

भारत सरकार
रेल मंत्रालय
रेलवे बोर्ड

RB/L&A/No. 39/2005
आर. वी./एल. एंड ऐ./ सं. 39/2005

सं.2005/LMB/01/04.

नई दिल्ली, दिनांक: 17.02.2005.

Correction Slip No. 10 dated 17.02.2005
अग्रिम शुद्धि पत्र संख्या 10 दिनांक 17.02.2005

Addressed to: As per list attached.
पता: संलग्न सूची के अनुसार.

Sub: Advance Correction Slip to Indian Railway Works
Manual (Edition 2000) – (Chapter II & III).
विषय : भारतीय रेल निर्माण कार्य नियमावली में शुद्धि (संस्करण 2000)-
चैप्टर-II व III.

Ministry of Railways (Railway Board) have decided that
correction/additions as indicated in the enclosed Advance Correction Slip
No. 10 dated 17.02.05. to relevant paras of the Indian Railways Works
Manual (Edition 2000), be made.

Receipt of this letter may please be acknowledged.

रेल मंत्रालय (रेलवे बोर्ड) ने यह विनिश्चय किया है कि भारतीय रेल निर्माण
कार्य नियमावली (संस्करण 2000) के सम्बद्ध पैरा में संलग्न अग्रिम शुद्धि पत्र संख्या
10 दिनांक 17.02.2005 में वर्णित शुद्धियाँ/संशोधन किए जाएं.

कृपया पावती दें.


(देश रत्न गुप्ता)
निदेशक,
भूमि एवं सुविधाएं,
रेलवे बोर्ड.

INDIAN RAILWAY WORKS MANUAL (2000)

ADVANCE CORRECTION SLIP No.10 DT 17.02.2005

Sub: Correction Slip to Indian Railways Works Manual (2000) Chapter II and III thereof –

It has been decided that the following amendments should be carried out to the provisions of Indian Railways Works Manual (2000 edition)

1. Add at the end of the para 201(d)
“For quick reference, some of the provisions of National Building Code (NBC) are listed in Annexure 2.10”.
2. Para 202(a) Should be replaced with
“a) *Orientation of buildings*:- The chief aim of orientation of buildings is to provide physically and psychologically comfortable living inside the building by creating conditions which suitably and successfully ward off undesirable effects of severe weather to the best possible extent.
For this, the following factors should be considered for the optimum orientation of the building.
 - (i) Natural light and temperature
 - (ii) Prevailing winds
 - (iii) Relative humidity
 - (iv) Surrounding view & features

As per IS code No.SP-41 (S&T) – 1987, Four types of climatic conditions are mainly found in India:

- (i) Hot and dry
- (ii) Hot and humid
- (iii) Warm and humid
- (iv) Cold

The list of cities falling in these climatic zones is given in annexure 2.11.

The following orientation principles with respect to various climatic condition along with building features can be used as a guideline:

i) Hot and dry climatic zones:

This climatic condition generally occurs at latitude between 15 degrees to 30 degrees on both the hemispheres. Maximum day time summer temperature goes as high as 45 degree centigrade and relative humidity as low up to 20 %. Major areas falling in this climatic zone are Delhi, U.P., Bihar, Rajasthan, parts of Punjab and Madhya Pradesh. These areas are far away from coast and do not experience very heavy rainfall. The buildings should be oriented from solar point of view so that as a whole it should receive the maximum solar radiation in winter and the minimum in summer. Desirable features of building in this zone are:

1. **Orientation:** Longer walls of building should face North & South. Non-habitat rooms can be located on outer faces to act as thermal barrier. Preferably the kitchen should be located on leeward side of the building to avoid circulation of hot air and smell from the kitchen.

2. **Windows and fenestration:** Large openings with heavy shutters should be provided on northern and western faces as light coming from north is always diffused and indirect. Also direction of breeze, which is from west at most of the places enters from opening on west side. Windows area should be 15 to 20 percent of floor area. Internal courtyard caters for cross ventilation & thermal buffer. Suitable radiation barriers in the form of canopies, Chhajjas, long verandahs etc. should be provided on the West side of the building. Sufficient number of ventilators close to the bottom of slab should be provided.

3. **Walls:** Thick walls are preferred to act as insulating barrier. Walls with light and shining paints on outer surface have good reflective quality and do not absorb heat. The surface of walls should be smooth and non-dust catching type. Cavity walls also can be provided as they provide very good thermal insulation. Hollow bricks available in the market can also be used for making hollow - insulated walls.

4. **Roofs:** Should be built up with good insulating material having slope in windward direction. False ceiling can be used to improve thermal performance of building. Terracing should

be provided on the flat roof with mud phuska, lime concrete, foamed concrete or burnt clay block paving over roof slab. Top roof surface should be made reflective by providing whitewashing or any reflective paint.

5. **Vegetation:** Large shady trees whose roots do not strain foundation and basement should be planted near external walls to provide shade.

6. **Special needs:** Outdoor sleeping area for summer nights preferably be provided. Desert coolers and fans can be used during summer months. Therefore, proper space to provide coolers should be planned in the building.

ii) **Hot and humid climatic zone:**

In these regions the climate is hot and air contains moisture. Sun's glare is more and undesirable. Relative humidity is above 40% and temperature is above 32 degree centigrade. Mostly interior peninsular region fall under this category. Interiors should be protected from hot Sun and dusty winds. The thermal characteristics are almost identical to hot & dry zone except that desert coolers are not suitable for hot & humid zone. The orientation and other features of the building would remain the same as in hot and dry climatic zone.

iii) **Warm and humid climatic zone:**

This type of climate is normally found in the coastal areas. Mean maximum temperature during summer does not rise beyond 32 degree centigrade and relative humidity ranges between 70% and 90%. Because of less diurnal variation of temperatures along with high humidity, the emphasis should be on prevailing winds. Coastal regions of Gujrat, Maharashtra, Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Orrissa and West Bengal fall under this category. Desirable features of buildings in this zone are:

1. **Orientation:** should be preferably in North-South direction for habitable rooms i.e. longer walls should face north & south so that shorter sides are exposed to direct sunlight.

2. **Windows and fenestration:** Proper cross ventilation of building is of extreme importance therefore large openings

should be positioned on windward and leeward direction. However, openings should be provided with suitable protection like sunshades, chhajjas etc. from Sun and rain. Windows area should be 15 to 20 percent of floor area. The sill height of windows should be at low level between 0.5 to 0.7 metre. Fixed windows should be avoided. Internal doorways between drawing & dining and dining to passage etc. may be left open without shutters/leaves. Ventilators should be provided as near to ceiling as possible. Provision of mechanical ventilation for circulation of fresh air as well as exhaust of used air should be made.

3. **Walls:** Low thermal capacity material be used in construction and walls can be thinner as temperatures are not very high. Compound wall on the windward side should be low. Bare fencing or light screen walls are preferable. RCC jalis are more advantages as they allow passage of air through them and at the same time provide privacy by obstructing the vision.

4. **Roofs:** should have large overhangs to avoid rainwater hitting the wall. Roof should be finished with materials of low thermal conductivity. Top roof surface should be made reflective by providing whitewashing or any reflective paint / tiles. Proper slope is essential for effective removal of rainwater.

5. **Vegetation:** Shrubs of medium height or coconut trees grove or casuarinas, which do not act as wind barriers are recommended.

6. **Special needs:** Good rain-water drainage is essential. Desert coolers are not suitable in these areas.

iv) **Cold climatic zone:**

Cold climate occurs in mountainous regions and plateaus 800 to 1200 metres above sea level. Snowfall and rainfall is also heavy and mean daily temperatures is 6 degree or less. Minimum temperature may fall up to minus four degrees or even less at some locations. Mountainous regions of Jammu & Kashmir, Himachal Pradesh, Uttaranchal and North Eastern States and other hilly and mountainous regions of the country

fall under this category. Main requirement of this region is heating during winter months and protection from chilling winds. Walls and roofs should be protected against heavy rain and snowfall.

1. **Orientation:** Should preferably be in North – South direction i.e longer walls should face north & south to receive more solar heat during winter months.
2. **Windows and fenestration:** Glazing windows upto 25% floor area may be provided. Double glazing is preferable to avoid heat losses during winter nights.
3. **Walls:** Thin walls with insulation from inner side (2.5cm thick insulation) are preferable. Some of the insulating materials are listed in table 2 of SP41-1987 Part 2 of BIS titled as Handbook on functional requirement of Buildings - Heat insulation. The insulation should be protected against the risk of condensation by providing sufficient vapour barrier like 2 coats of Bitumen, polythene sheet 300 to 600 gauge or aluminium foil on warm side. Hollow and light weight concrete blocks are also quite suitable.
4. **Roofs:** should be preferable made of asbestos cement or G.I. sheets backed by false ceiling of wood, 2.5cm wood-wool board or equivalent material. The roof should have sufficient slope for quick drainage of rainwater and snow. Vapour barrier should be used depending on location and possible wind pressure.
5. **Special needs:** Provision for heating of building should be kept like fire places etc. Ceiling fans are not normally required, but may be used during summer on special occasions. Outdoor sleeping area is not required.

The services of an architect may be availed of for finalising the design and layout wherever required particularly in case of important stations, other important buildings and where new colonies/establishments are being set up.”

3. Add under para 203 before para 203(a)
“A building should not only be functionally suitable but also aesthetically pleasing, peaceful, suitable to the inhabitants, economical to construct and easy to maintain.
While designing the building the following factors should be considered
1. **Easy maintenance** – At planning stage itself, the facility of maintenance should be kept in mind. This should include cleaning of floors, windows, walls, ceiling etc. It should also take care the periodic inspection and repair of various components of building like windows, roofs, walls, plumbing, electrical fittings and wirings etc. For this sufficient space, illumination, and service connections like plug points, master valve for whole plumbing etc. should be provided.
 2. **Socio cultural variables** – like privacy, family structure, recreational patterns and different cultural background of people should be kept in mind while finalising the design of building.
 3. **Safety** – Due care should be taken to create an environment in which user can be safe as far as possible. The following safety features should be incorporated in design & layout of building :-
 - (i) Use of non-flammable, non-toxic materials
 - (ii) Eliminating sharp edges, corner etc. These should be rounded or chamfered properly.
 - (iii) Properly designed and adequately illuminated stairs, ramps and walkways.
 - (iv) Appropriate barriers to prevent people from walking through large glass door and windows, when they are closed.
 - (v) Use of non-skid materials in area prone to becoming wet, such as in toilets, kitchen and open veranda, walk ways, stairs etc.
 - (vi) Emergency escape routes should also be planned.
 - (vii) Proper fencing around special facilities like swimming pools, electric poles, high voltage wires and heaters etc.
 - (viii) Fire fighting system and fire alarm system should be as per national building code or local bye-laws wherever required

4. **Natural ventilation** – Proper natural ventilation is an important factor in planning building layouts specially in warmer/humid climates and during the hot season of the year. The arrangement of ventilation will depend upon prevailing wind direction. Proper opening should be planned as per wind direction so as to get effective cross ventilation.
5. **Noise control** – To minimise noise pollution through ground reflection, the dwelling units/areas should be surrounded by plants and grass area, whereas from maintenance reasons a large amount of hard paving is necessary. It should be broken up by areas of plants and grass to minimise noise pollution. Windows and doors should be kept away from noise side as far as possible or they should be properly designed to reduce noise pollution. Proper location and orientation of building can also contribute in controlling noise. Where there is ample space, trees can be planted to reduce noise. Multiple rows of trees and bushes are more effective in controlling the noise. Provisions of National Building Code 1983, (Part VIII) may be used for proper design of noise control in buildings.
6. **Natural lighting** – Good lighting is necessary for all buildings and has three primary aims. The first aim is to promote work and activity. The second is to promote safety and the third is to create a pleasing environment. Additionally it also preserves energy consumption (electricity). The natural lighting can be achieved by careful planning of brightness and colour pattern within the working area and surroundings. To improve reflectivity, Light colours should be used on the walls and ceilings for better brightness in the interiors. The proper natural lighting can be provided with the help of proper orientation of building in relation to position of sun and internal open spaces. Translucent corrugated roof sheets with or without false ceiling of Perspex sheet may also be used for this purpose.

The direct and reflected glare from light source should be controlled. The corridors, passage and stairways should be properly lighted to avoid accidents. The lighting throughout the building should be correlated to avoid excessive differences between adjacent areas to reduce risk of

accidents. Emergency lighting system should also be provided wherever necessary.

7. Energy efficient buildings:

‘House for all seasons’ of yesteryears is now known as energy efficient or climate-conscious or energy conscious or sustainable buildings. The aim is to make a building that –

- Requires minimum artificial energy for providing comforts like temperature, ventilation and illumination.
- Effectively utilizes renewable sources of energy to power the building.
- Uses low energy materials (building materials that require less energy during manufacturing process) and involves minimum energy in transportation and construction methods.

7.1 Energy Management in building – Building should be designed in such a way that energy requirement for cooling, heating etc. should be the barest minimum. For this as already discussed in the above paras, the orientation of building along with ventilation is of prime importance. For minimising the energy requirement in a building, the solar energy is to be made use of. This can be done in two ways. One is by passive solar design and second by active solar design.

(A) Passive Solar System: Passive solar system makes use of natural energy flows as the primary means of harvesting solar energy. Passive solar design is an approach that integrates building components – exterior walls, windows, and building materials – to provide solar collection, heat storage and heat distribution. Passive solar heating systems are categorized as sun-tempered, direct-gain, sunspaces and thermal storage walls.

(i) Passive solar heating: Passive solar building that makes use of sunlight as a heating source should also be designed to take advantage of sunlight as a lighting source. Day-lighting benefits from the gentle diffusion of sunlight over large areas of light-coloured surface. Integrating these two approaches requires an understanding and coordination

of day-lighting of passive design, electric lighting and mechanical heating system and controls. This will require a proper orientation of building as already discussed alongwith proper planning of various openings. Thermal storage have added features. Thermal storage features in a passive solar building is intended to meet two needs. It should be designed to quickly absorb solar heat for use over diurnal cycle and to avoid overheating. This provides slow release of the stored heat when the sun is no longer shining. The thermal storage strategies are: -

(a) flooring of concrete, tile, brick or stone masonry.

(b) Trombe Wall: Trombe wall is a south facing wall covered with glass spaced a few inches away from the wall. Sunlight passes through the glass and is absorbed and stored by the wall. Heat is transferred by conduction to building some hours later. This should be used in buildings in cold climatic conditions.

(c) Insulated Masonry and Concrete Walls: New technologies have lowered the cost and increased the options for insulated masonry. Various foam insulations are available in panels that can be adhered directly to the masonry surface and then protected with a troweled or sprayed on weathering skin.

