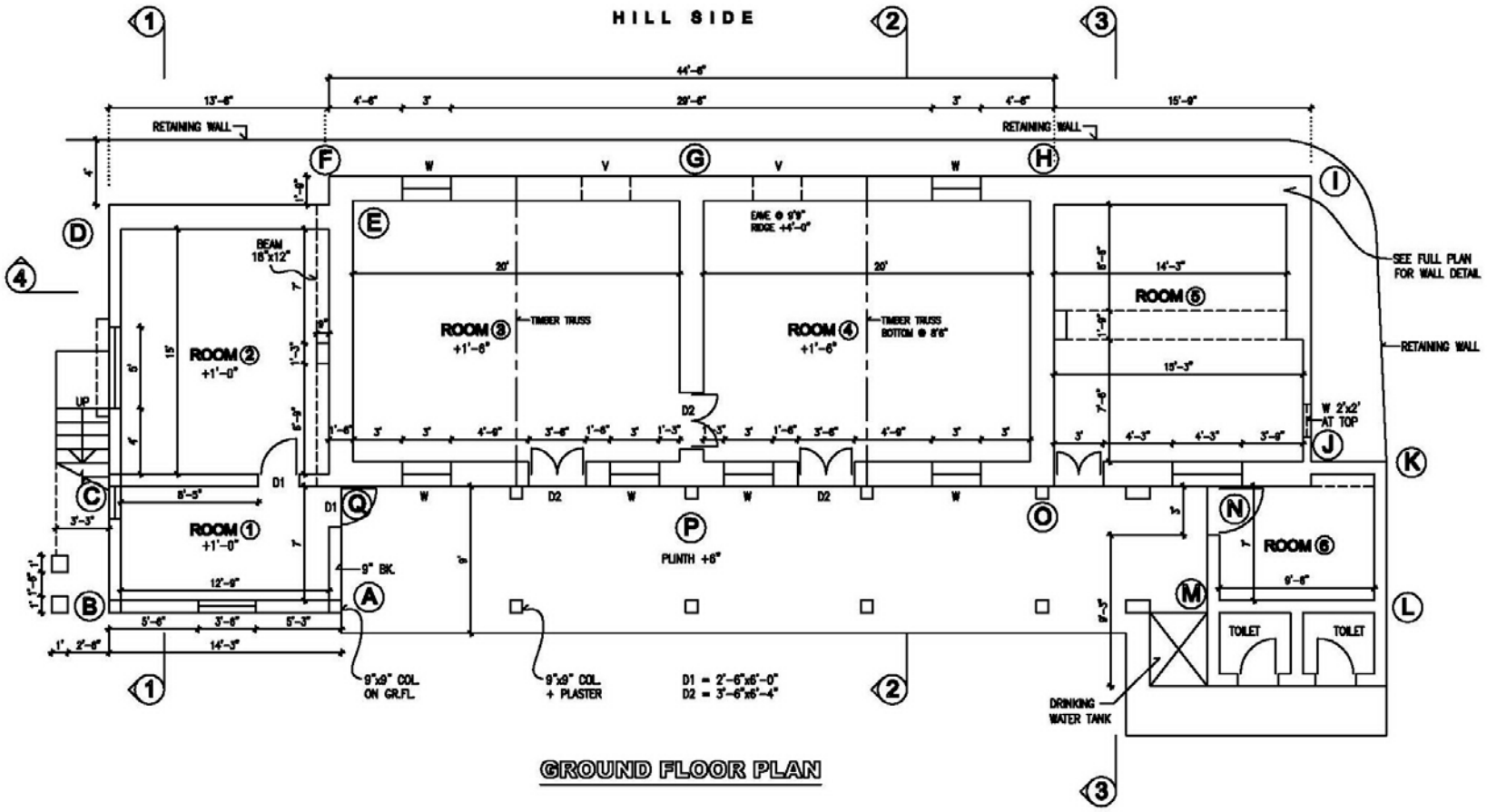
Installed WWM belt

WWM belt on wall plastered and finished

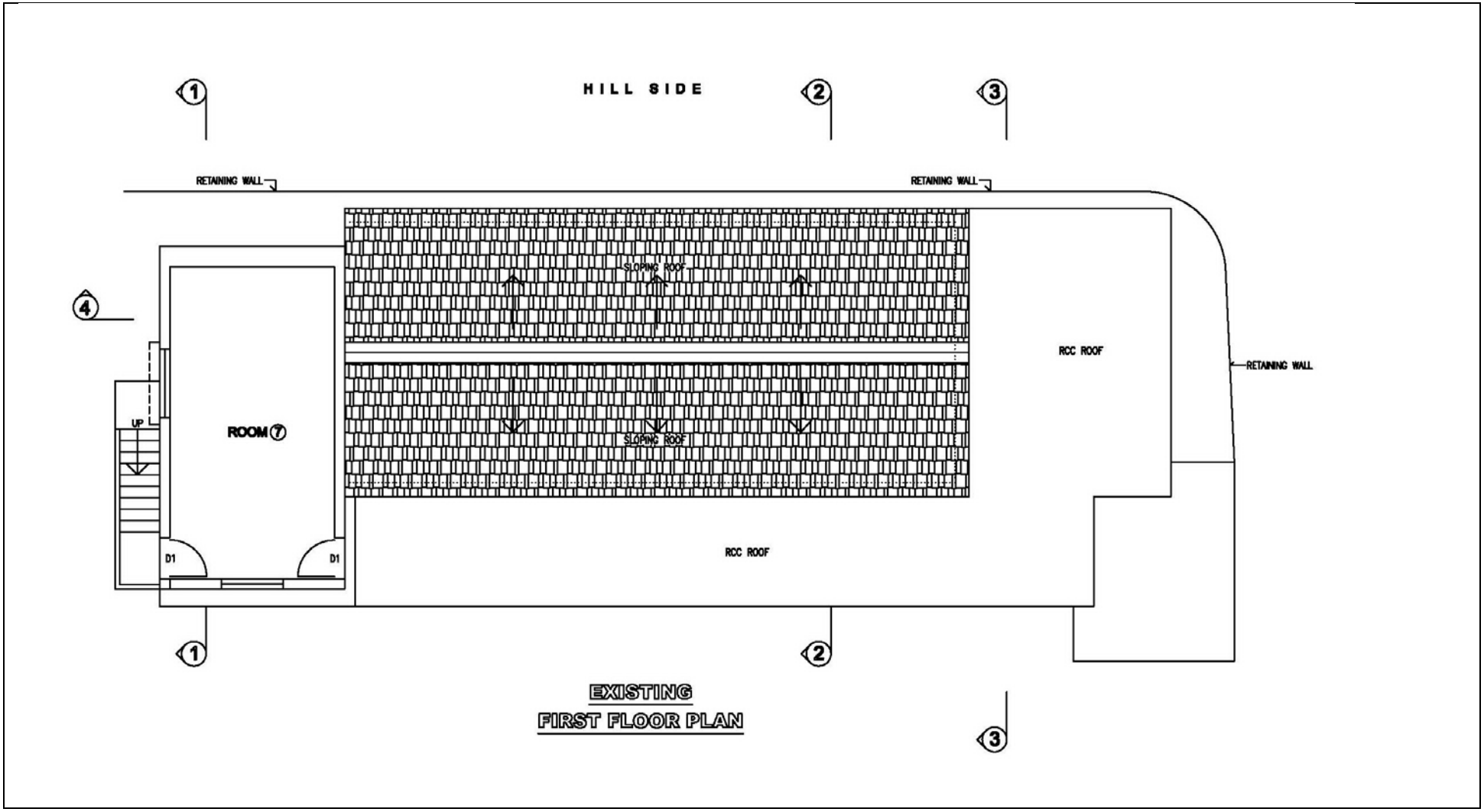
Send off from masons and labourers

School children in clasroom

School children



GROUND FLOOR PLAN


HILL SIDE
1
2
3
4
RETAINING WALL
RETAINING WALL
SLOPING ROOF
SLOPING ROOF
RCC ROOF
RETAINING WALL
UP
ROOM 7
D1
D1
RCC ROOF
1
2
3
EXISTING
FIRST FLOOR PLAN