



PRECAST CONCRETE DOOR AND WINDOW FRAMES

Production and Construction Guide



Government of India
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Cover Photo Credit	:	Development Alternatives
Author(s)	:	Zeenat Niazi, Pankaj Khanna, Suhani Gupta, Rashi Sirohi
Layout	:	Binu K George

Disclaimer

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INTRODUCTION

This manual has been prepared as part of a project on '*Delivery Model for Eco-friendly Multi Hazard Resistant Construction Technologies and Habitat Solutions in Mountain States*', which has been implemented in Uttarkashi (Uttarakhand) under the TIME LEARN (Technology Innovation in Mountain Ecosystem Livelihood Enhancement through Action Research and Networking) programme of the Department of Science and Technology. The project envisage to introduce new system of construction in the region which are resource and energy efficient, can be produced locally in a decentralized production setup, cost effective and easy to adapt. Considering all the above factors, **Precast concrete door and window technology** was proposed in the region. The technology was produced locally at an enterprise unit setup developed under the project. The local artisans and entrepreneurs were trained in the technology specifications, production and its implementation through demonstration buildings at the project area.

This manual has been prepared as a guide for the use of building artisans, entrepreneurs and government officials for production and implementation of precast concrete door and window technology in mountain regions. The manual is comprised of five sections – First, **Introduction** which covers a brief about the technology along with its application in the context of Uttarakhand region, Second, **Technology Profile** covers all the design and technical details of the technology. Third, **Production Infrastructure** covers all details of technology production along with the specification of production unit. Fourth, **Construction Process** covers the installation details and specification of the technology and Lastly, **Communication Products** shows all the posters developed for the community trainings.

Background

The traditional use of timber door window frames is today more difficult due to limited access to good quality timber in Uttarakhand. There is no practical evidence of certified timber in the prevailing supply chain of timber from wood depots. Due to heavy regulations regarding its utilization to prevent indiscriminate deforestation, accessing timber and its affordability is also becoming difficult. In this scenario, steel door window frames have emerged as an affordable option. Hence a local material has been replaced by an industrial material produced far away.

Precast Reinforced Concrete Door and Window Frames have been proposed in the region. As an alternative to timber and steel door window frames. RCC frames are much more durable than both timber and steel frames. Timber frames are susceptible to termite and fracture in case of high moisture, even steel is susceptible to corrosion in high rainfall region. In this case RCC frames provides lifelong alternative material which is durable in all weather conditions.



Traditional practice of timber door window frames

Precast concrete door and window frames comprise of separate RCC members corresponding to the sides of the opening. The horizontal member joins with vertical members through interlocking profiles when installed at site. The members are minimally reinforced using wire reinforcement. Being reinforced concrete, the top member of the frame is also capable of acting as a lintel over a door or window. The profile of frames is similar to wooden frames with the option of single and double rebates.



*Shift from timber to steel door and window frames
Use of timber door window frame sin new construction practices*