(d) Double Gypsum Board: Thermal capacity of the building can be increased by simply increasing the thickness of the gypsum board used on interior walls of the building.

(e) Hollow brick walls; either rat trap bond type or cavity wall as per BIS - S.P.20 titled as Hand Book of masonry design and construction, can be used on all outer walls of a buildings located in hot dry climate. It will keep the interior cool in summer months due to air pocket inside the walls.

(f) Water wall: Water walls are based on the same principle as that for Trombe walls, except that they employ water as the thermal storage material. A water wall is a thermal storage wall made up of drums of water stacked up behind glazing. It is usually painted black to increase heat

absorption. Buildings that work during daytime, such as schools and offices, benefit from the rapid heat transfer in the water wall. Overheating during summer may be prevented by using suitable shading devices.

(ii) Passive Solar Cooling: Passive solar cooling are designed strategy that minimize the need for mechanical cooling system. This includes proper window placement and day-lighting design, selection of appropriate glazing for windows and skylights, proper shading of glass when heat gains are not desired, use of light coloured materials for the building, careful siting and orientation decision and good landscaping design. Use of traditional full window (leaf window) stops heat and sunlight in summer months and keeps the interior cool whereas fully glazed windows admit and trap the heat in the interior rooms. Therefore, the traditional windows should be used in hot and dry climate whereas the fully glazed windows should be used in cold climate.

(B) Active Solar System: Active solar energy should be integrated with a building's design and systems only after passive solar and energy-conserving strategies are considered. Active solar collector systems take advantage of the sun to provide energy for domestic water heating, space heating etc. Water heating for domestic use is generally the most economical application of active solar systems.

Major components of the system include collectors, the circulation system that moves the fluid between the collectors and storage, the storage tank, a control system and a backup heating system.

8. Seismic consideration – The building should be designed for seismic forces as per relevant IS codes as per seismic zone and importance of building. Some of the general considerations along with seismic repair and strengthening of building are given in Annexure 2.12 for ready reference. However, these should be confirmed with the latest provision of relevant IS codes.

Following updated IS codes may be used for this purpose.

- i) SP22 –1982: Explanatory handbook on codes for earthquake engineering.
- ii) IS 1893-1984: Criteria for earthquake resistant design of structure.
- iii) IS1893 – Part I –2002: Criteria for earthquake resistant design of structure part 1 – General Provisions and buildings.
- iv) IS4326-1993: Code of structures for earthquake resistant design and construction of buildings
- v) IS13828 –1993: Improving Earthquake resistance of low strength masonry buildings - Guidelines
- vi) 13920-1993: ductile detailing of reinforced concrete structure subject to seismic forces - code of practices
- vii) 13935-1993: Criteria for repair and seismic strengthening of buildings.
- viii) Any other IS codes related to earthquake issued afterwards.
- ix) National Building Code.

9. Other general design requirements –”

- 4.** Add at the end Para 203(a)
“Minimum height of plinth shall not be less than 45 cm from the surrounding ground.”
- 5.** Replace para 203(b) with
“b) Anti-termite treatment should be done at the time of construction from the foundation stage itself. ”
- 6** Add at the end of para 203(d)
“Floor of bathroom should be provided with a slope of minimum 1 in 60 towards water outlets.”
- 7.** Add new para 203 (l) after para 203(k)
“(l) The detailed construction plan which includes Sections and Elevations of building should not be approved unless following detailed plans are also available:
 - (i) Site plan and General layout plan showing various service connections like sewerage, drainage, water & power supply, roads etc to town services.
 - (ii) Roof plan showing terracing with slopes, water proofing

- and water outlets. (*Sample Plan at Annexure 2.13 – Fig.1*)
- (iii) Detailed larger size plans of toilets and kitchens indicating the location and type of fittings and treatment on floor and walls. (*Sample Plan at Annexure 2.13 – Fig.2, 3*)
- (iv) Plan showing layout of furniture and furnishing and their type. (*Sample Plan at Annexure 2.13 – Fig.4*)
- (v) Sanitary fittings, drainage and sewage plan, plumbing details. (*Sample Plan at Annexure 2.13 – Fig.5, 6, 7*)
- (vi) Horticulture landscaping plan (optional).
- (vii) Electrical wiring plans. (*Sample Plan at Annexure 2.13 – Fig.8*)”

8. Add new para 204 (c) after para 204(b) -

204(c) RAIN WATER HARVESTING (RWH)

1. **Introduction**:- Rain Water harvesting is the technique of collection and storage of rain water at surface or in sub-surface aquifer, before it is lost as surface run-off. The augmented resource can be harvested when needed. Thus it covers wide range of means of collecting and storing water but popularly this item is becoming synonymous to artificial recharging of ground water aquifer.

2. **Necessity**:- Water is one of the most essential requirement for existence of living beings. Surface water and ground water are two major sources of water. Due to over population and higher usages levels of water in urban areas, water supply agencies are unable to cope up demand with surface sources like dams, reservoirs, rivers etc. This has led to digging of individual tubewells by house owners. Even water supply agencies have resorted to ground water sources by digging tubewells in order to augment the water supply. Replenishment of ground water is drastically reduced due to paving of open areas. Indiscriminate exploitation of ground water results in lowering of water table rendering many bore-wells dry. To overcome this situation bore-wells are drilled to greater depths. This further lowers the water table and in some areas which leads to higher concentration of hazardous chemicals such as fluorides, nitrates & arsenic. In coastal areas like Chennai, over exploitation of ground water resulted in sea water intrusion thereby rendering ground water bodies saline. In rural areas also Government policies on subsidized power supply for agricultural pumps and piped water supply through bore wells are resulting in to decline in ground water level. The solution to these problems is to replenish ground water bodies with rain water by man made

means.

3. Basic types:- Following are three basic types:-

- (a) Roof top rain water harvesting and storage in tanks.
- (b) Roof top rain water harvesting and recharging subsurface aquifer.
- (c) Surface run-off harvesting and recharging subsurface aquifer.

4. Advantages:-

- (a) Promotes adequacy of underground water.
- (b) Mitigates the effect of drought.
- (c) Reduces soil erosion as surface run-off is reduced.
- (d) Decreases load on storm water disposal system.
- (e) Reduces flood hazards.
- (f) Improves ground quality/decreases salinity (by dilution).
- (g) Prevents ingress of sea water in subsurface aquifers in coastal areas.
- (h) Affects rise in ground water table. Thus saving energy (to lift water).
- (i) The cost of recharging subsurface aquifer is lower than surface reservoirs.
- (j) The subsurface aquifer also serves as storage and distribution system.
- (k) No land is wasted for storage purpose and no population displacement is involved.
- (l) Storing water underground is environment friendly.

5. Legislation:- Under section 15 of Environment (Protection) Act 1986, Central ground Water Authority (Ministry of Water resources) has made it mandatory to adopt rain water harvesting system for certain types of building/institutions located in specified regions of National Capital territory.

In Chennai, rain water harvesting has been made compulsory. In Delhi, Building bye-laws have been modified making rain water harvesting mandatory for new buildings erected on plots of more than 100 sq. mtrs.

Ministry of Environment & Forest (Government of India) has circulated draft Gazette Notification regarding rain water harvesting in hilly area of entire country.

6. MODES AND TECHNIQUES

Roof top water/storm runoff is harvested. The collected water can be stored directly in a storage tank or existing sump through a filter chamber or this water can be used to recharge ground water. Normally, debris, dirt and dust get deposited on the roof during non-rainy periods. When the first rains arrive, this unwanted material would be washed into the storage tank. This may cause contamination of water collected in the storage tank thereby rendering it unfit for drinking and cooking purposes. Therefore, a first flush system can be incorporated in the Roof top Rainwater Harvesting System (RRHS) to dispose off the first flush so that it does not enter the tank. There are two such simple systems. One is based on a simple manually operated arrangement whereby, the down pipe is moved away from the tank inlet and replaced again once the first flush water has been disposed. In another simple and semi automatic system, separate vertical pipe is fixed to the down pipe with a valve provided below the T-junction. After the first rain is washed out through the first flush pipe the valve is closed to allow the water to enter the down pipe and reach the storage tank.

Collection of roof top water –

Roofs made of corrugated iron sheet; asbestos sheet or tiles can be utilized for harvesting the rainwater. Gutter and channels can be fixed on the edges of roof all around to collect and transport the rainwater from the roof to the storage tank. Gutters can be prepared in semi-circular and rectangular shapes. Locally available materials such as plain Galvanized Iron sheets can be easily folded to required shapes to prepare semi-circular and rectangular gutters. Semi-circular gutters of PVC materials can be readily prepared by cutting the PV pipes into two equal semi circular channels. Bamboo poles can be used for making gutters if they are locally available in sufficient quantity. Use of such locally available materials reduces the overall cost of the system. In flat roofs, rainwater drain pipes should be extended upto the bottom of the building. If no. of rain water drain pipes are more than one then they should be interconnected or connected separately to rainwater collection systems.

Methods of recharging subsurface aquifer:

- 6.1 Through recharge pit.
- 6.2 Recharge through abandoned hand pump.
- 6.3 Recharge through abandoned dug well/open well.
- 6.4 Through recharge trench.
- 6.5 Recharge through shaft.
- 6.6 Recharge trench with bore.

6.1 THROUGH RECHARGE PIT

This method is suitable where permeable strata is available at shallow depth. It is adopted for buildings having roof area up to 100 sq m. Recharge pit of any shape is constructed generally 1-2 m wide and 2-3 m deep. The pit is filled with boulders, gravel and sand for filtration of rain water. Water entering into the RWH structure should be silt free. Top layer of sand of filter should be cleaned periodically for better ingress of rain water into the sub soil. Details are shown in figure **A**.

6.2 RECHARGE THROUGH ABANDONED HAND PUMP

In this, an abandoned hand pump is used as a recharge structure. It is suitable for buildings having roof top area up to 150 sq m. Roof top rain water is fed to the hand pump through 100 mm dia pipe as shown in figure **B**. Water fed into the Rain Water Harvesting structure should be silt free. Water from first rain should be diverted to drain through suitable arrangement. If water is not clear then filter should be provided.

6.3 RECHARGE THROUGH ABANDONED DUG WELL / OPEN WELL

In this method, a dry / unused dug well can be used as a recharge structure. It is suitable for buildings having a roof top area more than 100 sq. m. Recharge water is guided through a pipe of 100 mm to the bottom of the well as shown in figure **C**. Well cleaning and desilting is imperative before using it. Recharge water guided should be silt free, otherwise filter should be provided as shown in the figure. Well should be cleaned periodically and chlorinated to control bacteriological contamination.

6.4 THROUGH RECHARGE TRENCH

This method is used where permeable strata is available at shallow depth. It is suitable for buildings having roof top area between 200 to 300 sq. m. In this, trench of 0.5-1.0 m wide, 1-1.5 m deep and of adequate length depending upon roof top area and soil characteristics should be constructed and filled with boulders, gravel and sand as shown in the figure **D**. Cleaning of filter media should be done periodically.

6.5 RECHARGE THROUGH SHAFTS

This method is suitable where shallow aquifer is located below clayey surface. It is used for buildings having roof top area between 2000-5000 sq. m. Recharge shaft of diameter, 0.5-3 m and 10-15 m deep is excavated mechanically. The shaft should end in impermeable strata. The shaft should be filled with boulders, gravel and sand for filtration of recharge water. Top sand layer should be cleaned periodically. Recharge shaft should be constructed 10-15 m away from the buildings for the safety of the buildings. The details are given in figure **E**.

6.6 RECHARGE TRENCH WITH BORE

This method is used where sub-soil is impervious and large quantity of roof water/ surface run off is available. In this, trench is made 1.5-3 m wide and 10-30 m length depending upon water availability. Wells of 150-300 mm. diameter and 3-5 m deep (below pervious layer) are constructed in the trench. No. of wells to be dug are decided in accordance to water availability and rate of ingress. Trench is filled with filtration media as shown in figure **F**. A suitable silt chamber is also inserted with grating for water diverting arrangements as shown in the figure.

