आज़ादी का अमृत महोत्सव

भारत सरकार **Government of India**
रेल मंत्रालय **Ministry of Railways**
(रेलवे बोर्ड **Railway Board)**

Azadi Ka Amrit Mahotsav

No. 2024/CE-I/ACS-12/IRWM

New Delhi, dated:13.08.2024

To,
As per list attached.

Sub: Indian Railway Works Manual, 2000 (Advance Correction Slip No.12)

1. Please find enclosed herewith Advance Correction Slip No. 12 to Indian Railway Works Manual, 2000.

2. This issues with the approval of Board (MI).

DA: As above (18 pages)

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(गौरव)

निदेशक सिविल इंजी.(जी)/रेलवे बोर्ड

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CHAPTER-VI

D. STATION YARD DRAINAGE

633 Introduction

The drainage system for station yards is critical for satisfactory maintenance of track and proper functioning of track circuits. Water from various sources, such as rain, washable apron, carriage washing hydrant, water booths, platform surfaces etc., or any other nearby source, must be effectively drained out.

Effective drainage systems prevent water accumulation that could potentially damage the infrastructure and cause operational delays. Therefore, designing an efficient drainage system suitable for each yard's unique layout is essential for optimal performance as well as safety of P. Way.

634 Design Concept for Yard Drainage Systems

A. General Approach

1. For existing yards as well as new yards being constructed, the yard layout, centre to centre distance between tracks and topography of the yard location vis-a-vis adjacent area varies from one yard to another yard. Thus, it may not be possible to exactly stipulate single yard drainage system which can be used for all the yards.
2. However for guidance, a typical drainage arrangement is given (Fig. 1A, Fig.1B and Fig. 1C) for a common yard configuration with four lines (two main lines and two loop lines).

3. The design principles are as follows:

i) **Longitudinal drains:** Water entering through track ballast and on top of the formation should be collected in longitudinal drains between the tracks. These drains have circular holes on the sides and with grated covers at top for water entry.

ii) **Chambers:** Along the longitudinal drains, chambers should be placed at suitable locations for effective collection of water from longitudinal drains.

iii) **Cross Drains:** Water from the chambers will be drained out through suitable outfall arrangement, including cross drains, wherever needed.

iv) **Pumping Arrangements:** Depending on the topography of the yard vis-à-vis adjacent area, pumping arrangement may also be required from the chambers or sumps, for pumping out of water to nearest outfall or waterways.

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B. Providing drainage in yards

1. In all new yards, this yard drainage can be implemented. Hence, for all new yards and during major yard re-modelling works due to Gauge Conversion, Doubling Works etc., a "Drainage Plan" shall be developed and got approved. For this, the yard drainage system given in this chapter can be easily implemented.

2. In existing yards, a detailed survey should be done to examine feasibility of designing/constructing the proposed yard drainage system. In case it is not possible to construct longitudinal drains due to site conditions, site specific solutions may be implemented.

   One such alternative is constructing chambers at longitudinal spacing of about 150 – 200m, based on the gradients in the yards and collecting the water flowing between the tracks (in longitudinal direction) in these chambers. The water collected in chambers can be taken to suitable outfall arrangements either by pumping out or through cross drains.

3. The location of Signal masts, Water hydrants, OHE masts, S&T and Electrical cables in the yard shall be kept in mind while deciding the drainage layout of the existing yard. Suitable modifications, if required, to divert/modify/re-fix these installations shall be done to avoid the obstructions to the free flow of drainage water.

4. The Planning and Design of the yard drainage system should be carried out in a professional manner.

C. Cross Slope of Track Formation

Top of track formations, for ballasted track as well for concrete aprons, should have cross slope towards the longitudinal drain. In new yards, this can be ensured during the construction of new tracks. For yards being re-modelled due to gauge conversion or doubling, this can be ensured for newly constructed tracks. In existing yards or tracks not newly laid during yard re-modelling, such cross slopes can be provided during deep screening work.

635 Design Criteria of a typical Yard Drainage System

The longitudinal drain, chambers and cross drains should be designed as follows:

635 (i) Type of longitudinal drain

a) In station yards it is difficult to cast the drains in-situ with required quality. Hence, the drains should be kept as pre-cast RCC Drains only. They should be casted in casting yard, with proper control on quality and dimensions.

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b) The drains should be cast in elements of suitable lengths (with typical segment length of 1m or 0.5m), depending upon the method of handling/machinery proposed to be used, and pre-cast elements should be laid at site.

c) For ease of casting, the drains can be rectangular shape with rounded inners corners, with rows of circular holes in the vertical walls.

d) The joint/junction between the two pre-cast elements of longitudinal drain shall be sealed with Cement Mortar or any other suitable sealing material.

635 (ii) Bed Gradient of Longitudinal Drain

a) The drains shall be designed using Manning's Formula. The bed gradient of longitudinal drain needed is generally 1 in 350 or steeper, to get required self-cleansing velocity of flow (about 1.0 m/s) and to ensure sub-critical flow conditions (Froude Number being within 0.8). The maximum velocity of flow shall be 3.0 m/s to avoid excessive scouring and hydraulic jumps. The drain being proposed shall be checked for these hydraulic properties.

b) To minimize the excavation, the bed gradient of longitudinal drain shall be same as the gradient. As per Schedule of Dimensions (IRSOD), the Steepest Gradient in yards can vary from 1 in 260 to Level (generally being 1 in 1200 for new yards). Therefore, in cases where the gradient of yard/formation is 1 in 350 or steeper, the longitudinal drain should have same gradient as that of yard/formation. However, in cases where gradient of yard/formation is flatter than 1 in 350, the longitudinal drain should have gradient of 1 in 350.

c) In cases where bed gradient of longitudinal drain is 1 in 350 and yard/formation gradient is flatter than this, the depth of drain will increase in the direction of its' bed gradient.

635 (iii) Size and other features of longitudinal drains

a) The width of longitudinal drains should be kept as 450mm, to facilitate their cleaning during service life.

b) In case the longitudinal drain meets any culvert in the yard, it shall connect to and discharge in the culvert subject to invert level and discharge capacity of the culvert permitting it & can be decided as per site conditions.

c) The location of longitudinal drains vis-à-vis location of adjacent tracks is decided based on following three considerations:

   i) The ballast profile side slope line should cut the drain below its top to avoid ballast rolling down on the drain cover;

   ii) The invert level line of bottom most row of holes in the vertical wall should be at the level of top of formation level to avoid washing away of formation soil in the drain;

   iii) Drain depth of 150mm should be provided below the invert level line of the bottom most row of holes in the vertical wall;

   To avoid deep excavation on the side of running track, the maximum depth of longitudinal drains should be restricted to a value of 1200mm. This may be

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restricted to 1000mm or any other value, depending on the site conditions and stability of excavation for placing drain elements.