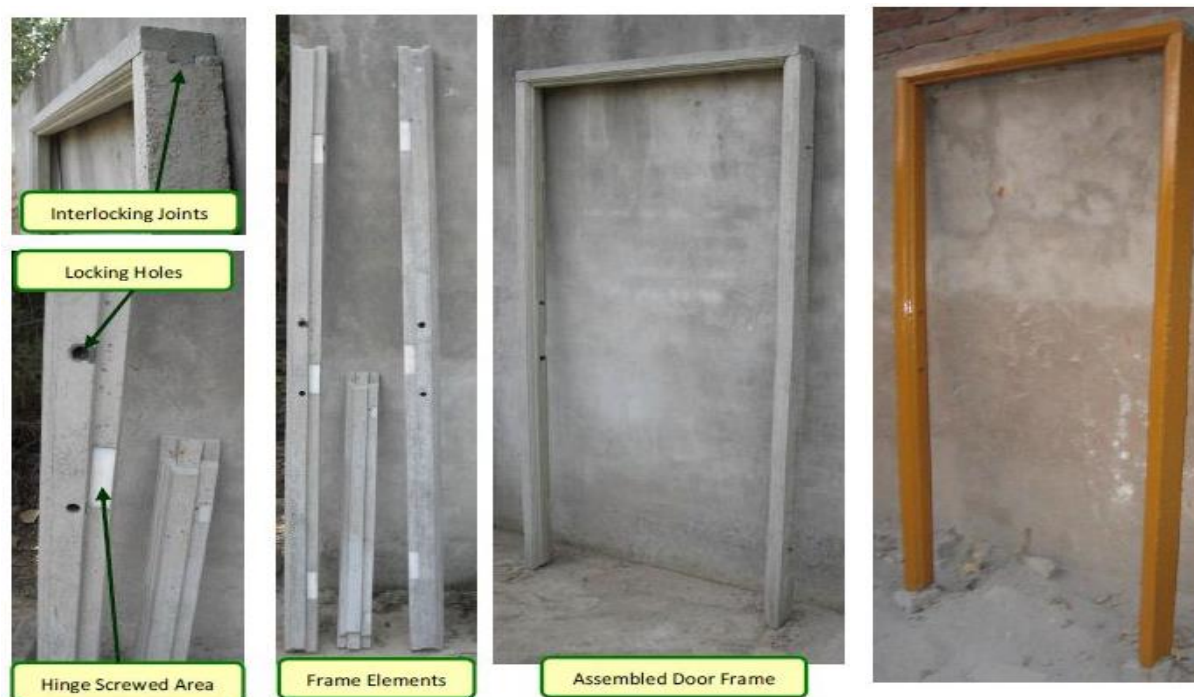


Use of timber door window frame sin new construction practices

Technology Profile

Components of Pre-cast Door and Window frames

Pre-cast concrete Door & Window frames (IS code 6523-1983) are available in a knock-down state with three and four pieces respectively. For Doors, two vertical Posts, one lintel member are fixed in a proper position through interlocking grooves. For the window frame, an additional horizontal element is provided at its base. With a cross-section of 4 x 2.5 inch; varied length between 5 – 7.5 feet can be manufactured. The frame uses nominal MS reinforcement, typically 4 mm bar and concrete of grade M-15 and provided with locking holes and hinge screw area casted within the frames. The Technology provides uniform shape and size, which is at par with the wooden alternative.



Components of precast concrete doors and windows

Technical specifications

Size	Width - 4 inch x 2.5 inch with length – 2.5 feet to 7.5 feet
Raw Material	OPC 43 grade cement, sand of fineness modulus
Concrete mix	M15, the ratio of cement, sand and aggregate 1:2:4
Reinforcement	Nominal MS reinforcement 5mm dia – 3 Nos. for main reinforcement.

Applicability

Precast reinforced concrete door window frames are feasible in any weather conditions and any building typology. This easy to install technology is even applicable for multi storey buildings. However, the technology is best suited to attain for longevity and high durability of door window frames. RCC frames are best suited in regions with high rainfall – they doesn't require anti termite treatment as required in wood or corrode as in case of metal frames. Since frames are made of RCC, they also provide structural support to the building.

Advantages

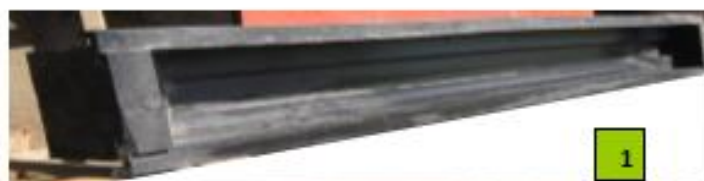
Cost	Over 40% cost saving in comparison to the high-quality timber frame
Employment	Generates local employment through enterprise mode production unit—can be easily adopted by a group of trained persons.
Durability	Durability in all weather conditions, easy and lifelong fixing of panels.
Structural and Aesthetics	Easy to assemble, provides dimensional accuracy, excellent surface finishing allows polishing and easy painting and resistance to pests and white ants.