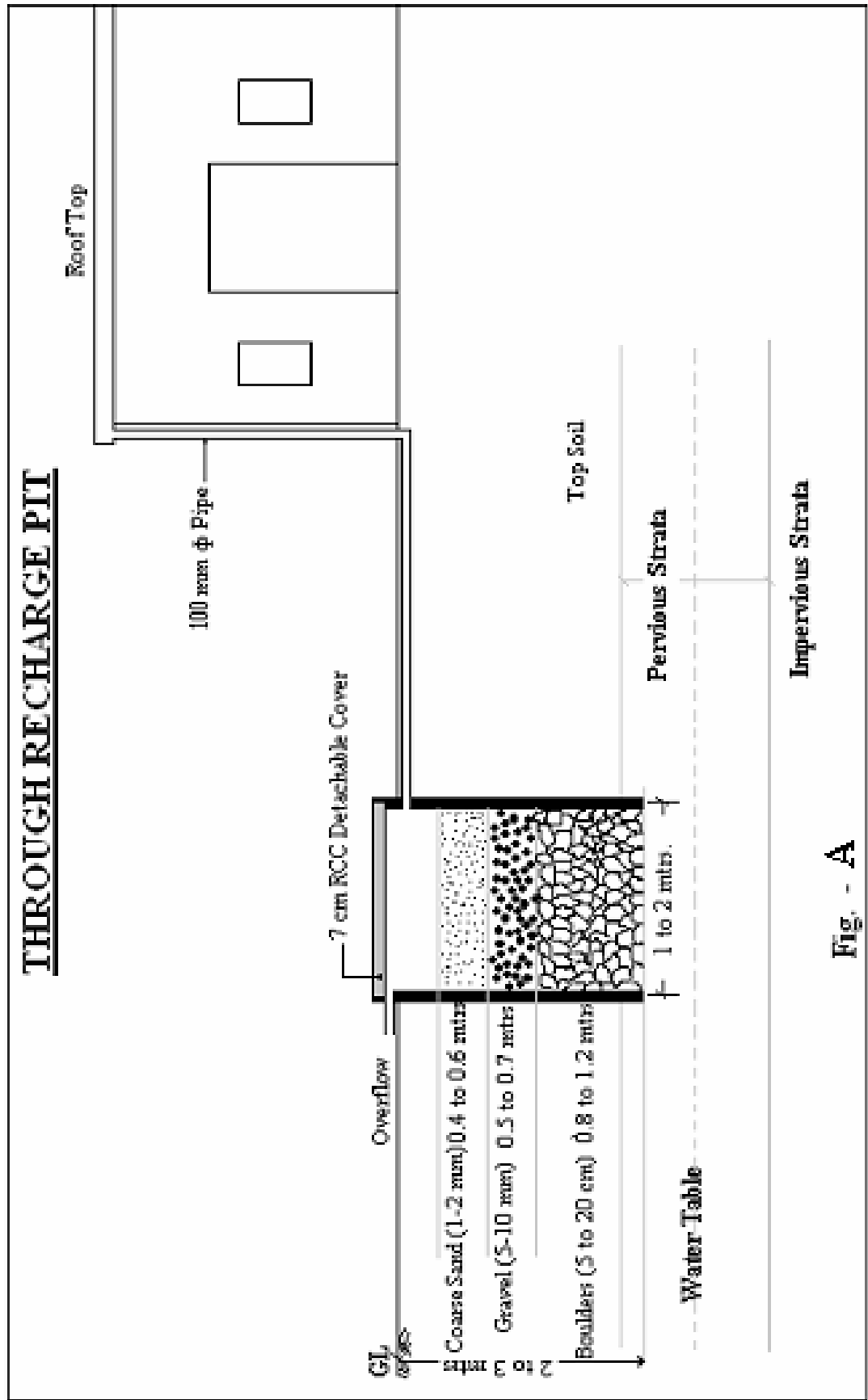


Fig. - A

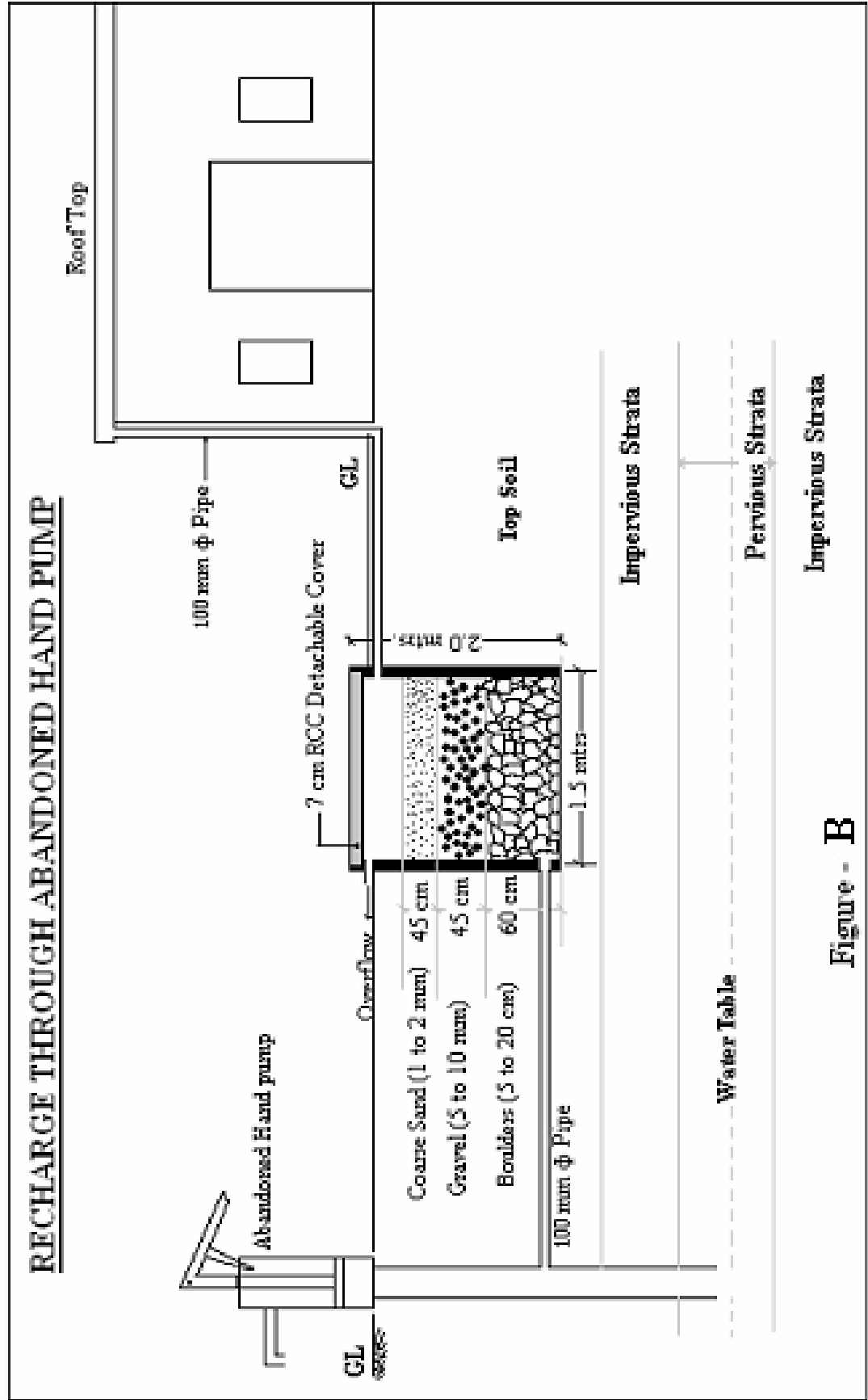


Figure - B

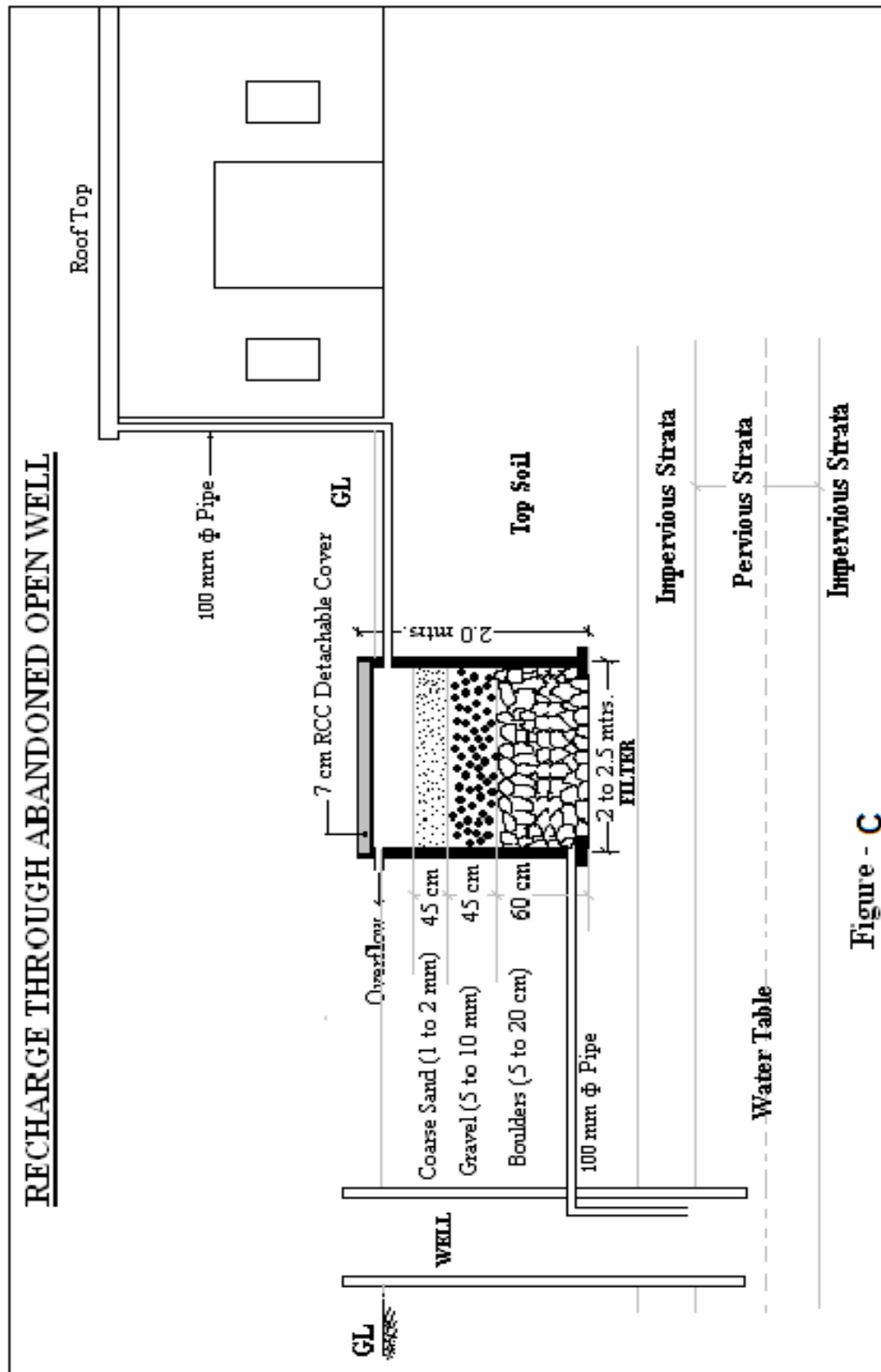


Figure - C

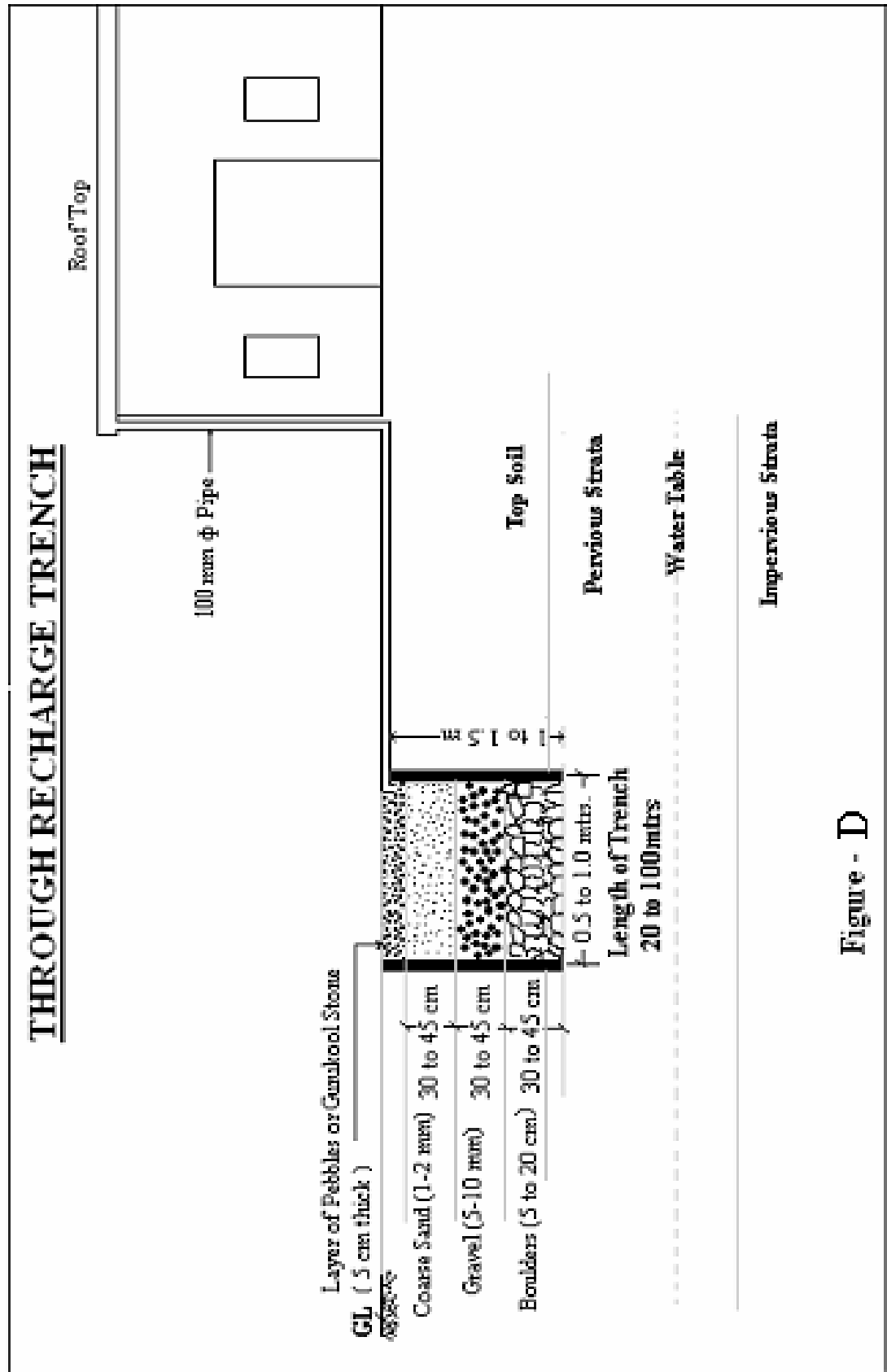
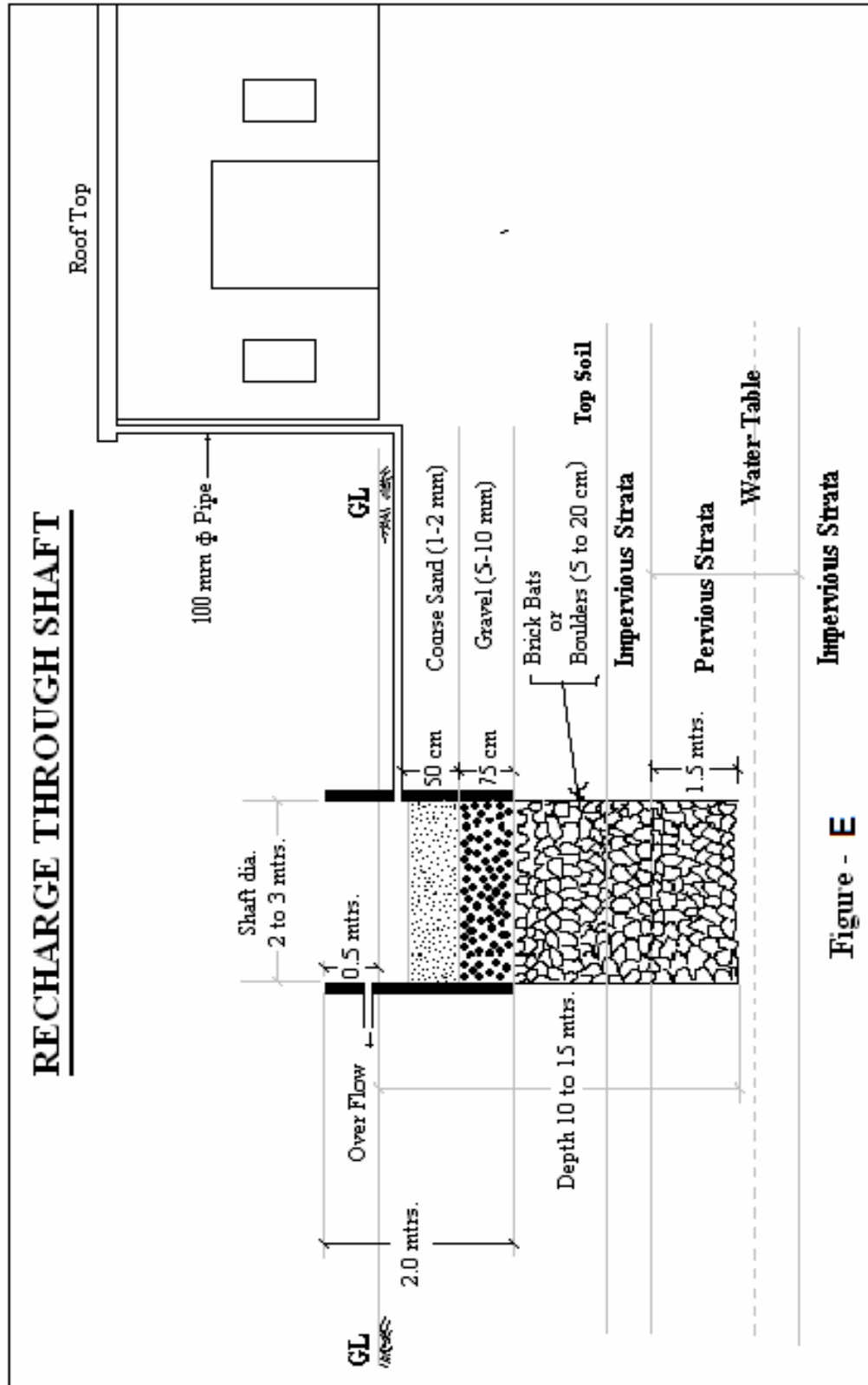