d) As per Schedule of Dimensions (IRSOD), the minimum distance between track centres in yards is 4265mm for existing yards and 5300mm for all new yards. Thus, the drain depth has to be decided for both these track centre distances, out of which the lower track centre (4265mm) will require deeper drain to ensure that the ballast profile side slope line cuts the drain below its' top. Based on consideration in Para (c) above, depth of longitudinal drain will work out to be as under:

i) For Track Centres at 5300mm
Clear depth of drain is 450mm (minimum) at the starting point and when the depth reaches the maximum decided depth, it will be terminated in a chamber/sump.

ii) For Track Centres at 4265mm
Clear depth of drain is 750mm (minimum) at the starting point and when the depth reaches the maximum decided depth, it will be terminated in a chamber/sump.

e) The location of the longitudinal drain vis-à-vis location of adjacent tracks has been shown in Fig. 2 and relevant details of longitudinal drains have been shown in Fig. 2A and Fig. 2B for track centre distances of 4265mm & 5300mm respectively.

f) The longitudinal drains should be provided with grated covers, to avoid ballast falling in the drain and at the same time facilitating their easy cleaning.

g) For Yard gradient of 1 in 1200 and bed gradient of longitudinal drain as 1 in 350, the spacing of chambers will be as following:

Track Centre Distance	**Maximum Depth of Longitudinal Drain**	**Spacing of Chambers**	
		When bed gradient of Longitudinal Drain is in same direction as Yard Gradient	**When bed gradient of Longitudinal Drain is in direction opposite to Yard Gradient**
4265 mm	1200 mm	222.3 m	122.0 m
	1000 mm	123.5 m	67.7 m
5300 mm	1200 mm	370.6 m	203.2 m
	1000 mm	271.7 m	149.0 m

h) A typical case showing direction of bed gradient of longitudinal drain vis-à-vis direction of Yard Gradient and locations of chambers for new yard (with track centre distance of 5300mm) and maximum depth of longitudinal drain as 1000mm) are shown in Fig. 1A, Fig. 1B and Fig. 1C.

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i) If there are number of outfalls present nearby, drainage layout may accordingly be planned using the same approach. For other cases, site specific details can be worked out.

j) Expected water flow in the longitudinal drains and its comparison with the drain capacity is indicated in Annexure-1.

635 (iv) Longitudinal drains in case of yards located in curves

In case of yards located in curves, casting longitudinal drain elements with required curvature may not be easily possible. In such cases, smaller elements lengths of 0.5m length can be used. The excavation for longitudinal drains in such cases should be done taking this aspect into account. The minor extra space on the outer side at joints of pre-cast elements, due to joining of straight elements in curved layout, may be filled up using suitable mortar or sealing product.

635 (v) Size of chambers

The chamber size should be kept as 0.9m x 1.2m, as per the stipulations of IS:1742-1983, for Building Drainage. The arrangement at chambers, with cross drain(s) is given in Fig. 3. The chambers should be casted with 200mm length of longitudinal drains on either sides or one side, as per site requirement and the longitudinal should be extended further by joining the pre-cast elements

635 (vi) Type, Size and Bed Gradient of Cross Drain

a) The bed gradient of cross drains should be 1 in 350 or steeper to achieve self-cleansing velocity of flow in them also.

b) The cross drain(s) should be perforated pipes, 300mm diameter, with wrapping of non-woven geotextiles (also known as Geo-pipes). Their numbers can be decided based on the discharge to be carried by them.

c) For provision of cross-drains in yards beneath the track, Micro-tunneling can also be a useful method for installation. It is a trenchless construction method for installing pipelines that uses a remotely controlled Micro-tunneling Boring Machine (MTBM) combined with the pipe jack and bore method to directly install pipes underground in a single pass. This process avoids the need to have a long stretch of open trench.

For details, "Guidelines on Pipe Pushing by Microtunneling Technique for Railway Bridges" (Sep' 23), Report No. BS-134, issued by B&S Directorate of RDSO can be referred.

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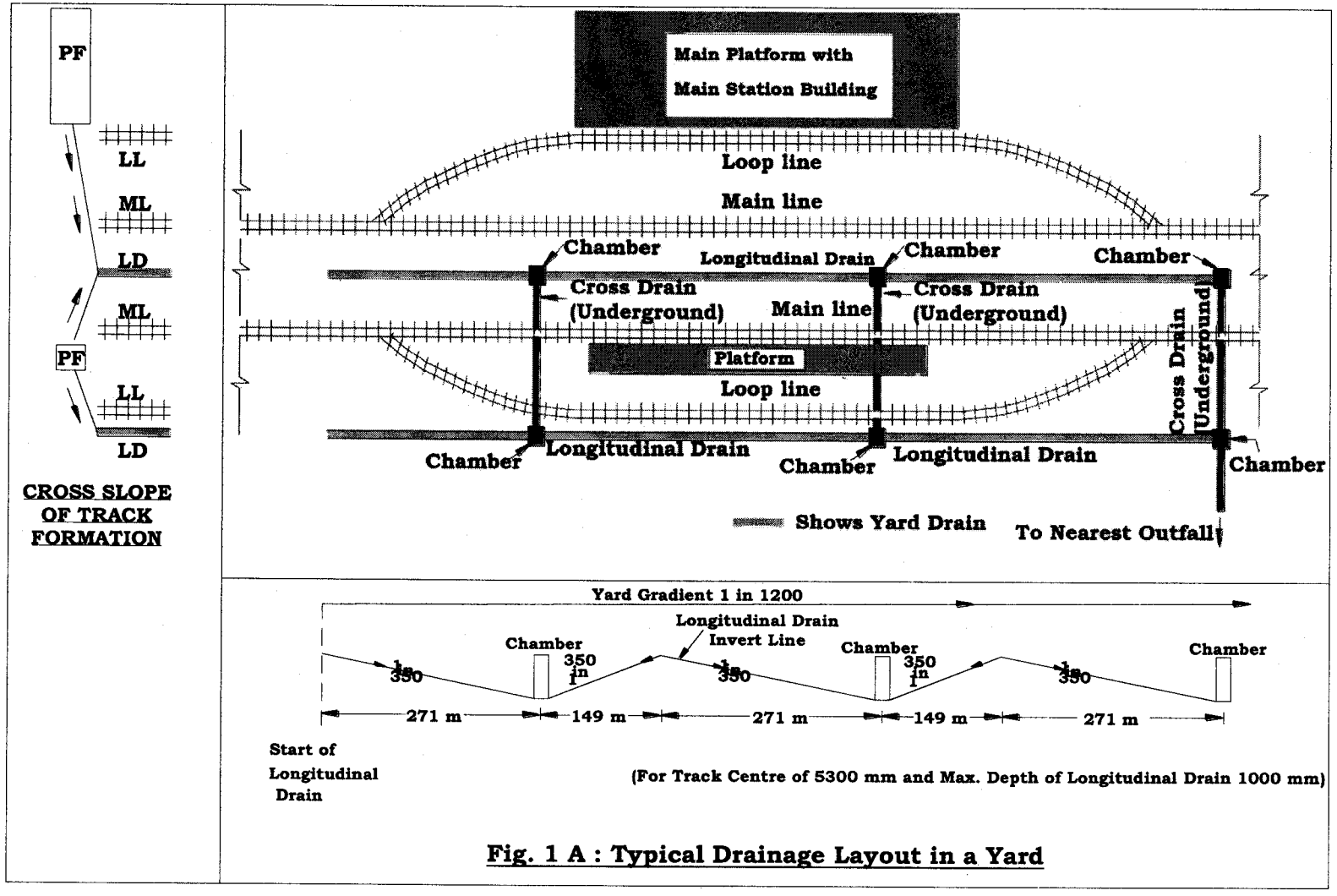