Production Infrastructure

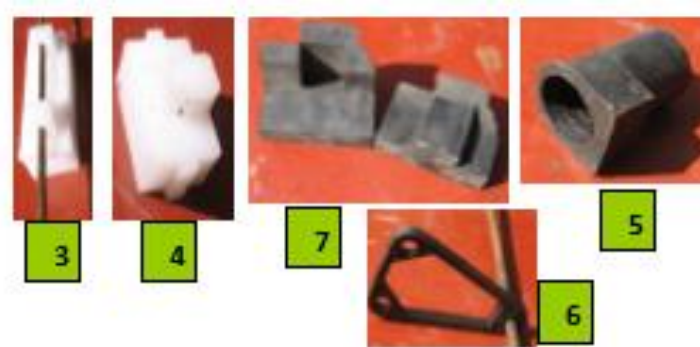
The production infrastructure for precast door-window frames consists of a set of moulds, accessories for reinforcement and hinge placement and a vibrating table to compact the concrete once placed in the moulds. The production system has been developed by Technology and Action for Rural Advancement (TARA) Machine and Tech Services Pvt. Ltd, which provides green technology solutions for building construction through small and micro-enterprises.

Production equipment

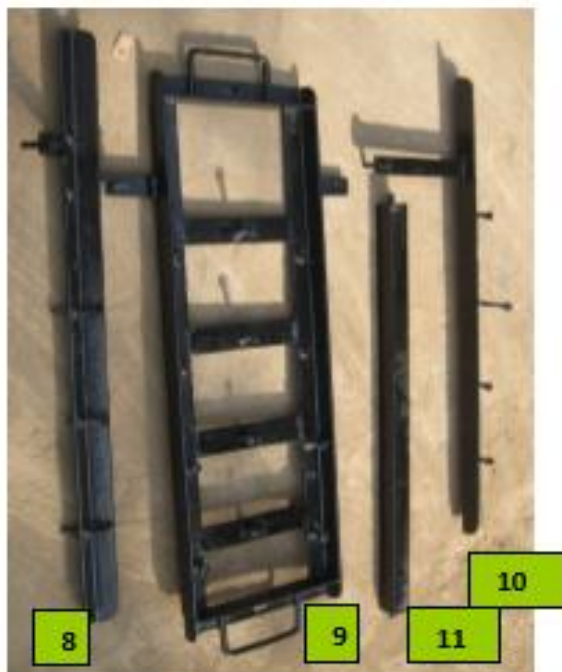
S. No	COMPONENTS	SPECIFICATIONS/DESCRIPTION	QUANTITY (for two set of doors)
1.	Rubber Mould	Section: 4 inch x 2.5 inch, Length: 3.5 feet - 7 feet	5
2.	GI Enclosure	Galvanized Channel: 5 inch x3 inch, Length: 9 feet	5
3.	Fibre Hinge Block	Used for fastening the hinge of D/W	2 in each horizontal member, total 8
4.	Fibre Tower Bolt	Used for locking at top	2 in each horizontal member, total 8
5.	Fibre Cap Aldrop	Used for holes for locking Doors	4 in each horizontal member, total 16
6.	Stirrups	Used for positioning the Metallic Rods	Each @ 9 inch spacing and at every corner, total 24
7.	End Cap	Used for adjusting the length	2 in each member
8.	Inserts Holding Jig-1	Used at Left side of the Table	1
9.	Inserts Holding Jig-2	Used at the Middle of the Table	1
10.	Inserts Holding Jig-3	Used at Right side of the Table	1
11.	GI Enclosure Aligner	Used to level the position of GI Enclosure	1
12.	Vibrating table	With 2hp, 3 Phase (Single Phase Optional) Electrical power. Size – 12 feet x 3 feet or 10 feet x 2.5 feet	1



1. Rubber mould
2. GI Enclosure



- 3. Fibre hinge block
- 4. Fibre tower bolt
- 5. Fibre cap Aldrop
- 6. Stirrups
- 7. End cap