Figure - D



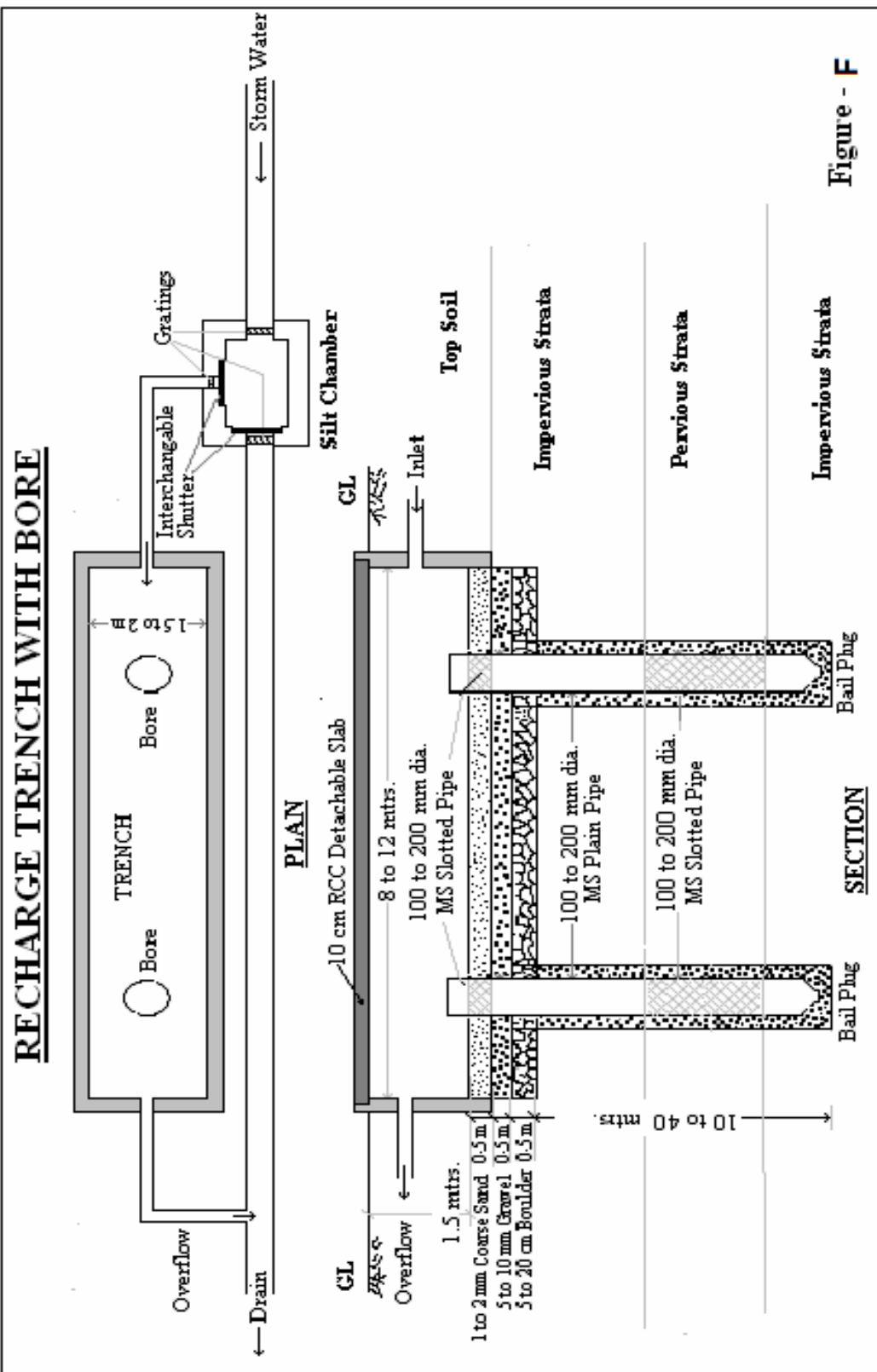


Figure - F

7 REFERENCES

7.1 Chairman, Central Ground Water Authority, vide his DO letter No. 29-5/CGWA/Meetings/MOWR/2003-853 dtd. 27-05-2003, copy enclosed as Annexure 2.14 assured for giving all technical help and guidance for rain water harvesting. This also gives the addresses of offices of Central Ground Water Board which may be contacted for such help.

7.2 Mannual on Rain Water Harvesting and conservation of consultancy services organization CPWD can also be referred for more details.

9. Replace Para 2.1 in Annexure 2.7 with -
“2.1 Provision of adequate slopes:
It is absolutely essential that roofs are provided with adequate slope to ensure effective drainage. The slope of roof should be such that the water gets drained off quickly by achieving adequate velocity under influence of gravity. Even areas with light rainfall will require adequate slope as continuous light drizzling without dry spell also effect roof leakage problem badly. A slope of 1 in 100 or steeper depending upon the type of water proofing system, is required for effective drainage.”

10. Para 308 of Chapter III is deleted.

11. Para 309 of Chapter III is deleted.

Annexure 2.10

Para 201(d)

DIMENSIONS FOR THE RESIDENTIAL BUILDINGS (Ref: NBC 1983)

- 1 HABITABLE ROOMS
 - Minimum plinth : 45 cm above road level
 - Minimum height(clear) : 3.00* m
 - Minimum ventilation : 1/12th of floor area for cold climate
 - : 1/10th of floor area for dry hot climate
 - : 1/8th of floor area for intermediate climate
 - : 1/6th of floor area for wet hot climate
 - Minimum size : 9.5 sqm
 - Minimum dimension : 2.4m
- 2 KITCHENS
 - Minimum size : 5.0 sqm
 - Minimum width : 1.80m
 - Minimum ventilation : 25% more than specified for item 1
- 3 KITCHEN & DINING
 - Minimum size : 7.5 sqm
 - Minimum width : 2.10 m
- 4 BATHROOM
 - Minimum size : 1.8 sqm
 - Minimum width : 1.2m
- 5 WATER CLOSET
 - Minimum size : 1.1sqm
 - Minimum width : 0.9 m
- 6 TOILET
 - Minimum size : 2.8 sqm
 - Minimum width : 1.2 m
- 7 Minimum height (For : 2.0 m
4,5, & 6)
- 8 STAIRCASE
 - Flight Width : 1.0 m
 - Minimum tread : 0.25m
 - Maximum riser : 0.19 m
 - Maximum riser/flight : 15 nos.
- 9 MINIMUM PARAPET
 - Minimum : 1.05 m
 - Maximum : 1.20 m

*NBC specifies as 2.75 m, however for railway residential buildings it is considered that it should be 3.00m

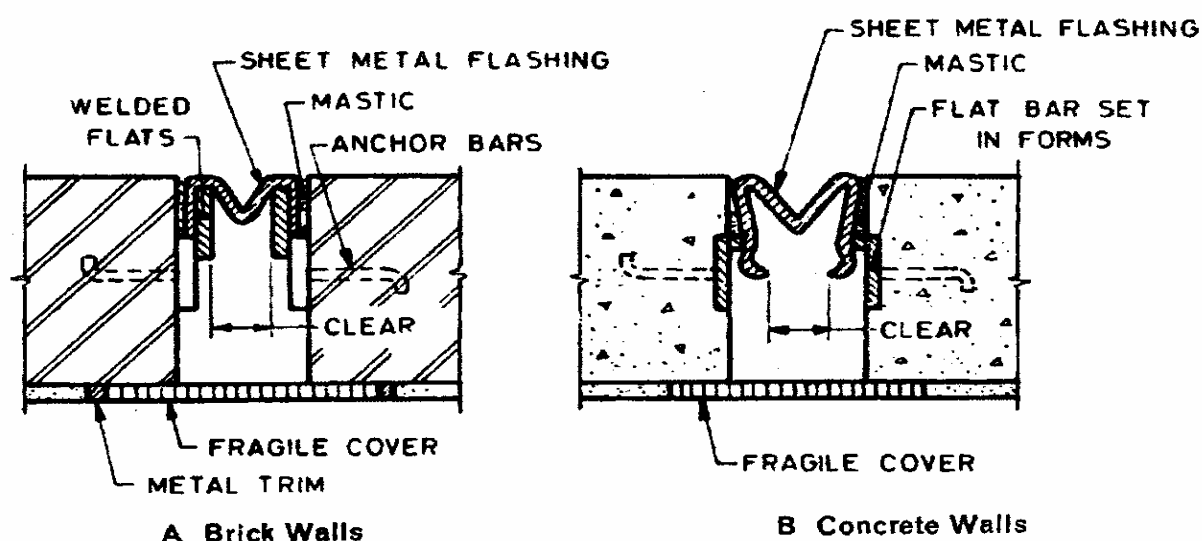
Annexure 2.11
Para 202(a)

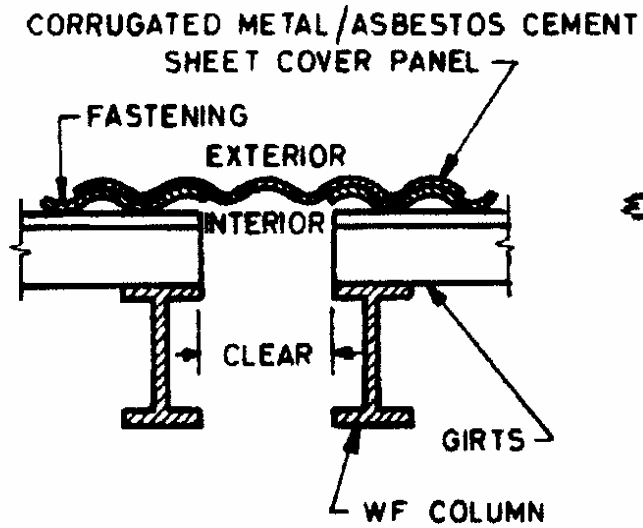
Representative Towns and different climatic zones

Hot & Arid Zone	Hot & Humid Zone	Warm & Humid Zone	Cold Zone
Agra	Ahmedabad	Cochin	Darjeeling
Ajmer	Asansol	Dwarka	Drass
Akola	Bhavnagar	Guwahati	Gulmarg
Aligarh	Bhuj	Puri	Leh
Allahabad	Bombay	Sibsagar	Mussoorie
Ambala	Calcutta	Silichar	Nainital
Bareilly	Calicut	Tezpur	Ootacamund
Bikaner	Cuttack	Trivadrum	Shillong
Gaya	Dohad	Veraval	Shimla
Jabalpur	Jamnagar		Skardu
Jaipur	Jamshedpur		Srinagar
Kanpur	Madras		
Khandwa	Madurai		
Kota	Mangalore		
Lucknow	Masulipatam		
Ludhiana	Midnapur		
Nagpur	Nellore		
Neemuch	Patna		
New Delhi	Rajkot		
Roorkee	Ratnagiri		
Sambalpur	Salem		
Sholapur	Surat		
Umaria	Tiruchichirapalli		
Varanasi	Vellore		
	Vishakhapatnam		

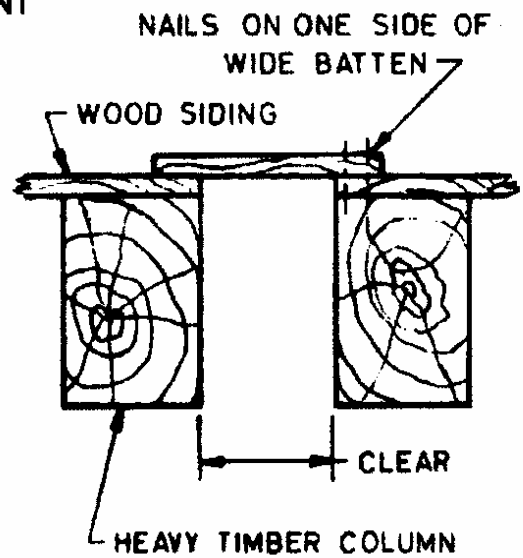
General Principles/Special features of Earthquake resistant buildings

- 1 Hospitals, control office buildings, water tanks and electrical sub-stations should be specifically designed to withstand highest probable earthquake forces with minor damages so that functioning of activities can continue unhampered.
- 2 **Lightness:** The building shall be as light as possible consistent with structural safety and functional requirements. Particularly, the roofs and upper storeys should be light.
- 3 **Continuity of Construction:**
 - 3.1 As far as possible the parts should be tied together in such a manner that the building acts as one unit.
 - 3.2 For parts of buildings between separation or crumple sections or expansion joints, floor slabs shall be continuous throughout as far as possible. Concrete slabs shall be rigidly connected or integrally cast with the support beams.
 - 3.3 During addition and alteration, provision of separate crumple section between new and existing structures shall be provided as far as possible, unless possible measures are taken to establish continuity between the existing and new construction.
 - 3.4 Typical details of few types of separation or crumple sections are shown below in figures A to G.