Fig. 1 A : Typical Drainage Layout in a Yard

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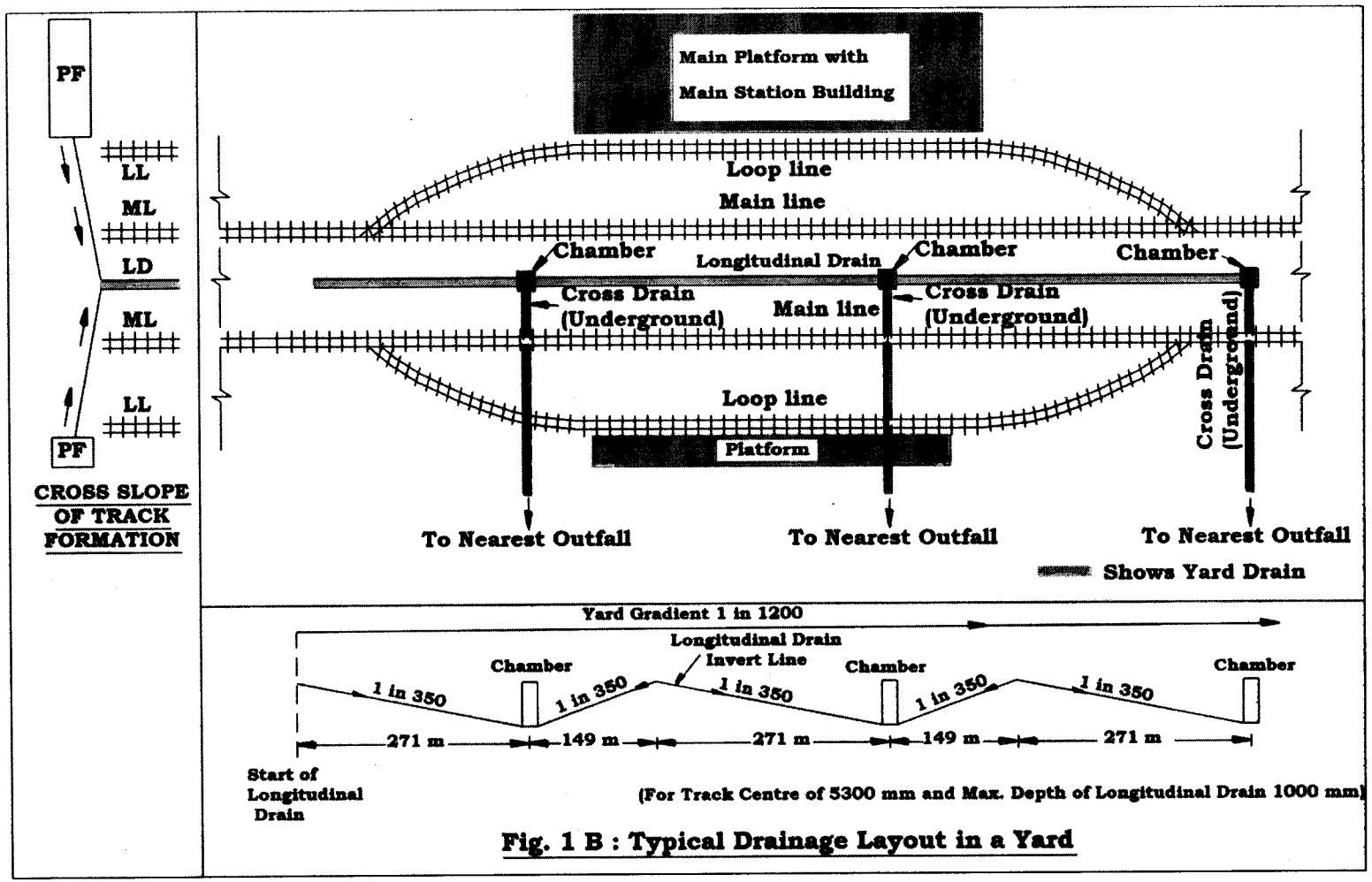

Fig. 1 B : Typical Drainage Layout in a Yard

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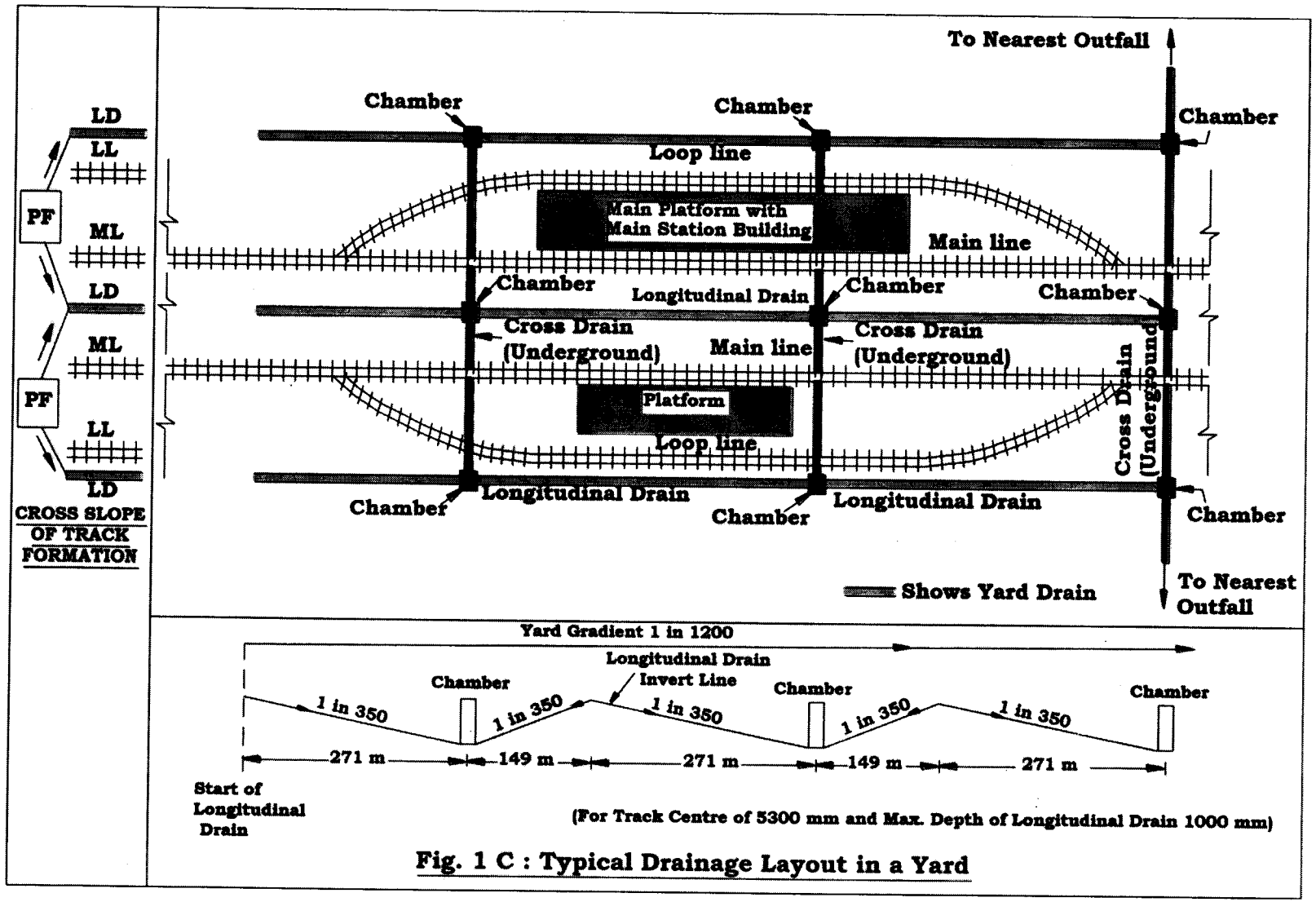