- 8. Inserts holding Jig-1
- 9. Inserts holding Jig-2
- 10. Inserts holding Jig-3
- 11. GI Enclosure Aligner



Vibrating table with five moulds and total capacity of two set of door frames in one cycle

Production unit

PRODUCTION UNIT SPACE REQUIREMENT	SPECIFICATIONS
Total area of production yard	4000 sq. ft
Area for machines	25% of the total area - 1000 sq. ft
Area for curing and storage of finished products	25% of the total area - 1000 sq. ft
Area for storage of raw materials – like cement, steel bars, sand and aggregate.	30% of the total area – 1200 sq. ft (out of which 50% has to be covered)
Preparation and circulation space – preparation of sand sieving, reinforcement bending and concrete mixing.	20% of the total area – 800 sq. ft
INFRASTRUCTURAL REQUIREMENTS	
Availability of electricity for minimum 6 hours, for a full production day (Minimum 500 KW/h)	
Supply of clean water for minimum of 3-4 hours and water storage of at least 1000 litres capacity.	

Setting up production unit requires an initial investment – in terms of land, infrastructural cost, cost of machines and equipment and other registration/paperwork charges. Additionally, working capital is needed for raw materials, labour and transportation. The fixed capital is one time investment which is needed for setting up the production unit and working capital is a recurring cost which would be needed as the demand of technology and production requirements.

COMPONENTS	
Land and infrastructure , includes- production unit land, levelling of land and floor preparation, construction of shed, installation of main gate, construction of water tank with approx. 1000 litres capacity, provision of electricity and water supply line.	*Costing entirely varies as per the market rate of the land and the choice of materials used in the construction of components.
Machinery and equipment, includes – Concrete mixer, vibrating table and other frame equipment.	Approx. 2.5-3 Lakhs

Below is an estimated cost of the production unit at Matli, Uttarkashi setup in 2017. The actual cost will vary from case to case, the cost shown below were valid for a particular location for particular time period

LAND AND BUILDING	Area (Sq.ft)	Rate (Sq. ft)	Amount (INR)
Workshop Land	4000	0	-
Shed for production area-CGI sheet on steel frame	1000	150	150,000
Levelling of land and floor preparation	25	2500	62,500
Gate- MS fabricated	95	1300	123,500
Generator(future)	-	-	300,000
Sub Total			636,000
MACHINERY AND EQUIPMENT	Qty.	Rate	Amount (INR)
TARA Eco Concrete – Vibrating table (12 feet x 3 feet), fitted with 3 Phase vibratory motor	1	125,000	125,000
TARA Eco Concrete – Concrete mixer	1	85,000	85,000
Rubber mould (Section- 4 inch x 2.5 inch, Length – 7 feet x3.5 feet)	1	14,500	14,500
Rubber mould (Section- 4 inch x 2.5 inch, Length – 7 feet x3 feet)	1	14,500	14,500
Rubber mould (Section- 4 inch x 2.5 inch, Length – 7 feet x2.5 feet)	1	14,500	14,500
Fibre hinge block (6 nos./set)	75 set	104	7,800
Fibre tower bolt (2 nos./set)	75 set	25	1,875
Fibre cap Aldrop (4 nos./set)	75 set	18	1,350
Stirrups (10 nos/set)	75 set	25	1,875
Electronic weight machine	1	4,000	4,000
Tools for mixing concrete – <i>spade, belcha, tasla</i>	-	-	1,000
Water Tank	1	7,000	7,000
Sub Total			278,400

**It is feasible to set up precast door window production along with other precast concrete products like concrete blocks, RCC plank and joist roofing technology. This is advisable to maximize the profit and ensure sustainability of the production unit. Hence the requirements of the production unit requirements have been provided accordingly.*

Material and Labour requirement for production

Material and manpower requirement has to be prepared as per daily production capacity of the production unit. In one production cycle two set of door or window frames can be produced. Each production cycle takes approx. 1 to 1.5 hour including setting of mould on vibrating table, casting and transfer of frame mould from vibrating table to ground. In one day of production it is possible to cast maximum 12-15 pieces of door or window sets. The daily production entirely depends on the set of moulds available at the production unit, only one set of frame can be casted with one set of mould in a day as it requires 24 hrs setting time. The material and manpower estimate has been provided here for the quantity of two set of doors or window sets (window sizes vary as per design of the building).