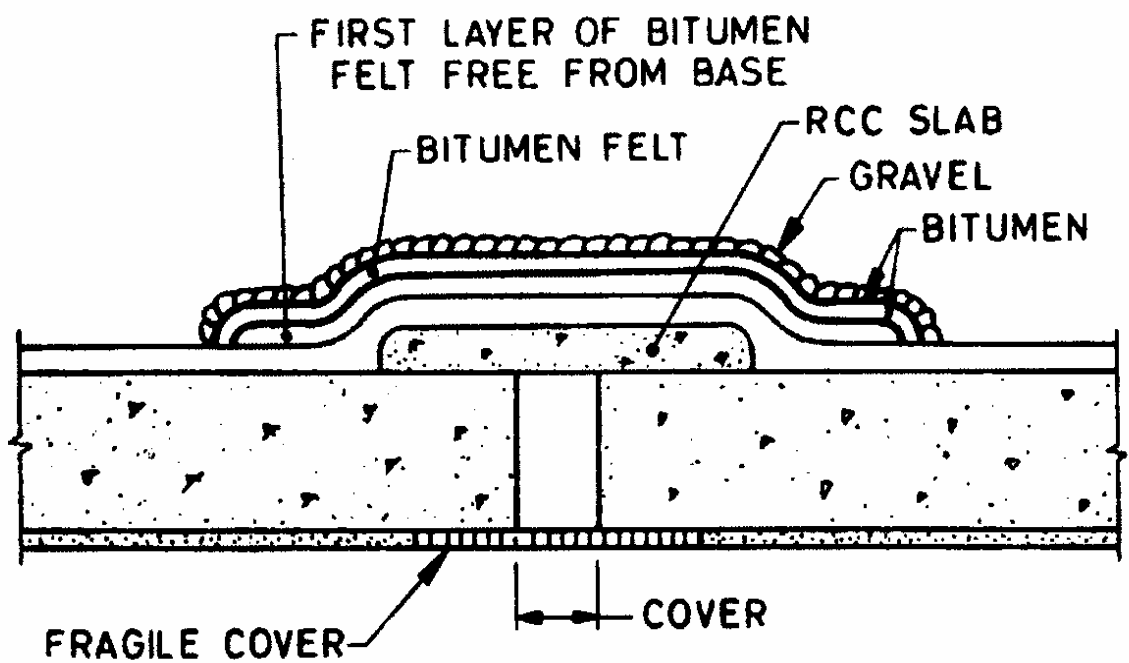




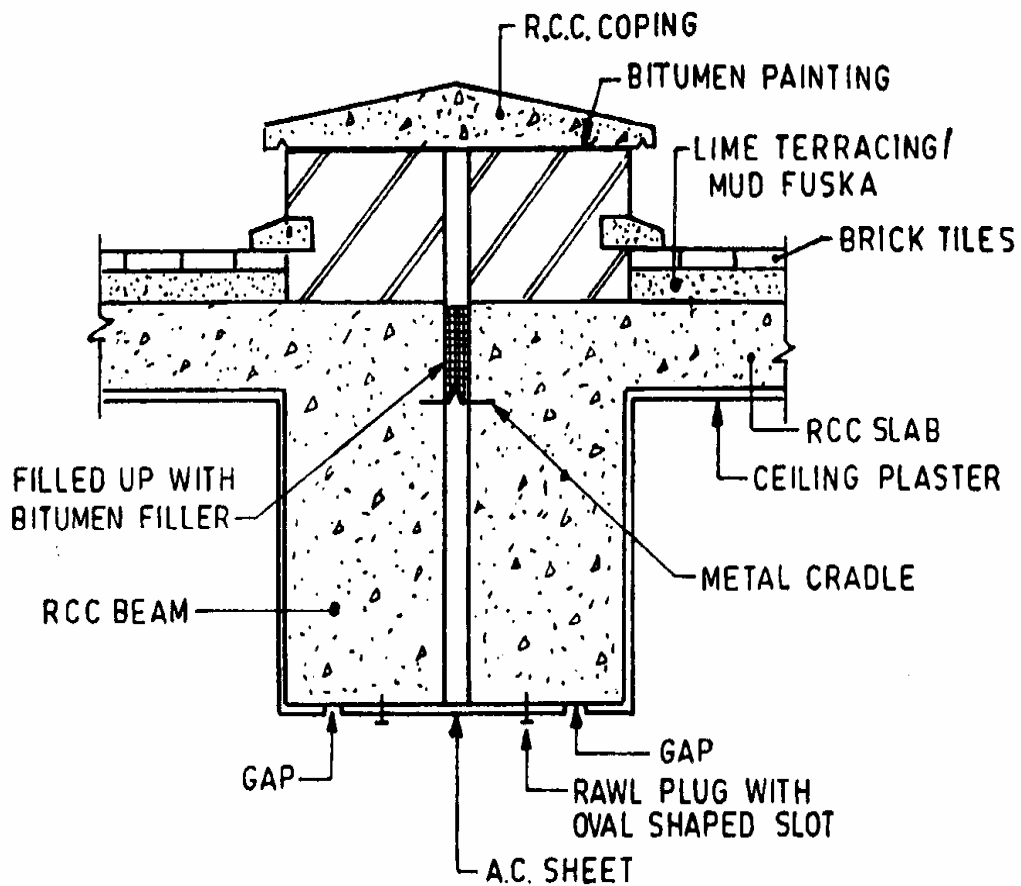
C Metal Siding Industrial Work



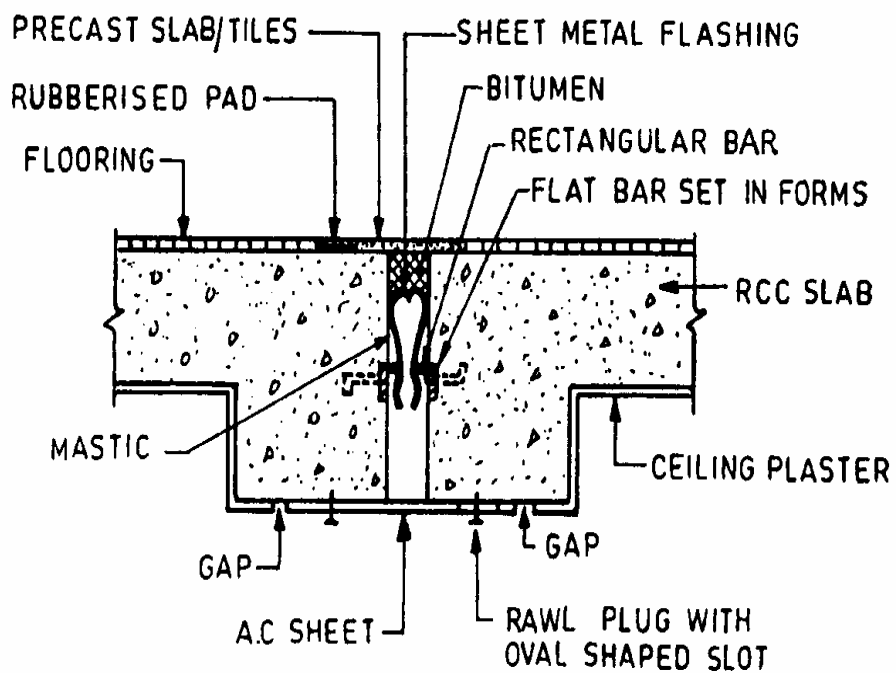
D Wood Sheathing Industrial Work



E RCC Slab on Roof Surface



F Separation Joint Details at Roof



G Separation at Floor Level

4 Projecting and Suspended Parts:

- 4.1 Projecting parts shall be avoided as far as possible. Otherwise, they should be properly reinforced and firmly tied to main structure. Their design shall be in accordance with IS 1893:1984.
- 4.2 Ceiling plaster shall preferably be avoided or shall be as thin as possible.
- 4.3 Suspension ceiling shall be avoided as far as possible or they shall be light, adequately framed and secured.

5 Building Configuration:

- 5.1 The building should be configured in such a manner so as to minimize torsion and stress concentration. The following provisions should be complied with to avoid such stresses.
- 5.2 The building should have a simple rectangular plan and be symmetrical both with respect to mass and rigidity, so that the centers of mass and rigidity coincide with each other and no separation section other than expansion joints are necessary. IS 3414:1968 may be referred for expansion of joints.
- 5.3 If symmetry of the structure is not possible in plan, elevation and mass, provision shall be made for torsional and other effects due to earthquake forces in the structural design. Otherwise parts of different rigidity may be separated through crumple section. The length of such building between separation sections shall not preferably exceed three times the width.
 - 5.3.1 Refer IS 4326:1993 for provision of minimum width of separation gap.
 - 5.3.2 For buildings of height greater than 40m, it will be desirable to carry out model or dynamic analysis of the structure in order to compute the drift at each storey, and the gap width between the adjoining structures shall not be less than the sum of their dynamic deflections at any level.
 - 5.3.3 Where separation is necessary, a complete separation of the parts shall be made except below the plinth level. The plinth beam, foundation beam and footings may be continuous. Where separation sections are provided in a long building, they shall take care of movement owing to temperature changes also.
- 5.4 Building having plans with shape like L, T, E and Y shall preferably be separated into rectangular parts by providing separation sections.
- 5.5 Any deviation or discontinuity in load transfer path results in poor performance of building. Building with vertical set backs, having fewer columns or walls in a particular story or with unusually tall

story should be avoided. Buildings on sloppy ground with unequal height of columns along slope cause ill effects like twisting and damage in shorter columns

6 Strength in various Directions:

- 6.1 The structure should be designed to have adequate strength against earthquake effects along both the horizontal axes. The design shall also be safe considering the reversible nature of earthquake forces.

7 Foundation:

- 7.1 For the design of foundations, the provisions of IS 1904:1986 in conjunctions with IS 1893:1984 shall generally be followed.
- 7.2 The structure shall not be founded on such loose soil which will subside or liquefy during an earthquake, resulting in large differential settlements.
- 7.3 The sub grade below the entire building shall preferably be of the same type of soil. Wherever this is not possible a suitably located separation or crumple section shall be provided.
- 7.4 Loose fine sand, soft silt and expansive clays should be avoided. In unavoidable circumstances, the building shall rest either on a rigid raft foundation or on piles taken to a firm stratum. However, for light constructions, foundation may rest on such a soil after improving the soil by sand piling or soil stabilizing.

8 Ductility:

- 8.1 The main structural elements shall be designed to have a ductile failure. This will enable the structure to absorb energy during earthquakes to avoid sudden collapse of the structures. Reinforcing steel should be provided in masonry in critical sections, which will not only increase the strength and stability but also the ductility. IS 13920:1993 may be referred for details.

9 Damage to non-structural parts:

- 9.1 Suitable details shall be worked out to connect the non-structural parts with the structural framing so that the deformation of the structural frame leads to minimum damage of the non-structural elements.

10 Roofs and Floors:

- 10.1 Flat roof or floor shall not preferably be made of terrace of ordinary bricks supported on steel, timber or reinforced concrete joints, nor these shall be of a type which is likely to be loosened or fall during earthquake. If this type of

construction cannot be avoided, the joists should be blocked at ends and bridged at intervals such that their spacing is not altered during an earthquake.

10.2 For pitched roofs, corrugated iron or asbestos sheets shall be used in preference to country, Allahabad or Mangalore tiles or other loose roofing units. All roofing materials shall be tied to supporting members. Heavy roofing materials shall generally be avoided.

10.3 Jack arch roofs or floors where used shall be provided with mild steel ties in all spans along with diagonal braces in plan to ensure diaphragms actions.

11 **Strengthening Arrangements and Bands:**

11.1 All masonry buildings are to be strengthened as per IS: 1893 - 1984. Lintel Band should be provided at lintel level and in all load bearing walls, panel walls as well as partition walls also. This will improve stability during severe earthquake.

11.2 R.C.C. roof bands should be provided immediately below the roofs or floors.

11.3 Gable band is provided at the top of gable masonry below the purlins.

11.4 Plinth band-cum-damp proof course is provided at plinth level of walls, on top of the foundation wall in cases where strip footing of masonry is used and soil is either soft or uneven in property. For details refer IS: 1893-1984.

12 **Staircases:**

12.1 The interconnection of the stairs with the adjacent floor should be appropriately treated by providing sliding joints at the stairs to eliminate their bracing effects on floors. Large stair halls shall preferably be separated from the rest of the building by means of separation or crumple section.

12.2 Three types of stair construction may be adopted, as below:

12.2.1 **Separated Staircases:** In this case, one end of the staircase rests on the wall and the other end is carried by columns and beams which have no connection with the floors. The opening between the floor and the staircase may be covered with some appropriate material which could crumple and fracture during an earthquake without causing structural damage. The supporting members, columns or walls are isolated from the roof by means of separation or crumple section.

12.2.2 **Built-in Staircases:** When stairs are built monolithically with floors, they can be protected against damage by providing rigid walls at the stair opening. Two walls enclosing the

staircase shall extend through the entire height of the staircase and building foundation

- 12.2.3 **Staircase with sliding joints:** In case it is not possible to provide rigid walls for built in stairs or to adopt separated stair case, the stair case shall have sliding joints so that they will not act as diagonal bracing.

The sketches on above types of staircases are shown below:

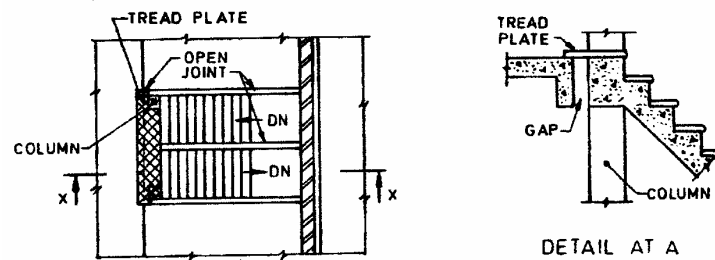
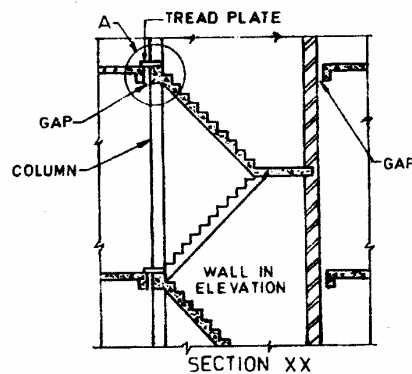


FIG. SEPARATED STAIRCASE

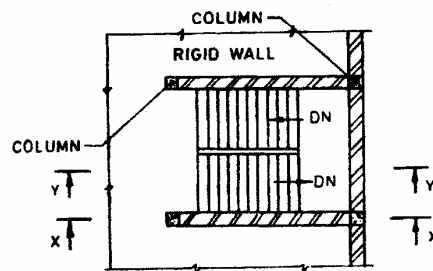
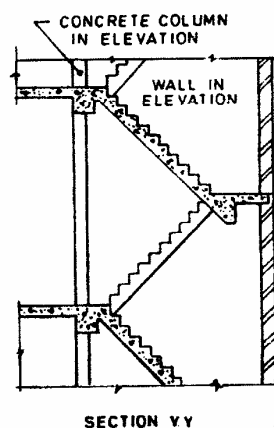
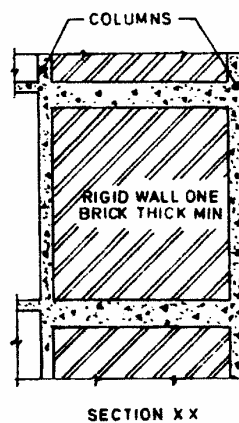


FIG. RIGIDLY BUILT-IN STAIRCASE

- 13 **Fire Safety:**
- 13.1 Fire frequently follows an earthquake and therefore, buildings should be constructed to make them fire resistant and in accordance with the provision of following IS code of fire safety – IS 1641:1988, IS 1642:1989, IS 1643:1988, IS 1644:1988 and IS 1646:1986.
- 14 **Seismic Retro fitting and Repair/Strengthening of Building:**
- 14.1 Many existing buildings do not meet the seismic strength requirements as per the provisions of codes due to original inadequacy in design of structure, material degradation over time or alteration carried out during the service life of the building.
- 14.2 There are two aspects of strengthening:
- (a) Retrofitting: i.e. strengthening of a weak building before hand so as to make it more strong to withstand seismic forces and,
 - (b) Repairs: Architectural repairs, Structural repairs and structural restoration of a building damaged during an earthquake.