Fig. 1 C : Typical Drainage Layout in a Yard

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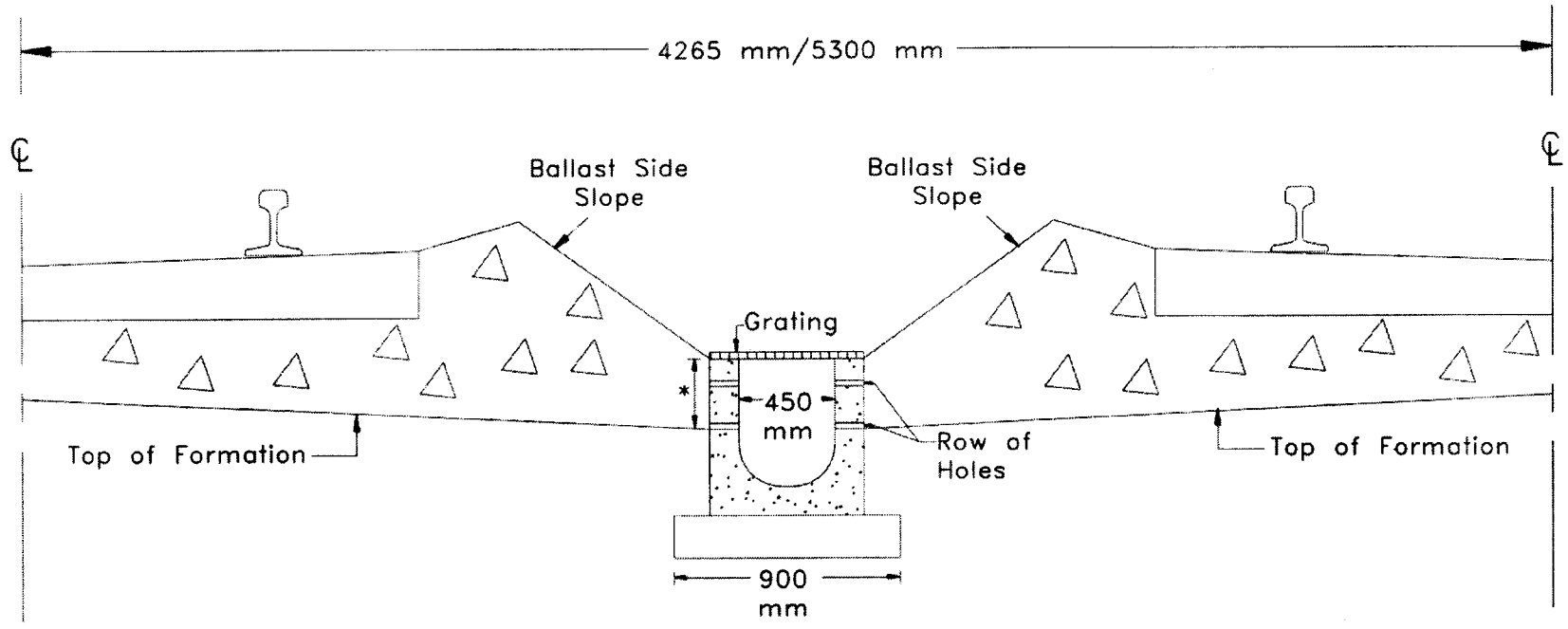

*** 300 mm/600mm for track centres of 5300mm/4265mm.**

Note: Details of Longitudinal Drain are shown in Fig. 2A and 2B.

Fig. 2: Schematic arrangement showing Location of Longitudinal Drain vis-à-vis Adjacent Tracks

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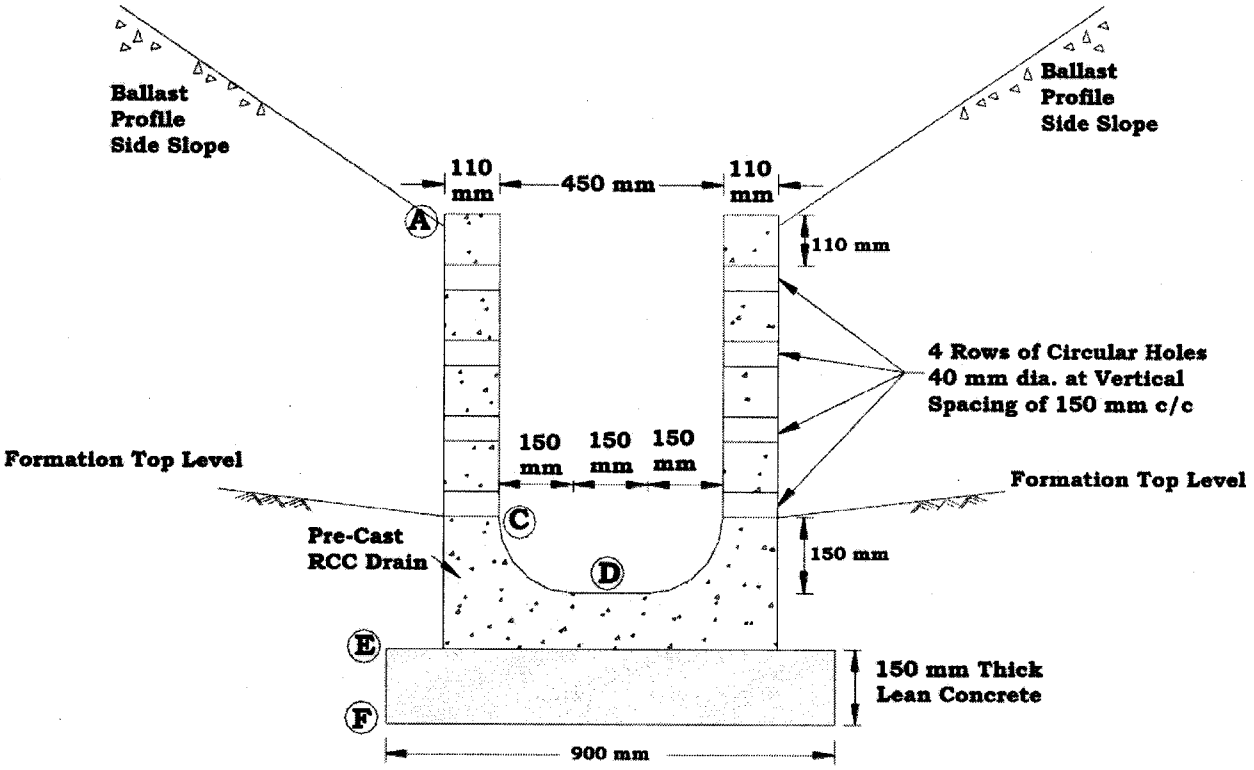