MATERIAL	UNITS	QUANTITY (2 set doors) <i>*One set of door weighs 72 Kg</i>
Cement	Bags	1
Sand	Cu. m	0.06
Aggregate – 0- 10 mm	Cu. m	0.06
5mm MS Bar	Kg	1.5 Kg
WORK PERSONS		
Machine operator	Man-days	1
Skilled	Man-days	1
Unskilled	Man-days	4

** 10% of wastage must be added to each material quantity mentioned above.*

Production Process

Preparation of machines and moulds

- Assemble the machine and check proper functioning of the machine before preparing mix. Ensure the ground of the casting yard is levelled.
- Check machine for vibration and free movement of lifting and transverse moments.
- Clean the mould with a clean dry or wet cloth and check the edges and corners of the mould for any mortar or concrete from last production. One can also use an air jet to clean the corners properly.
- Apply a fine coat of mould releasing agent (burnt engine oil) with the help of a spray or a paintbrush. Excess oil on the sides and corners should be wiped with a piece of clean dry cloth.

Preparation of concrete mix

- Concrete mix to be prepared with 43 grade cement, coarse sand and 0-10mm aggregate.
- All three raw materials to be mixed in the ratio of 1 bag of cement: 1.5 bags of coarse sand: 1.5 bags aggregate (1:1.5:1.5).
- Cement – Marks on bags (ISI, grade and manufacturer). Feel: cool, free from lumps.
- Quantity to be checked by weight.



Weighing process of raw materials for the preparation of concrete mix.



Preparation of concrete mix manually.

Casting of frames

Casting of door-Window frame comprises of several steps including– Preparation of reinforcement cage, placement of reinforcement into mould, casting of door-window frames, demoulding of the casted door-window frames and lastly curing of casted frames.



- *Straighten the round steel*



- *Assemble the inserts hinges and round*



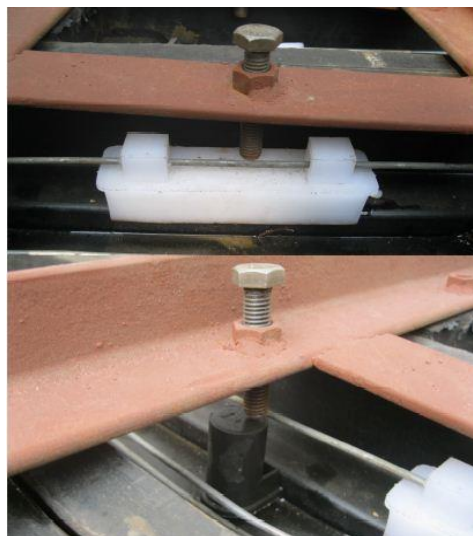
- Bolt the GI enclosure Aligner.
- Position the GI enclosure with rubber moulds.
- Coat the lubricating materials with a brush and put the Aldrop.



- Place the knitted Reinforcement and Inserts.
- Place and fasten the Insert Holding Jigs at their respective positions.



- Tighten the bolts to fix the positions of Aldrops and Hinges.
- Pour the rich cement mix inside the mould for surface.





- *Pour the desired concrete mix inside the cavity of mould*
- *Switch ON the vibrator and trowel for distributing throughout the length. Switch OFF as soon slurry comes at the top.*
- *Unscrew and remove the bolt on the Inserts holding jigs*



- *Lift the GI enclosures with casted green elements with moulds and keep on level floor.*
- *Insert the holdfast at the respective positions and keep it for 34 hours.*



- Flip the rubber moulds with cast frames from GI enclosure, place it on steps and remove.
- Pull the rubbers outside and gradually separate it from the cast frame.