Retro fitting and Repairs vs. Rebuilding: It is very important to know about the criteria for taking a decision whether to dismantle and rebuild a damaged structure/building or to do repairs/seismic retrofitting.

As per the IS 13935 “Repair and seismic strengthening of building –Guidelines” para 5.4.1 the thumb rule is “If the cost of repairs or seismic retrofitting is less than 50% of the rebuilding cost, only then the repair/retrofitting is adopted”.

A flow chart has been developed, which can be used as a guide towards decision making in case of seismic repair/retrofitting.

Materials: Common materials used in repairs/retrofitting are cement, sand, coarse aggregate and steel. However, shot-crete (cement mortar/ concrete conveyed through a hose under high velocity), Epoxy Resins, Epoxy mortar (for large void space), quick setting cement mortar, mechanical anchors and welded wire mesh etc. are also used depending upon the parameters such as type of requirements, cost time etc.

15 Retrofitting of the Existing weak buildings:

- 15.1 **Roof:** Tiled roof can be replaced by AC/CGI sheets. False ceilings of non-brittle material and light materials can be provided. Roof truss should be braced by providing horizontal, vertical and inclined diagonal bracings. Diagonal angle iron can be fixed between timber post and beam to strengthen the joint. Anchors of the roof truss with the walls should be provided. Flat iron bars with bearing running through the supporting joists of jack arch roof should be used in case of jack arch roof. Diagonal bracing in plan should also be provided.
- 15.2 **Walls:** New walls can be provided with proper bonding with the existing walls in case of unsymmetrical buildings. The new walls should be provided with horizontal reinforcements which should be anchored to the existing walls. An existing wall can be strengthened to improve the lateral strength of the building by grouting, by using wire mesh reinforcements and by prestressing. Large arch opening in the walls can be strengthened by steel ties at springing level or by an R.C.C. lintel above the arch.
- 15.3 R.C.C. beams and columns can be strengthened by casing. This can be done by encasing with additional new longitudinal and lateral (stirrup) steel bars. In case of beam and slabs system, holes may be drilled through the beam and floor.
- 15.4 Foundation can be strengthened by introduction of new load bearing walls, improving the drainage of the area by preventing saturation of foundation soil, provision of apron around the building and adding R.C.C. strips to the existing foundation of the building.
- 15.5 Seismic belts, both horizontal and vertical type can be provided at the corners, around openings and at the lintel levels by using wire mesh strip of width more than 40 cm. This is splint and bandaging technique.

16 Repairs to the earthquake damaged buildings:

After a severe earthquake, a detailed damage assessment shall be conducted as soon as possible to assess and decide whether the building/structure can be repaired economically and made habitable, or whether the same should be abandoned and dismantled partly or fully. Survey should be conducted in each building by using the forms for a quick assessment of the damages. Three types of repairs viz. Architectural repairs,

Structural repairs and Structural restoration, are generally adopted depending upon various guiding factors.

16.1 **Architectural Repairs:** It consists of patch repairs to superficial defects such as plastering, repairs to doors and windows, redecorations etc. as detailed below:

16.1.1 Patching up of defects such as cracks and fall of plaster.

16.1.2 Repairing doors, windows, replacement of glass panes.

16.1.3 Checking and repairing electric conduits/wiring.

16.1.4 Checking and repairing water pipes, drainage and plumbing services.

16.1.5 Rebuilding non-structural wall, smoke chimneys, parapet walls etc.

16.1.6 Re-plastering of wall as required

16.1.7 Rearranging disturbed roof tiles;

16.1.8 Rebuilding cracked flooring at ground level; and

16.1.9 Redecoration – white washing, paintings etc.

16.1.10 These repair do not restore the original strength of the structure.

16.2 **Structural Repairs:** This includes –Rebuilding cracked walls, damaged roofs, repair of pillars etc. The repair is generally carried out as detailed below:

16.2.1 Remove only those portions of masonry walls and piers which are cracked and then rebuild that portion.

16.2.2 Bolting/spiking of wire mesh on both side of a cracked wall and then covering with cement mortar/micro concrete

16.2.3 Cement/Epoxy grouting of cracks.

16.2.4 Repairs of RCC by epoxy grouting, shotcrete / jacketing.

16.2.5 The structural repair work can restore the lost strength only partly. The structure remains permanently weakened.

16.3 **Structural Restoration:** This includes adding strength to the weakened/damaged building to restore the lost strength. Due to earthquake, a building may develop any one or more combination, the following:

16.3.1 Minor cracks

16.3.2 Major cracks and crushed concrete

16.3.3 Fractured or excessive yielded or buckled reinforcements and

16.3.4 Fractured timber members.

Methods of their structural restoration are indicated as under:

- 16.3.1 Minor cracks (cracks 0.50mm to 5mm): Minor cracks can be repaired by injecting low viscosity epoxy resins through ports in the cracks after the cracks are sealed by use of epoxy sealant. Cement water mixture (1:1) can also be used after the cracks are cleaned by injecting water in it.
- 16.3.2 Major cracks (cracks more than 5 mm) and crushed concrete. After removing the loose materials, the expansive cement mortar/quick setting cement can be used. Steel wire mesh nailed to the wall can be provided outside and covered with plaster (1:2)
- 16.3.3 Fractured /yielded/ buckled reinforcements: The new steel should be welded to the old ones. Additional stirrup steel should be used and additional longitudinal bars can also be anchored in a hole drilled in the member.
- 16.3.4 Fractured timber members: After removing the rotten wood, splice should be nailed and preferably be covered with steel straps nailed to the member.

If the execution is done properly, then after the structural restoration, the building will be as strong as new.

- 17 Seismic Retro fitting and Repair/Strengthening of Building are specialized job. Therefore, services of an architect/ consultant may be availed of for carrying out these repairs.

Sample Plans

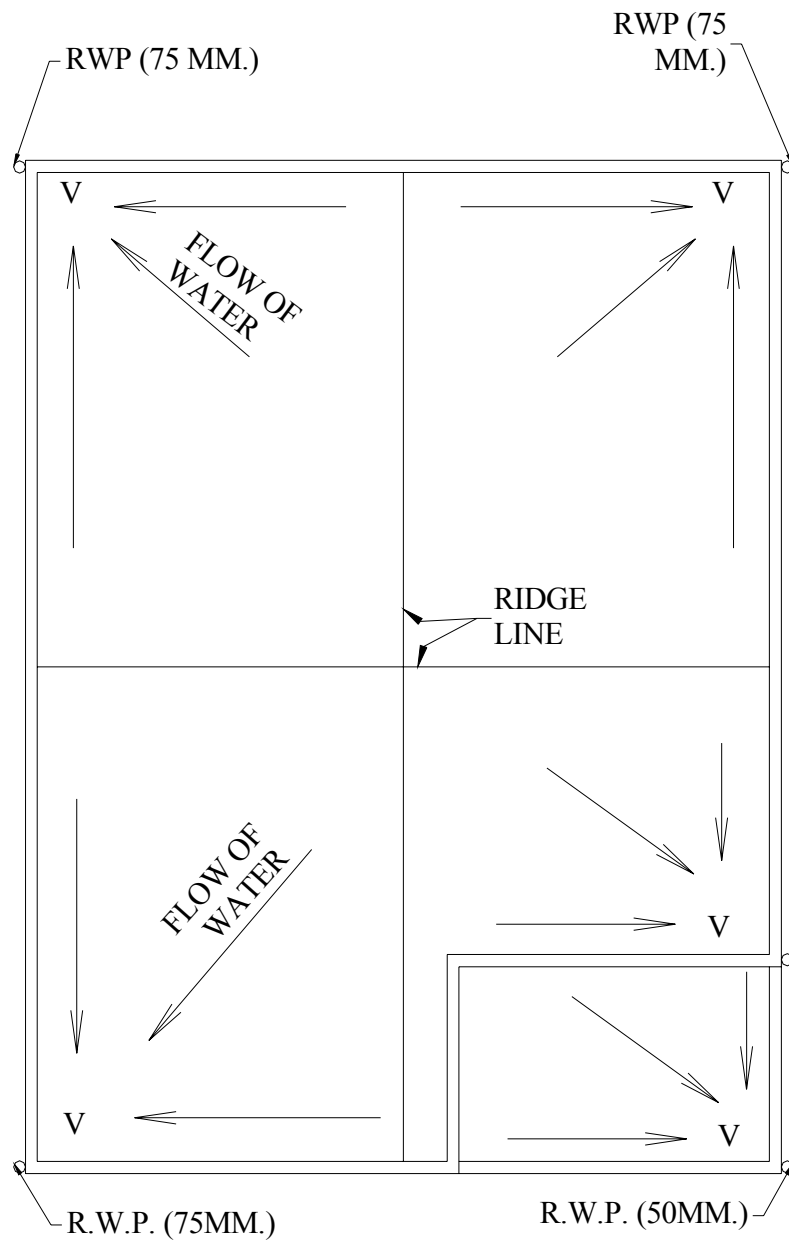
Fig. 1 - Roof plan showing terracing with slopes, water proofing and water outlets.

Fig. 2 & 3 - Detailed larger size plans of toilets and kitchens indicating the location and type of fittings and treatment on floor and walls.

Fig. 4 - Plan showing layout of furniture and furnishing and their type.

Fig. 5, 6 & 7 - Sanitary fittings, drainage and sewage plan, plumbing details.

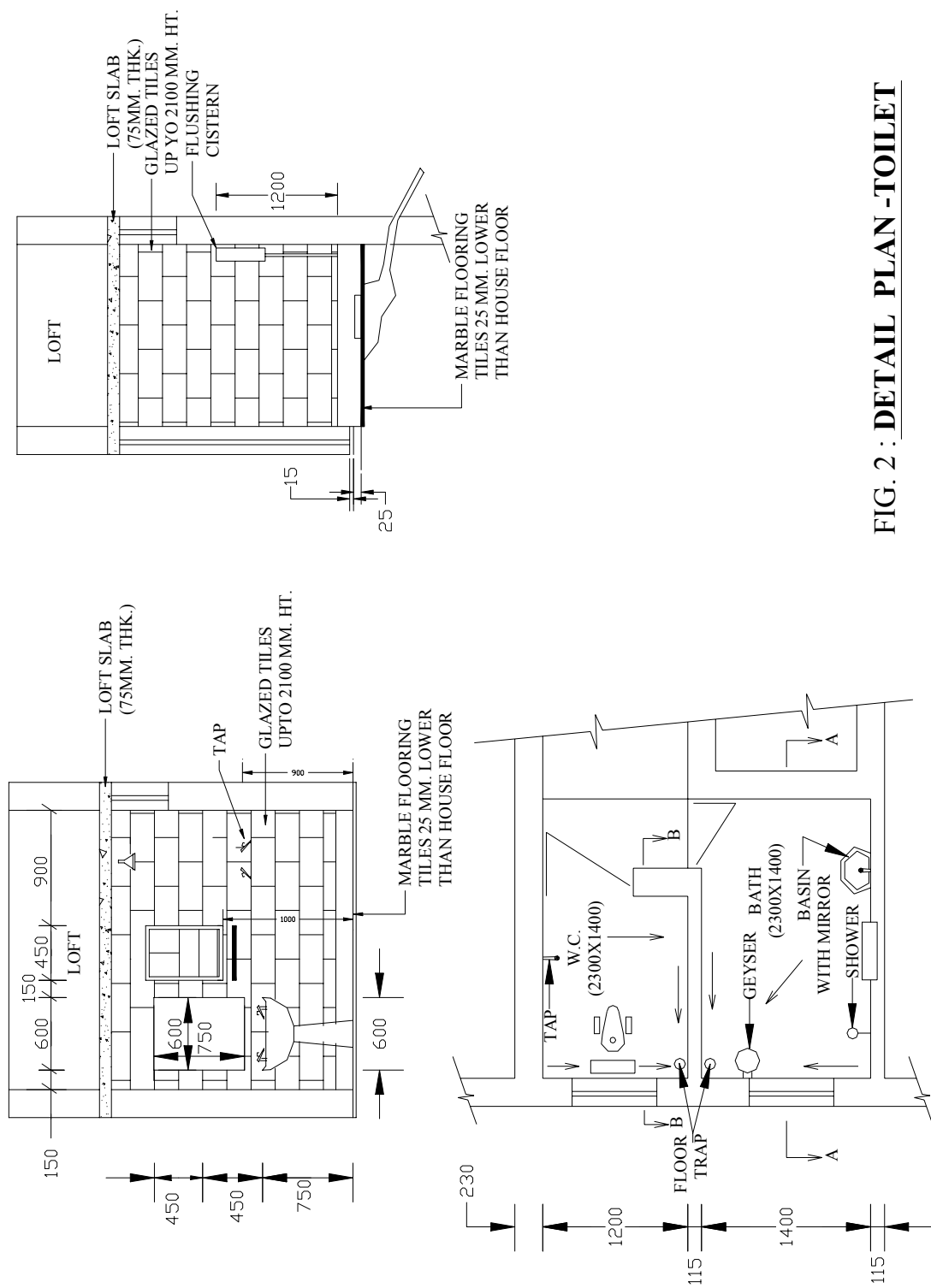
Fig. 8 - Electrical wiring plans.