Fig. 2A/1 : Details of Typical Longitudinal Drain (For Track Centre 4265mm)

Location		Levels For Drain depth 750mm	Levels For Drain depth 1200mm
Rail Level		L m	L m
Platform Level		L + 840 m For High level L + 760 m For Middle level L + 455 m For Low level	L + 840 m For High level L + 760 m For Middle level L + 455 m For Low level
Top of Drain	(A)	L – 0.111 m	L – 0.111 m
Formation level	(C)	F= (L – 0.711 m)	F = (L – 0.711m)
Invert Level of Drain	(D)	F – 0.150 m (L – 0.861 m)	F – 0.600 m (L – 1.311 m)
Bottom of Drain / top of Footing	(E)	F – 0.260 m (L – 0.971 m)	F – 0.710 m (L – 1.421 m)
Bottom Of Footing	(F)	F – 410 m (L – 1.121 m)	F – 0.860 m (L – 1.571 m)

Levels Table

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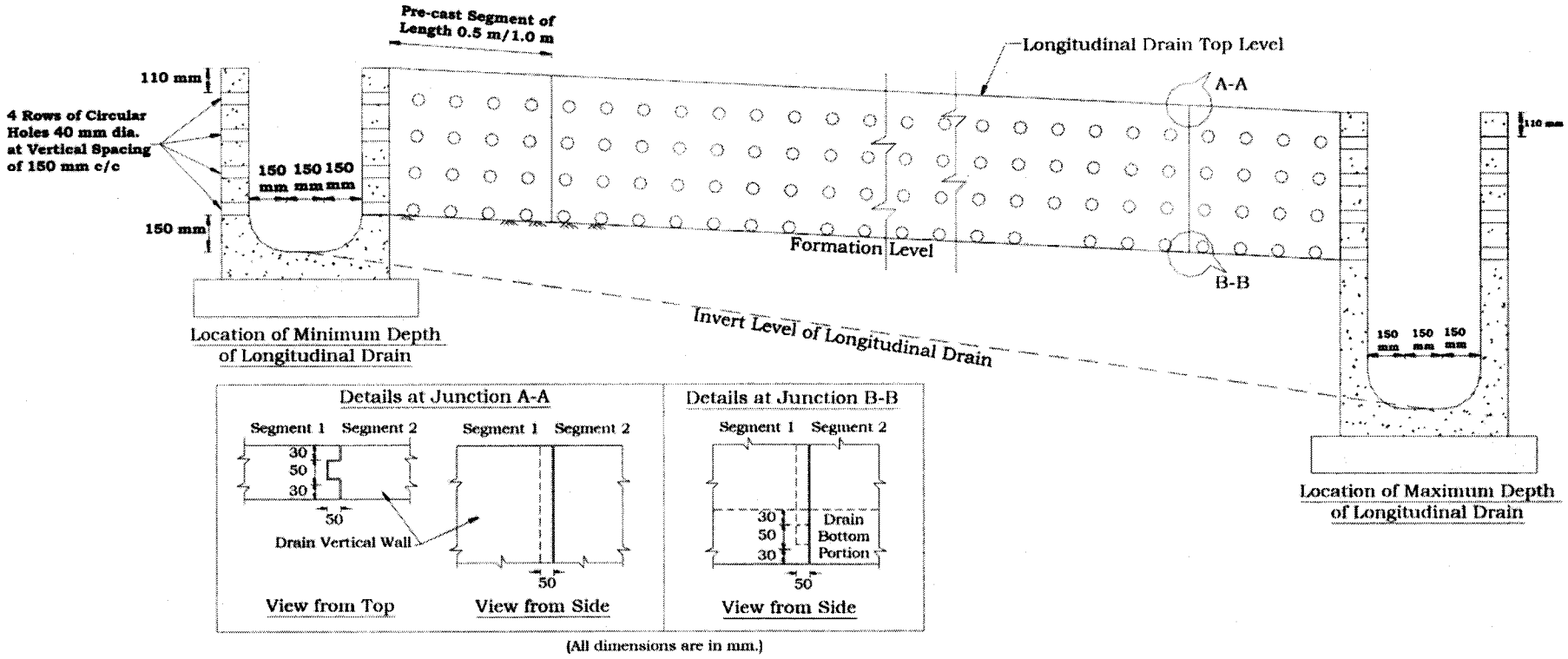

(All dimensions are in mm.)

Note: **(i) Circular holes of diameter 40mm are provided at horizontal spacing of 100mm c/c, with the centre of first hole being located at a distance of 100mm from the edge of the element. Thus, 0.5m long element will have four (4) holes in each row and 1m long element will have nine (9) holes in each row.**

(ii) The bottom most row of holes is located in such a way that that their invert level line matches with formation level.

(iii) The next row of holes above is spaced at 150mm c/c vertical spacing. There will four (4) rows of holes.

(iv) For ensuring required line and level of the longitudinal drain and proper junction between pre-cast elements, the ends of elements shall be cast with grove in one element and projection in matching element on other side (as shown in details at A-A and B-B above).

Fig. 2A/2 : Side Schematic View of Typical Longitudinal Drain (For Track Centre 4265mm)