- Flip the rubber moulds with cast frames from GI enclosure, place it on steps and remove.
- Pull the rubbers outside and gradually separate it from the cast frame.

Common problems in production	Their solutions
Frames stick to the mould at the time of demoulding	<ul style="list-style-type: none"> • Check quality of shuttering oil used. • Check for proper and uniform application of shuttering oil, especially in internal corners.
Product crack on demoulding	<ul style="list-style-type: none"> • Check if the product has developed adequate strength before demoulding. • In case of cold weather, increase the setting time for the mould. • If problem persists, check the quality of cement.
The irregular surface finish cause due to lack of toppings (fine mix slurry) and also excess water in the mix.	<ul style="list-style-type: none"> • Prepare the correct mix design and also add toppings. Need to keep the toppings little dry before adding concrete mix.
The honeycomb or holes on the surface causes due to lack of vibration.	<ul style="list-style-type: none"> • Need to vibrate the mould with the concrete and also check the water cement ratio.
The cracks at the centre and also at the edges causes due to lack of dryness of the block during demoulding.	<ul style="list-style-type: none"> • Need to check the harness of the frame before it gets demoulded from the rubber mould.

Maintenance

	After Production	Daily	Weekly
Casting Moulds	-	<ul style="list-style-type: none"> Clean the rubber mould with soft brush after demoulding. 	-
Machinery	<ul style="list-style-type: none"> Clean the top surface of the TARA Vibrating Table after the end of daily production. 	<ul style="list-style-type: none"> Check the holes on the TARA Vibrating table are clean and no concrete is stuck. 	<ul style="list-style-type: none"> Check the tightness of the vibrating table top with the Legs and the position of the springs. Check the tightness of the fasteners of Vibrating Motor with the mounting frame.

Quality control measures
<ul style="list-style-type: none"> Ensure proper cover to the reinforcement in Door and Window Ensure an appropriate grading of the concrete mix before casting of Door and Window All handling and transportation of Door-Window frames should be done in vertical position as far as possible. The frames should be handled at the ends and not in the centre. Position the Aldrop at its position before casting. Ensure proper positioning and tightness of hinge inserts by adjusting the fasteners in the Hinge inserts jigs need to be tightened properly. The fasteners of the hinge inserts jigs needs to be tightened properly. Ensure the right positioning of the rubber moulds on the GI mould. Ensure the position of the holdfast just after the casting. Place the cast green frames on the plain levelled surface. Position the rubber mould with casted products on the soft surface like sand bed. Wash the rubber moulds after demoulding.

Don't
<ul style="list-style-type: none"> Do not use unwashed rubber moulds for casting. Do not cast without putting lubricating material (inside mould surface). Do not keep the rubber mould directly in the sunlight when not in use. Do not over vibrate the moulds during casting. Do not put loose reinforcement into the rubber mould. Do not tighten the Aldrop fastener more, so that the Aldrop gets broken.