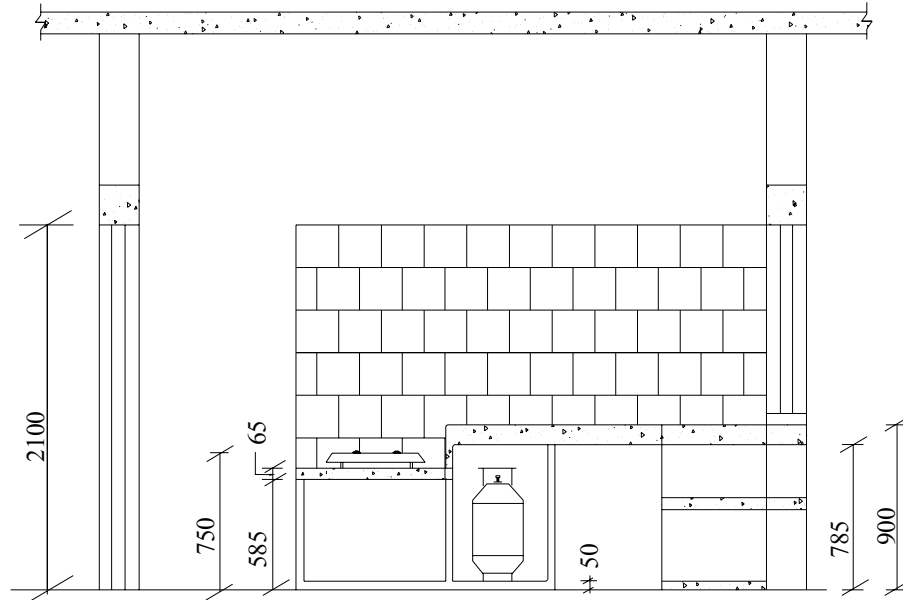


NOTES :-

1. RAIN WATER FLOW DIRECTION.
2. ALL SLOPES 1 IN 80.
3. RWP - (75MM.) = RAIN WATER
PIPE DIA. = 75 MM.
4. V = VALLEY

Fig. 1 : ROOF DRAINAGE PLAN





SECTION AT C-C

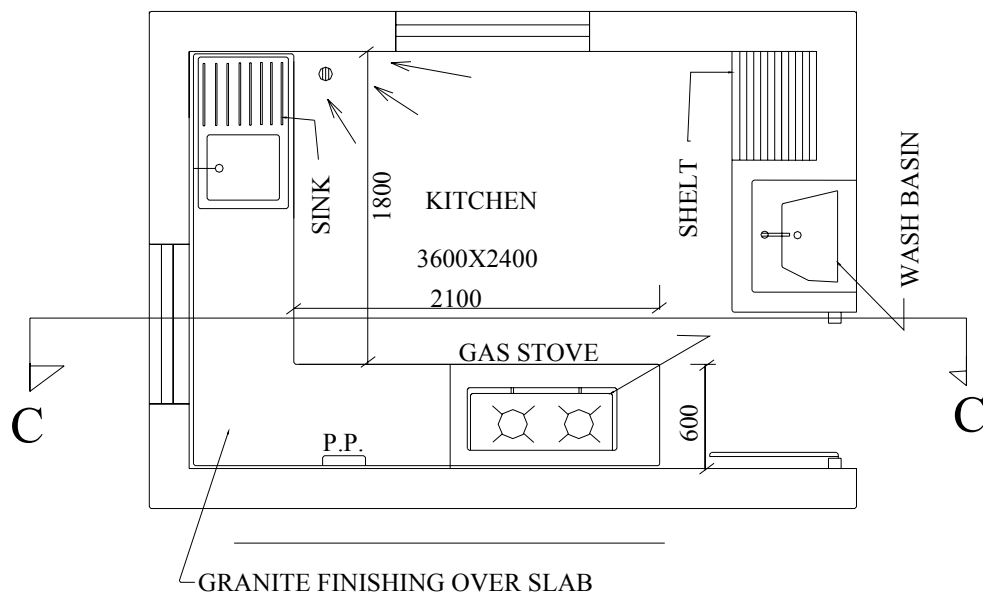
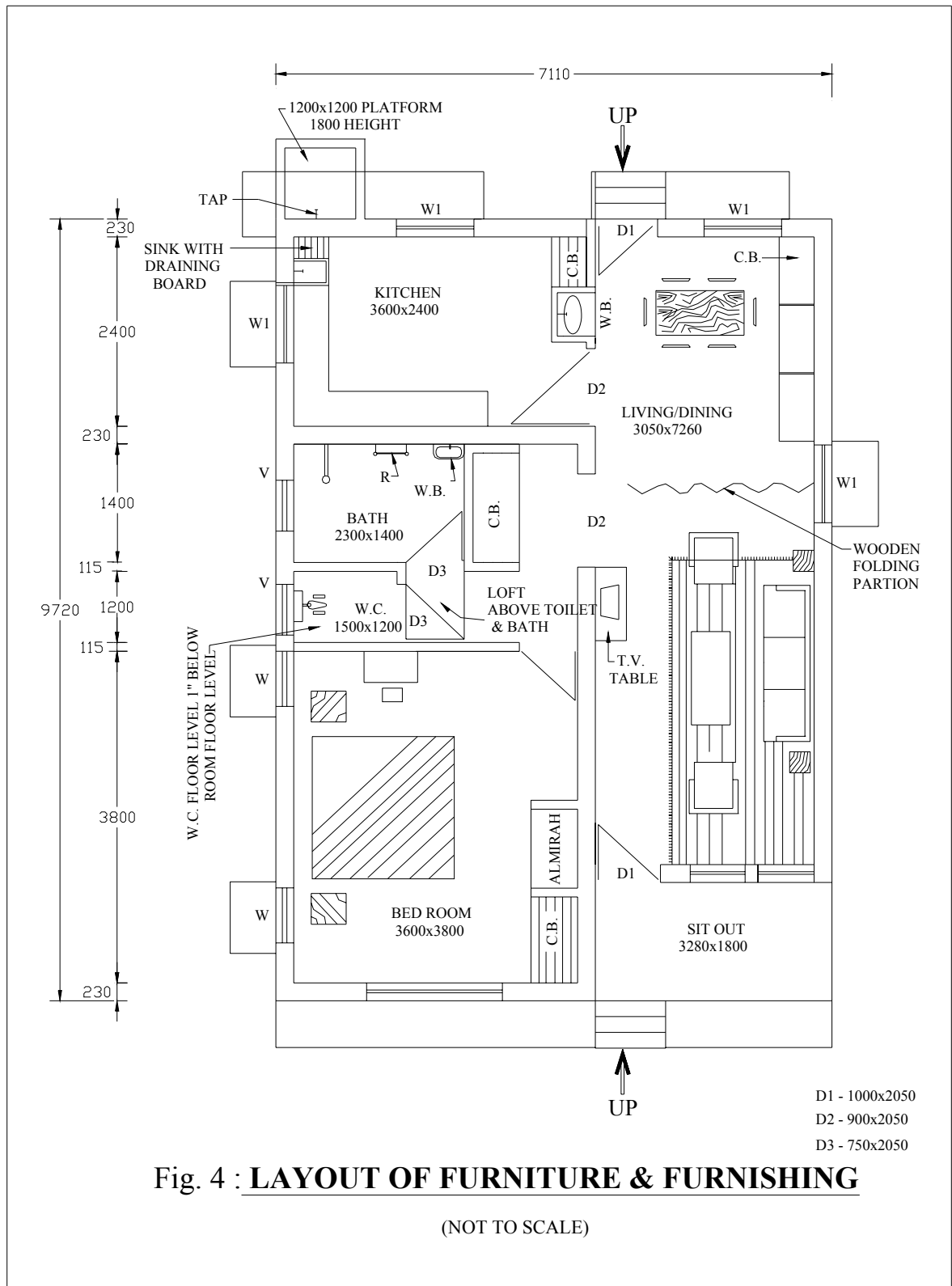