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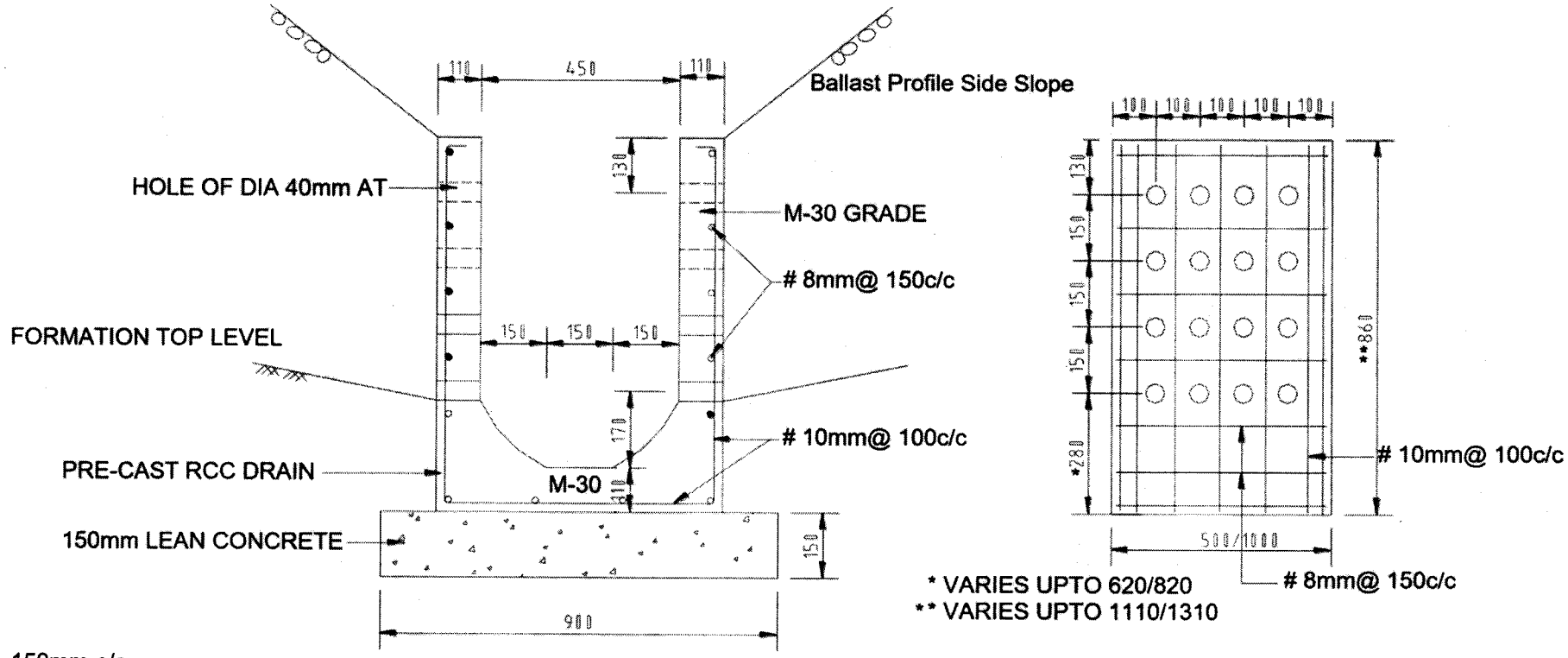

Note: (i) **Grade of Concrete is M-30.**

(ii) **Reinforcement shall be Fe-415 or higher.**

(iii) **Clear cover to reinforcement shall not be less than 25mm, which may be increased as per exposure condition. (as per Clause No. 15.9.2 of IRS Concrete Bridge Code).**

(iv) **Reinforcement shall be placed in such a way that holes are covered in both the directions (i.e. at least one main bar and one distribution bar be provided in between two holes).**

(v) **For lifting of one block, slings be used in at least two holes (outer holes i.e. holes near horizontal and vertical edges shall not be used for this purpose).**

(vi) **Construction of Walls and Base Slab shall be monolithic.**

Fig. 2A/3 : Typical Reinforcement tentative in Longitudinal Drain elements (For Track Centre 4265 mm)

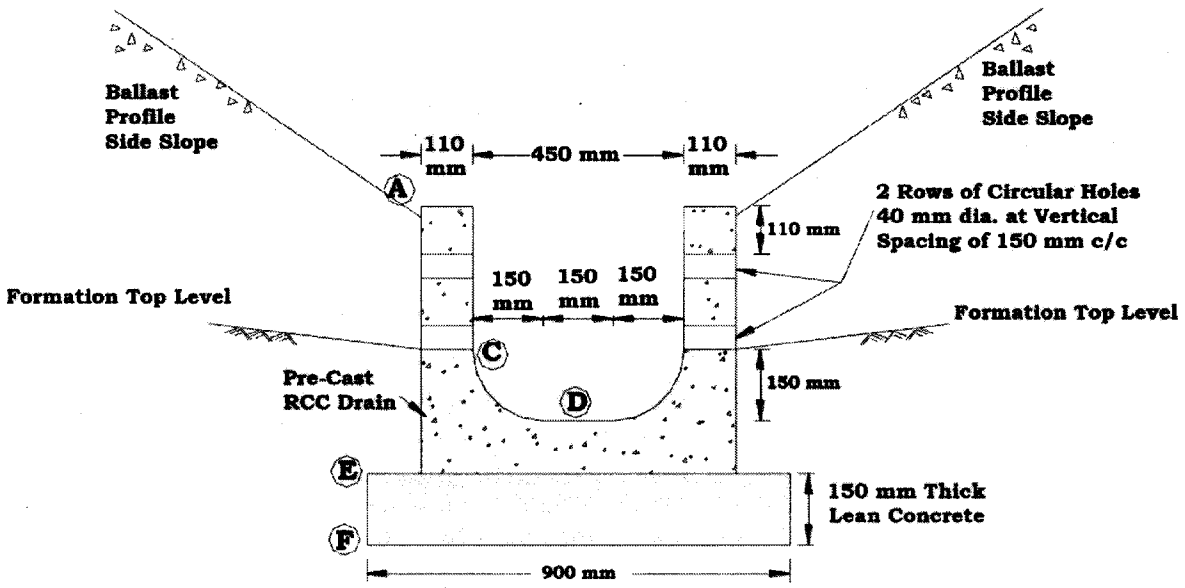

Fig. 2B/1 : Details of Longitudinal Drain (For Track Centre 5300mm)

Location		Levels For drain depth 450mm	Levels For Drain depth 1200mm
Rail Level		L m	L m
Platform Level		L + 840 m For High level L + 760 m For Middle level L + 455 m For Low level	L + 840 m For High level L + 760 m For Middle level L + 455 m For Low level
Top of Drain	(A)	L – 0.424 m	L – 0.424 m
Formation Level	(C)	F = (L – 0.724 m)	F = (L – 0.724 m)
Invert Level of Drain	(D)	F – 0.150 m (L – 0.874 m)	F – 0.900 m (L – 1.624 m)
Bottom of Drain / Top of Footing	(E)	F – 0.260 m (L – 0.984 m)	F – 1.010 m (L – 1.734 m)
Bottom Of Footing	(F)	F – 0.410 m (L – 1.134 m)	F – 1.160 m (L – 1.884 m)