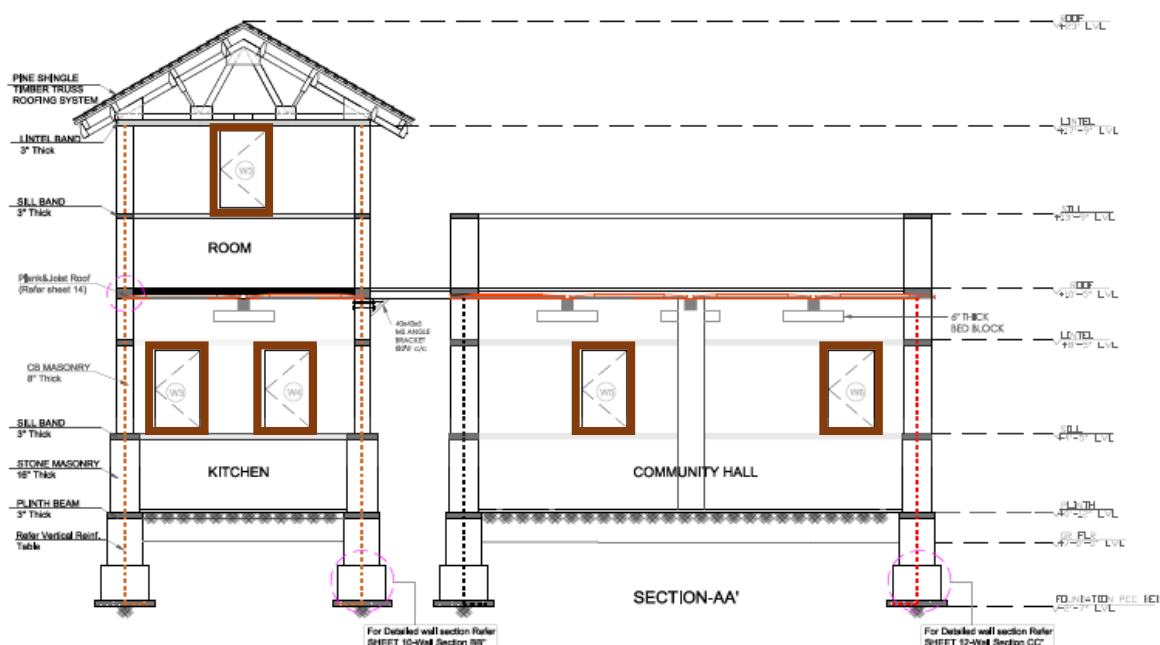
Installation Process

The installation of precast concrete door window frames is a simple process which can save time and cost of construction in a building. The process below shows the door window installation process in Community building at Kamad village, Uttarkashi. The frames were installed in total 15 windows (168 running feet) and 8 doors (136 running feet), all the door window frames were produced in precast concrete product local enterprise at Matli, Uttarkashi.

Design

The design of the community building has been prepared to incorporate earthquake resistant elements of building design. This has also been reflected in the design and sized of the windows - All the openings are at a distance of atleast 450mm from the inside corner of rooms and at least 600mm apart. The cumulative width of openings is not be more than 50% of the total length of the unsupported wall. All these guidelines have been provided and validated by NCPDP (National Centre for People's Action in Disaster Preparedness).

The section below shows the design and placement of windows in Community building at Kamad village, Uttarkashi prepared for total 560 sq.ft (with maximum room span of 17.5 feet) of slab area including roof of hall, verandah and intermediate slab of two storey block (comprising of 15 windows and 8 doors).



	Sizes	Quantity (Nos.)
Doors	3.5 feet x 7 feet	7
	2.5 feet x 7 feet	1
Windows	2.5 feet x 3.7 feet	10
	3 feet x 3.7 feet	1
	2.5 feet x 1.7 feet	4

Installation process



- Mark the location of doors as per building design.
- Assemble all the three members of the (two vertical and one horizontal) together and support it with a rope.



- Assemble all the door frames, supported with a rope.
- Complete wall masonry till sill level.



- Once wall masonry is complete till sill level, start assembling the window frames as per the building design.



- *After installation of window frames, complete wall masonry above sill level.*





About Development Alternatives Group

Development Alternatives (DA) is a premier social enterprise with a global presence in the fields of green economic development, social equity and environmental management. It is credited with numerous technology and delivery system innovations that help create sustainable livelihoods in the developing world. DA focuses on empowering communities through strengthening people's institutions and facilitating their access to basic needs; enabling economic opportunities through skill development for green jobs and enterprise creation; and promoting low carbon pathways for development through natural resource management models and clean technology solutions.

Development Alternatives
B-32, Tara Crescent, Qutub Institutional Area
New Delhi 110016, India
Tel: +91-11-2654-4100, 2654-4200, Fax: +91-11-2685-1158
Email: mail@devalt.org, Website: www.devalt.org