FIG. 3 : DETAIL PLAN OF KITCHEN



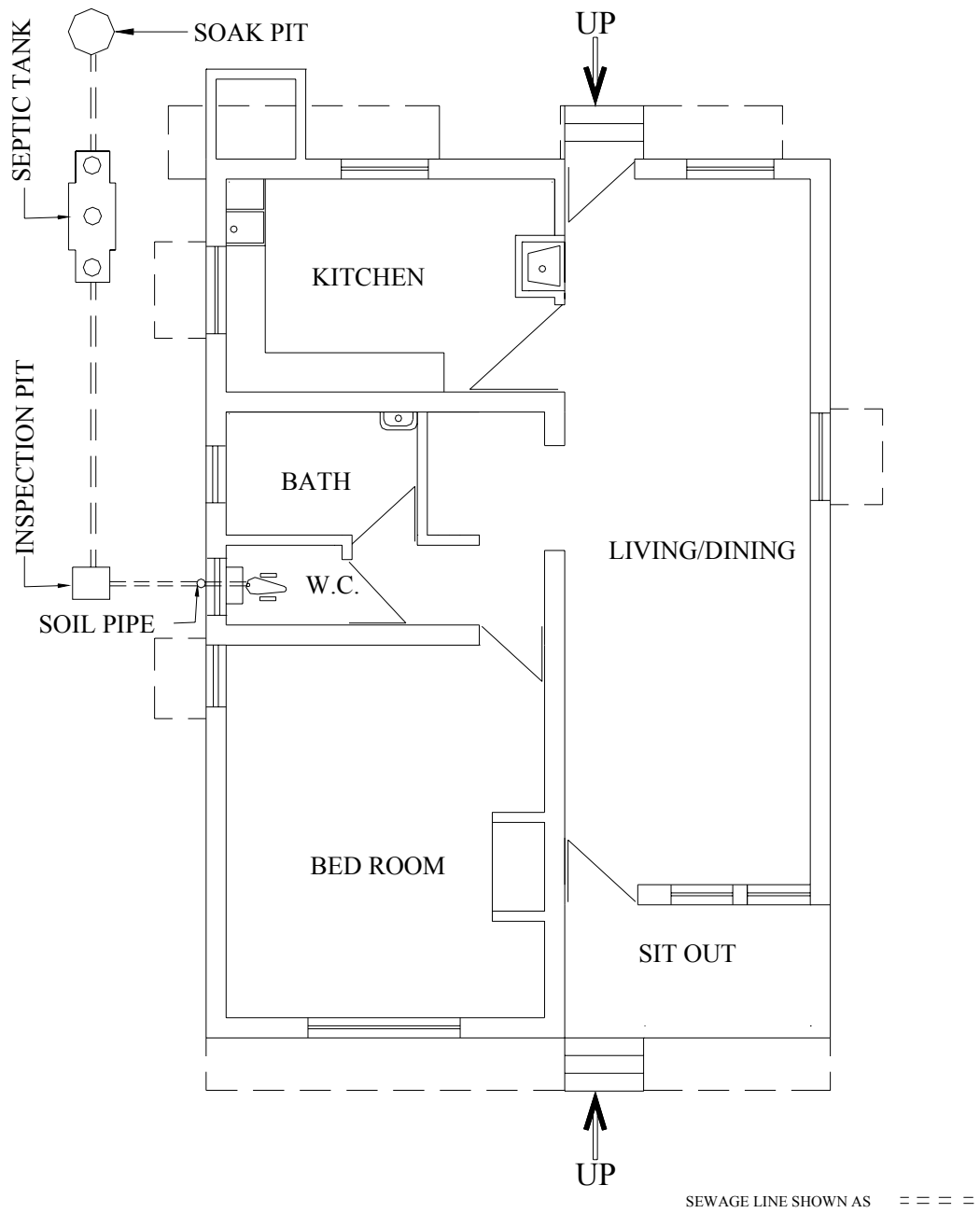


Fig. 5 : SEWAGE LINE PLAN

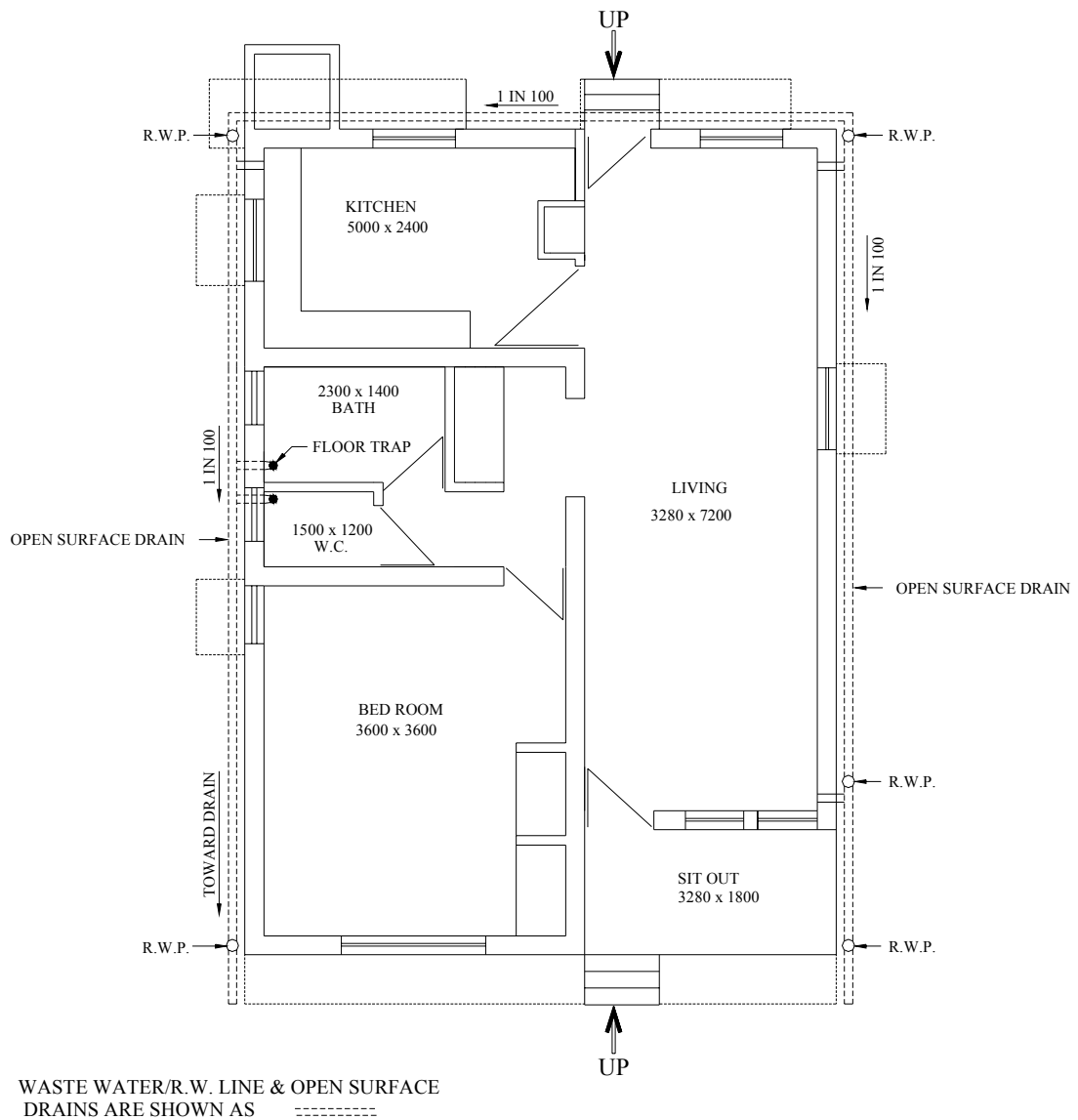
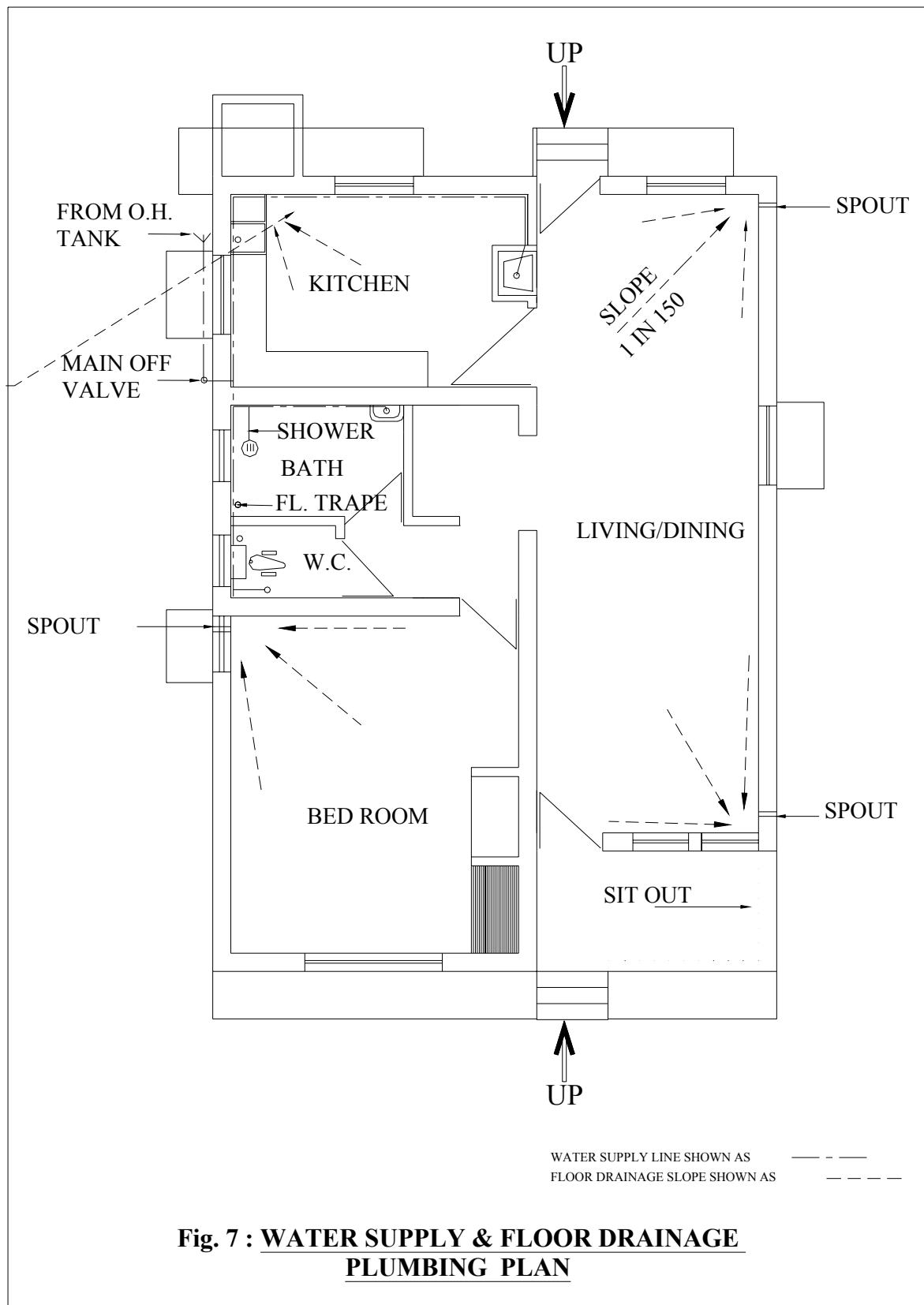


**Fig. 6 : WASTE WATER / R.W. LINE
&
OPEN SURFACE DRAIN PLAN**
(NOT TO SCALE)



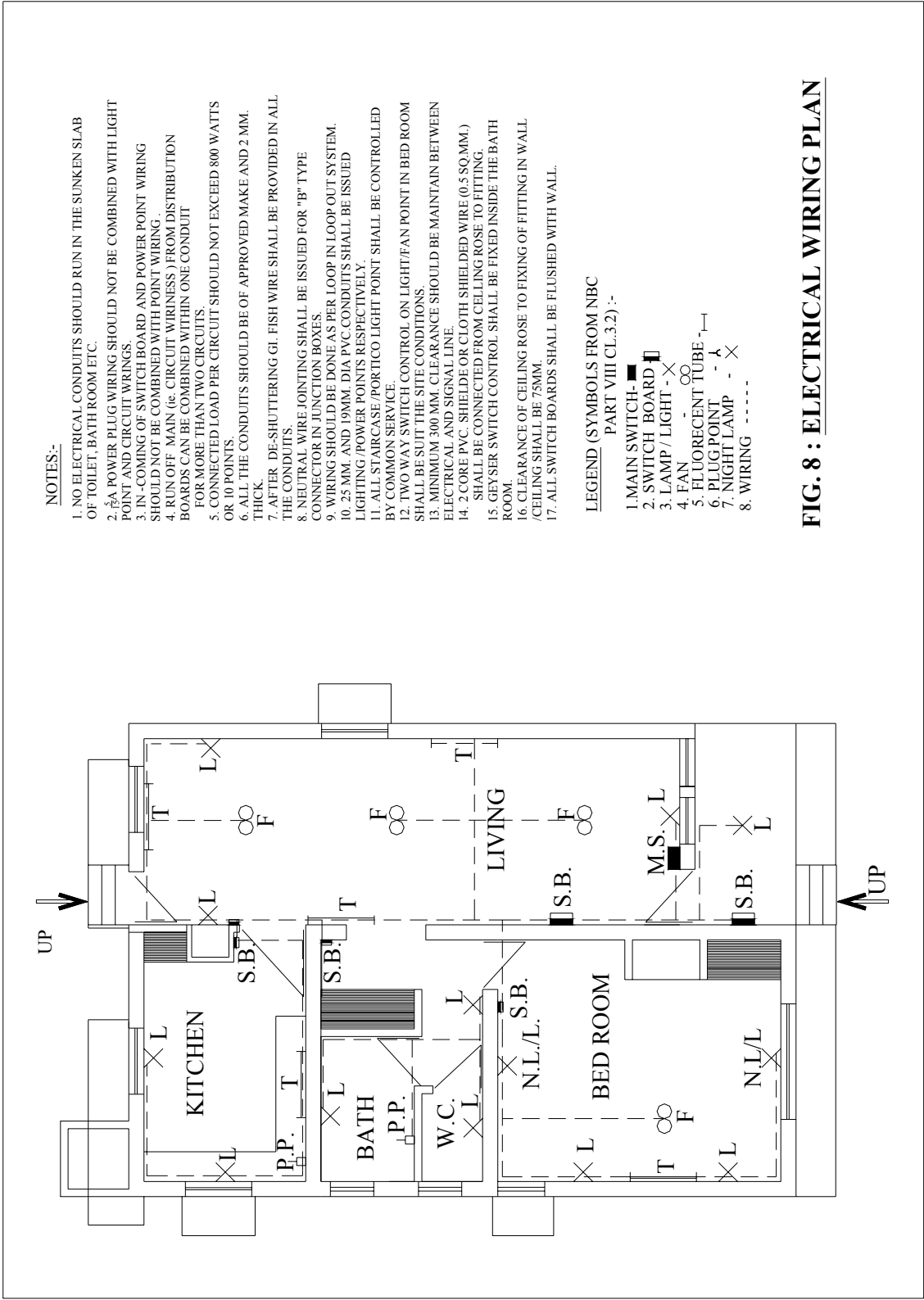


FIG. 8 : ELECTRICAL WIRING PLAN

Annexure 2.14
Para 204(c)

S.S. Chauhan
Chairman

Government of India
Central Ground Water
Authority
Ministry of Water Resources

D.O. No.29-5/CGWA/Meetings/MOWR/2003-853

Dated 27-05-2003

**Sub: Adoption of Rain Water Harvesting System
in the Railway Establishments**

Dear Shri Raina,

Ground Water has been the mainstay for meeting water supply requirements. However, growing demand for agriculture, industries and urban areas has led to over development of this resource resulting in substantial decline in ground water levels and deterioration in its quality threatening the sustainability of this resource. Through rain water harvesting measures to utilize the surplus monsoon runoff which otherwise goes to waste. Central Ground Water Board has taken up several rain water harvesting pilot projects in different hydrogeological and agro-climatic set ups and has proved the efficacy of rain water harvesting techniques to augment ground water resources.

The establishments under your control are having buildings having large roof area and open areas where these techniques can be fruitfully implemented. I shall request you to kindly advise your offices to take steps for adoption of rain water harvesting systems for sustainable management of ground water resources. Central Ground Water Board, having its offices in all the states offers to provide technical guidance in this regard. A list of offices and their addresses is enclosed for ready reference.

With regards,

Yours sincerely,

Sd/-
(S.S. Chauhan)

<p>The Regional Director Central Ground Water Board Northern Region Bhujal Bhawan Sector-B, Sitapur Road Yojna Ram Ram Bank Chau Lucknow-226021 (U.P.) Ph: 2363812 Fax: 2361177</p>	<p>The Regional Director Central Ground Water Board West Central Region Swami Narain College Building Shah Alam Tolnaka Ahmedabad – 38022 (Gujarat) Ph: 25320476 Fax: 25329379</p>	<p>The Regional Director Central Ground Water Board North Central Chhattisgarh Region 2nd floor, Reena Apptt. NH 43, Dhamtari Road Panchpadi Naka, Raipur-492001 Ph: 2413687 Fax: 2413687</p>
<p>The Regional Director Central Ground Water Board North Eastern Region Tarun Nagar, Bye Lane-1 Near Rajiv Bhawan Guwahati-781005 (Assam) Ph: 2456298 Fax: 2455497</p>	<p>The Regional Director Central Ground Water Board Central Region N.S. Building, Civil Lines Nagpur-440001 (Maharashtra) Ph: 2534314 Fax: 2534391</p>	<p>The Regional Director Central Ground Water Board South Western Region 31st Cross, 11th Main Block 4, Jayanagar Bangalore-560011 (Karnatak) Ph: 26631336 Fax: 26348442</p>
<p>The Regional Director Central Ground Water Board Southern Region 3-6-291, Sadhana Building 1st floor, Hyderguda Hyderabad-500029(A>P.) Ph: 23222873 Fax: 23222873</p>	<p>The Regional Director Central Ground Water Board Kerala Region Kedaram, Kesavadasapuram Trivendrum-695004 (Kerala) Ph: 2442191 Fax: 2442191</p>	<p>The Regional Director Central Ground Water Board Northern Himalayan Region House No.3 (HIG) H.P. Housing Board Colony Kangra (H.P.) Ph: 227171 Fax: 223535</p>
<p>The Regional Director Central Ground Water Board North Western Region S.C.O. – 3, Sector 26 Chandigarh –160026 Ph: 790980 Fax: 790980</p>	<p>The Regional Director Central Ground Water Board North Central Region Block-1, 4th floor, Paryawas Bhawan Area Hills, Jail Road Bhopal – 162011 (M.P.) Ph: 2557639 Fax: 2760090</p>	<p>The Regional Director Central Ground Water Board Uttaranchal Region Ankitpuram General Mahadev Singh Road Dehradun – 248001 Ph: 2729533 Fax: 2722709</p>
<p>The Regional Director Central Ground Water Board Eastern Region 'Bhujaiika', Sector-V, C.P. Block-6, Bidhan Nagar Kolkata – 700091 (W.B.) Ph: 23673081 Fax: 23673081</p>	<p>The Regional Director Central Ground Water Board North West Himalayan Ruby Shopping Complex Sanjay Nagar Jammu-180001 (J&K) Ph: 2451626 Fax: 2451626</p>	<p>The Regional Director Central Ground Water Board Western Region 6-A, Jhalna Doongri Jaipur-302004 (Raj.) Ph: 2706991 Fax: 2706991</p>
<p>The Regional Director Central Ground Water Board South Eastern Region Bhujal Bhawan Khandagri Chowk NH-IV Bhubaneswar, Orissa-751030 Ph: 2350332 Fax: 2350332</p>	<p>The Regional Director Central Ground Water Board Middle East Region Lok Nayak Bhavan, 68th Floor Dak Bunglow Chowk, Patna-1 Ph: 2231785 Fax: 231020</p>	<p>The Regional Director Central Ground Water Board South East Coastal Region E-Wing, G-Block Rajaji Bhawan, CGO Complex Besant Nagar, Chennai-600090 Ph: 24914334 Fax: 24914334</p>
<p>Officer Incharge Central Ground Water Board Jamnagar House Mansingh Road, New Delhi Ph: 23384355 Fax: 23386743</p>	<p>Officer Incharge Central Ground Water Board 1 Keating Road, Opp. Assam Secretariat Building Shillong (Meghalaya) Ph: 2223348 Fax:</p>	<p>Officer Incharge Central Ground Water Board 64 Polo-I Paota Jodhpur-342006 (Raj.) Ph: 2747614 Fax:</p>
<p>Officer Incharge Central Ground Water Board North Karnataka Unit 4642-B-16, 2nd Main 2-A Cross, Sadashiv Nagar Belgaum 590 001 Ph: 2470959 Fax: 2473160</p>	<p>Officer Incharge Central Ground Water Board Dhaleshwar Road, No.11 Agartala-799007 (Tripura) Ph: 2325876 Fax: 2303099</p>	<p>Officer Incharge Central Ground Water Board 14A Sea Sanda Andhra University Campus Vishakapatnam-530003 Ph: 2707870 Fax: 2768018</p>
<p>Officer Incharge Central Ground Water Board 21711, Deccan College Road Yervada, Pune – 411006 (MS) Ph: 2663905 Fax: 2347651</p>		