Levels Table

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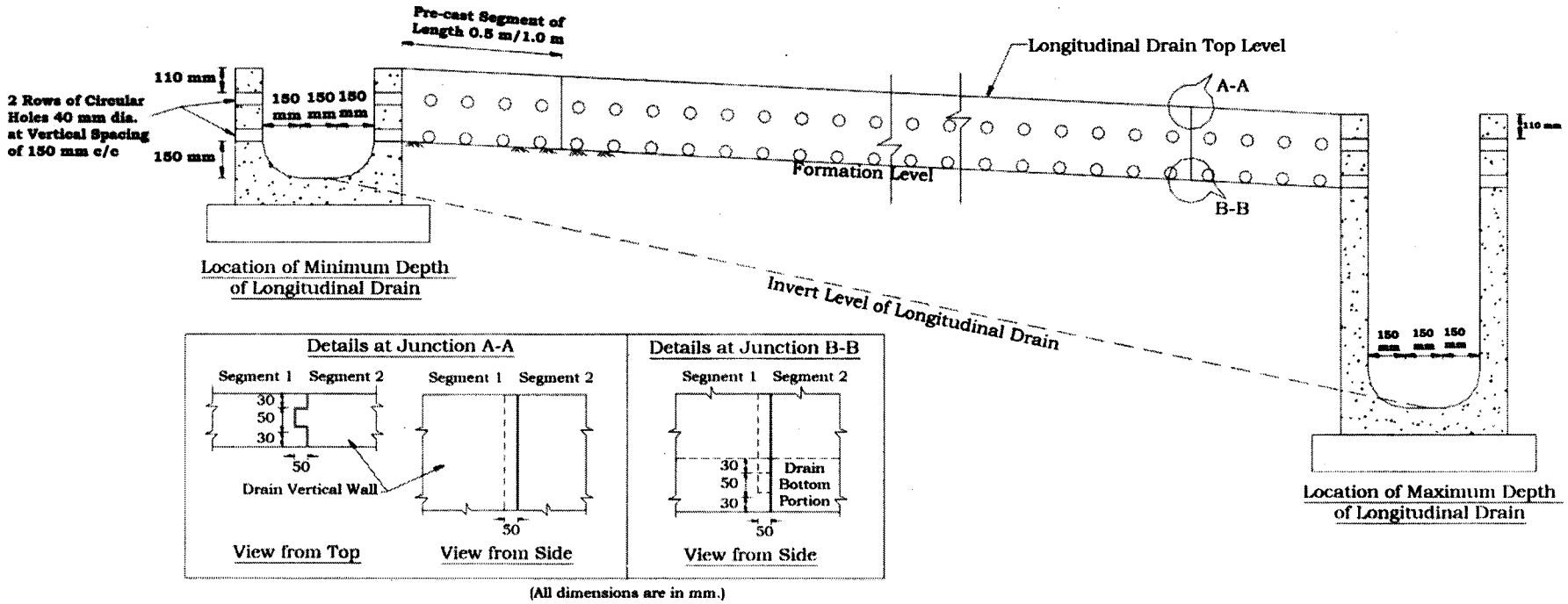

Note: **(i) Circular holes of diameter 40mm are provided at horizontal spacing of 100mm c/c, with the centre of first hole being located at a distance of 100mm from the edge of the element. Thus, 0.5m long element will have four (4) holes in each row and 1m long element will have nine (9) holes in each row.**

(ii) The bottom most row of holes is located in such a way that that their invert level line matches with formation level.

(iii) The next row of holes above is spaced at 150mm c/c vertical spacing. There will two (2) rows of holes.

(iv) For ensuring required line and level of the longitudinal drain and proper junction between pre-cast elements, the ends of elements shall be cast with grove in one element and projection in matching element on other side (as shown in details at A-A and B-B above).

Fig. 2B/2 : Side Schematic View of Typical Longitudinal Drain(For Track Centre 5300mm)

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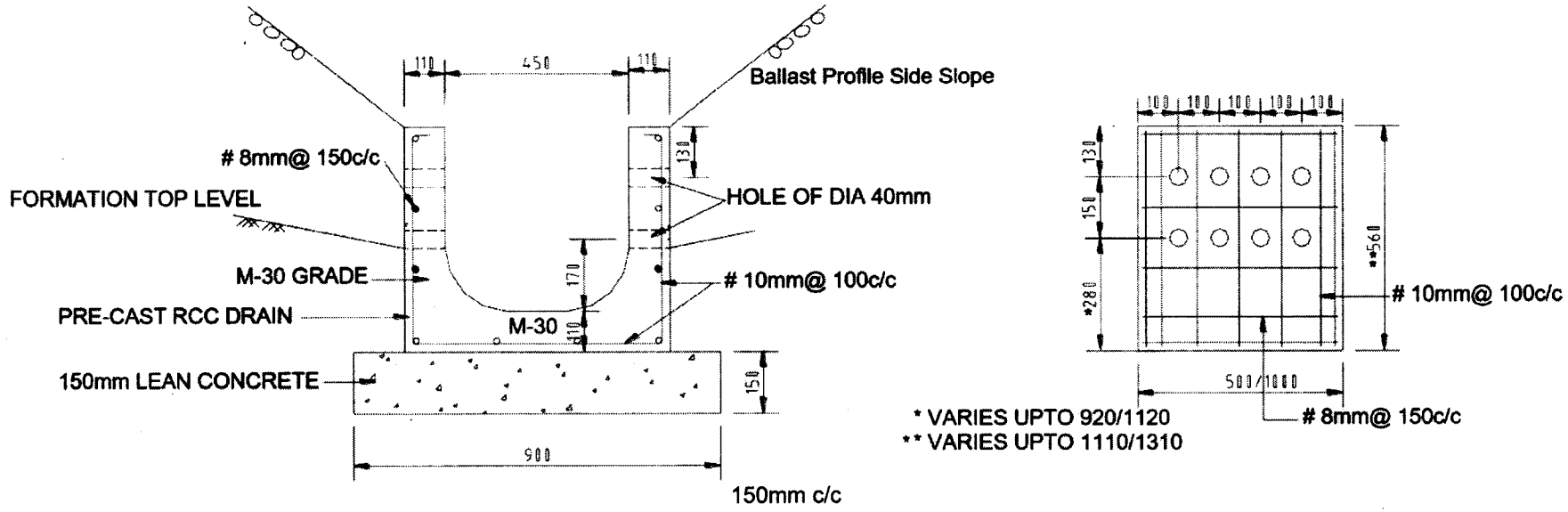

Note: (i) **Grade of Concrete is M-30.**

(ii) **Reinforcement shall be Fe-415 or higher.**

(iii) **Clear cover to reinforcement shall not be less than 25mm which may be increased as per exposure condition. (as per Clause No. 15.9.2 of IRS Concrete Bridge Code).**

(iv) **Reinforcement shall be placed in such a way that holes are covered in both the directions (i.e. at least one main bar and one distribution bar be provided in between two holes).**

(v) **For lifting of one block, slings be used in at least two holes (outer holes i.e. holes near horizontal and vertical edges shall not be used for this purpose).**

(vi) **Construction of Walls and Base Slab shall be monolithic.**

Fig. 2B/3 : Typical Reinforcement tentative in Longitudinal Drain elements (For Track Centre 5300 mm)

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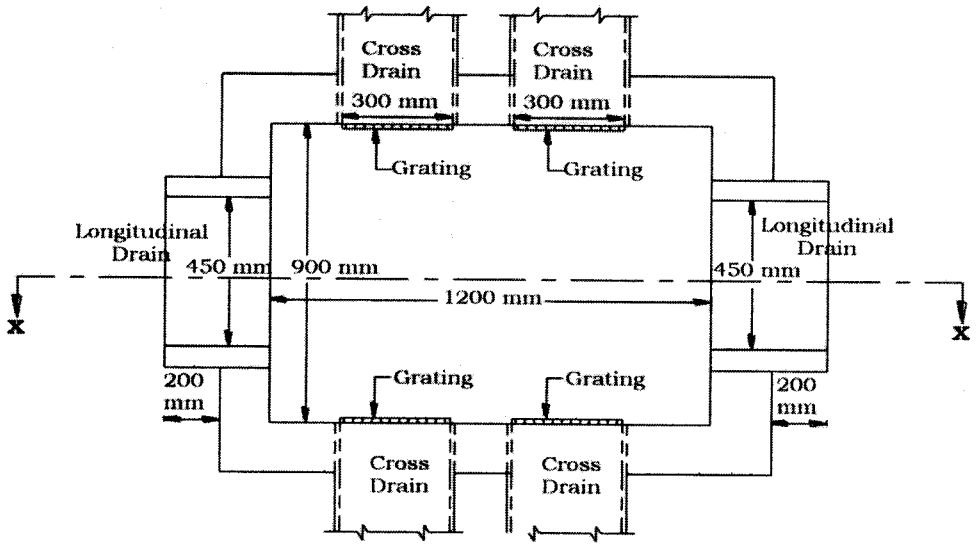
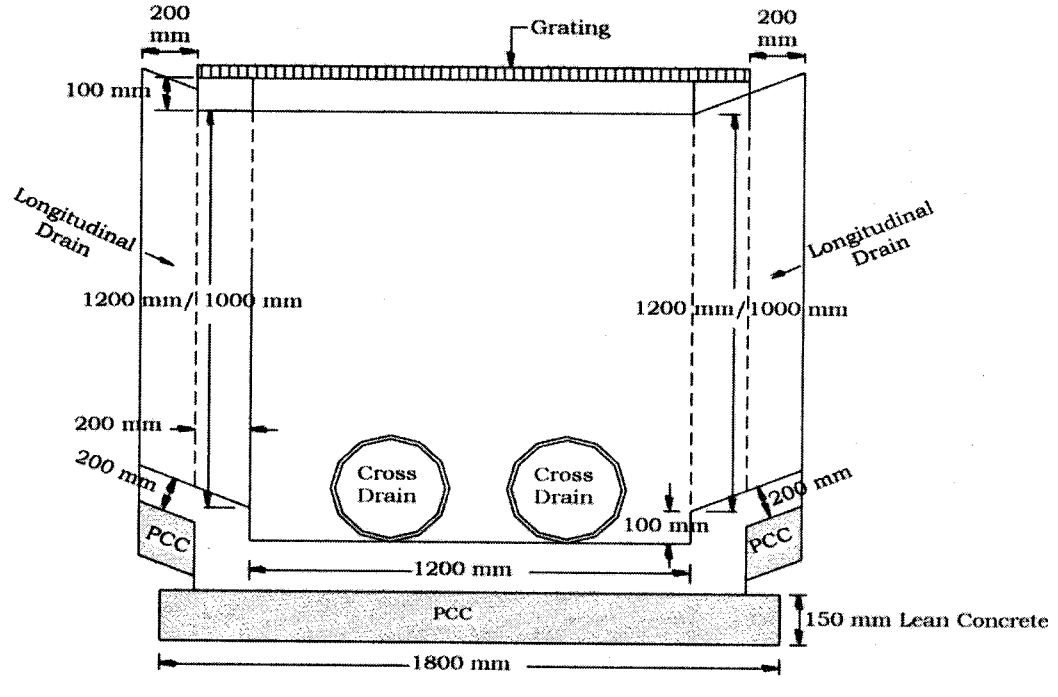


PLAN



SECTION AT X-X

Note: (i) For 200mm Length on each side of chamber, the Longitudinal Drain shall be cast with chambers. Further extensions of Longitudinal Drain shall be done by joining pre-cast drain elements.

(ii) The typical arrangements are shown, actual size and design needs to be decided as per site condition.

Fig. 3: Typical arrangement of Chamber with Cross Drain(s)

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ANNEXURE - 1

Calculation of Design Discharge for the Longitudinal Drain

1. As per Rational Formula (As per RDSO Report RBF 16 for "Flood estimation Methods'):

$Q = 0.278 \times C \times I \times A$

Where: Q = Design Flood Discharge (in m^3/s);
C = Run-off coefficient
I = Average Rainfall Intensity (in mm/h) lasting for given "time of concentration" & "return period"; and A = Catchment Area (m^2)

2. Run-off Coefficient (C)

The runoff coefficient (C) depends on the degree and type of development within the catchment. Catchments are classified according to the expected general characteristics when fully developed. The C values are as follows:

Characteristics of catchment when fully developed	**Value of C**
Roads, highways, airport runways, paved up areas	1.00
Urban areas fully and closely built up	0.90
Residential/industrial areas densely built up	0.80
Residential/industrial areas not densely built up	0.65
Rural areas with fish ponds and vegetable gardens	0.45

(Ref.: PUB Singapore's "Code of Practice on Surface Drainage")

3. Rainfall intensity (I)

Ideally, IDF Curves (intensity – duration - rainfall) curves for the given locality is required for calculating "rainfall intensity" for the given time of concentration.

However, Rambabu et. Al. (1979) developed an equation for Indian region. [Ref.: Ram Babu, Tejwani K. K., Agarwal M. C. & Bhusan L. S. (1979) – Rainfall intensity duration return period equations & nomographs of India, CSWCRTI, ICAR, Dehradun, India].

$I = (K \times T^a) / (t + b)^n$

where: I = rainfall intensity in cm/hour;
T = return period in years;
t = Time of concentration for storm duration in hours; and
K, a, b and n = coefficients varying with location; values of which for some locations are as under:

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Location	K	a	b	n
Agra	4.911	0.167	0.25	0.629
New Delhi	5.208	0.157	0.5	1.107
Nagpur	11.45	0.156	1.25	1.032
Bhuj	3.823	0.192	0.25	0.990
Gauhati	7.206	0.156	0.75	0.940
Bangalore	6.275	0.126	0.5	1.128
Hyderabad	5.25	0.135	0.5	1.029
Chennai	6.126	0.166	0.5	0.803

4. Return Period (T)

Area Served by Drainage System	Return Period (T)
Catchment of less than 100 ha	10 years
Catchment of 100 to 1000 ha	25 years
Catchment of more than 1000 ha or Critical installations	50 to 100 years

(Ref.: PUB Singapore's "Code of Practice on Surface Drainage").

5. Time of Concentration (t)

The time of concentration (t) depends on the type of catchment area and location at which the design discharge is to be measured/calculated.

Calculation of rainfall intensity for various durations of time of concentration, ranging from 0.5 hours to 6 hours or so, can be done using the formula given in para.3 above , and the time of concentration giving maximum rainfall intensity for that city (or nearest city from the Table in Para.3 above) can be adopted.

6. Design discharge 'Q' can be calculated using parameters described above. The capacity of the longitudinal drain to be provided shall be more than the calculated Design discharge.

13.08.24