ELECTRICAL SYSTEM DESIGN AND INSTALLATION GUIDELINES FOR ARCHITECTS & ENGINEERS

SECTION 10 : LIGHTNING PROTECTION SYSTEM FOR STRUCTURES

Mei 2012

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LIGHTNING PROTECTION SYSTEM FOR STRUCTURES

10.1 Description :

- A complete system used to reduce physical damage due to lightning flashes to the structure.
- This section will identify the requirement of installation for a complete lightning protection system (LPS) to MS IEC 62305.

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- 3 main components of an external lightning protection system and their functions are:

  a) *Air termination system* to intercept a lightning flash to the structure.

  b) *Down conductor system* to conduct the lightning current safely to earth.

  c) *Earth termination system* to disperse the lightning current into the earth.

10.2 Location :

- Not isolated from the structure to be protected. (LPS with an air termination system and down conductor system positioned in such a way that the path of the lightning current is in contact with the structure to be protected).

(Refer to Figure 10.1 : External Lightning Protection System)

10.3 Physical specification :

Item	Requirement	Action
10.3.1 Air Termination System	a) Structure with non metallic roof. (i) Air termination system shall consist of a network of vertical and horizontal conductors. The probability of structure penetration by a lightning current is considerably decreased by the presence of a properly designed air-termination system. Air termination systems can be composed by any combination of rods (including free-standing masts), catenary wires and meshed conductors.	A, C/S

10.3 Physical specification :

Item	Requirement	Action
10.3.1 Air Termination System	(ii) Lightning conductor shall be installed at corners, exposed points and edges (especially on the upper level of any facades).	A,C/S
	(iii) Positioning of the air termination component shall be determined by using one or any combination the following method : • Protection angle method • Rolling sphere method • Mesh method (Refer to Table 10.2 : Value of protection angle, rolling sphere radius and mesh size for eah class of LPS	A, C/S

10.3 Physical specification :

Item	Requirement	Action
10.3.1 Air Termination System	(iv) All metallic projections on or above the main surface of the roof of the structure shall be bonded to and form part of the air termination network.	A,M,C/S
	(v) Air termination will be run exposed along the roof and connected to the down conductors, usually at columns. (Refer to Figure 10.2 : Air Termination System For Concrete/Slate Roof)	A,M, C/S

10.3 Physical specification :

Item	Requirement	Action
10.3.1 Air Termination System	(Refer to Figure 10.3 : Air Termination Network) (v) For structure taller than 60 meters, a lateral air termination system shall be installed on the upper part typically the topmost 20% of the height of the structure for protection against flashes to the side of the structure. (Refer to Figure 10.4 : Air Termination Installation For Structure Higher Than 60 m) (vi) If there is metal facade, it must be bonded and formed part of the air termination.	A, C/S A,C/S

10.3 Physical specification :

Item	Requirement	Action
10.3.1 Air Termination System	b) Structure with metallic roof If the structure incorporates metallic roofing, the metallic roofs can be considered as a natural air termination system provided that it meets the minimum thickness and type of material under consideration. (Refer to Table 10.1 : Minimum Thickness of Metal Sheets/Metal Pipes in Air Termination System)	A, C/S
	(Refer to Figure 10.5 : Air Termination System : Installation of LPS conductor on metal deck roof) if the metallic roof does not form part of the air termination system .	A, C/S

10.3 Physical specification :

Item	Requirement	Action
10.3.2 Down Conductor System	a) A down conductor will be installed at each exposed corner of the structure. Down conductors shall be installed straight and vertical such that they provide the shortest and most direct path to earth. The down conductors shall not be installed in gutters or down-spouts even if they are covered with insulating materials. (Refer to Table 10.3 – Typical values of the distance between down conductors and between ring conductors according to the class of LPS) b) Methods of down conductor installation:	A, C/S

10.3 Physical specification :

Item	Requirement	Action
10.3.2 Down Conductor System	i. Exposed (Refer to Figure 10.6 : Exposed Down Conductor System Installation): - Fixed to the wall/column - May be painted - Test point will be installed at 2500 mm above ground level. ii. Encased in concrete (Refer to Figure 10.7 : Down Conductor System Installation – Encased in Concrete) - Bonded to the reinforcement steel structure in column. Properly clamped to structure rebar at 1 meter intervals and connected to air termination via Test Point installed 2500mm above ground level.	A A,C/S

10.3 Physical specification :

Item	Requirement	Action
10.3.2 Down Conductor System	iii. Use of natural components - Natural components made of conductive material, which will always remain in/on the structure and will not be modified (e.g. interconnected reinforced steel, metal framework of the structure, etc.) may be used as parts of LPS.	A,C/S
	- Steelwork within reinforced concrete structures is considered to be electrically continuous provided that the major part of interconnections of vertical and horizontal bars are welded (over a length not less than 30mm) or otherwise securely connected (Clamps conforming to EN 50164-1 may be considered suitable)	C/S

10.3 Physical specification :

Item	Requirement	Action
10.3.2 Down Conductor System	iii. Use of natural components (cont.) - Connection of vertical bars shall be welded or properly clamped or otherwise securely connected. - The overall electrical resistance measured between the uppermost part and ground level should not be greater than 0.2Ω.	C/S

10.3 Physical specification :

Item	Requirement	Action
10.3.3 Earth Termination System	a) General Down conductor shall be connected to the earth termination system consist of earthing conductor and earth electrodes. (Refer to Figure 10.8 : Earth Termination System) b) Types of earth termination system: Type A - comprises of horizontal/vertical earth electrodes installed outside the structure to be protected connected to each down-conductor.	A, C/S C/S

10.3 Physical specification :

Item	Requirement	Action
10.3.3 Earth Termination System	b) Types of earth termination system (cont.) Type B i) - comprises of a ring conductor external to the structure to be protected, in contact with the soil for at least 80% of its total length; - buried 500mm underground at least 1 meter from outside wall. **or** ii) - the structure foundations of interconnected reinforced concrete may be used as foundation earth electrode. - very low earthing resistance and perform an excellent equipotentialization reference. (Refer to Figure 10.9 &10.11 : Earth Termination System : Foundation Earth Electrode)	A, C/S C/S

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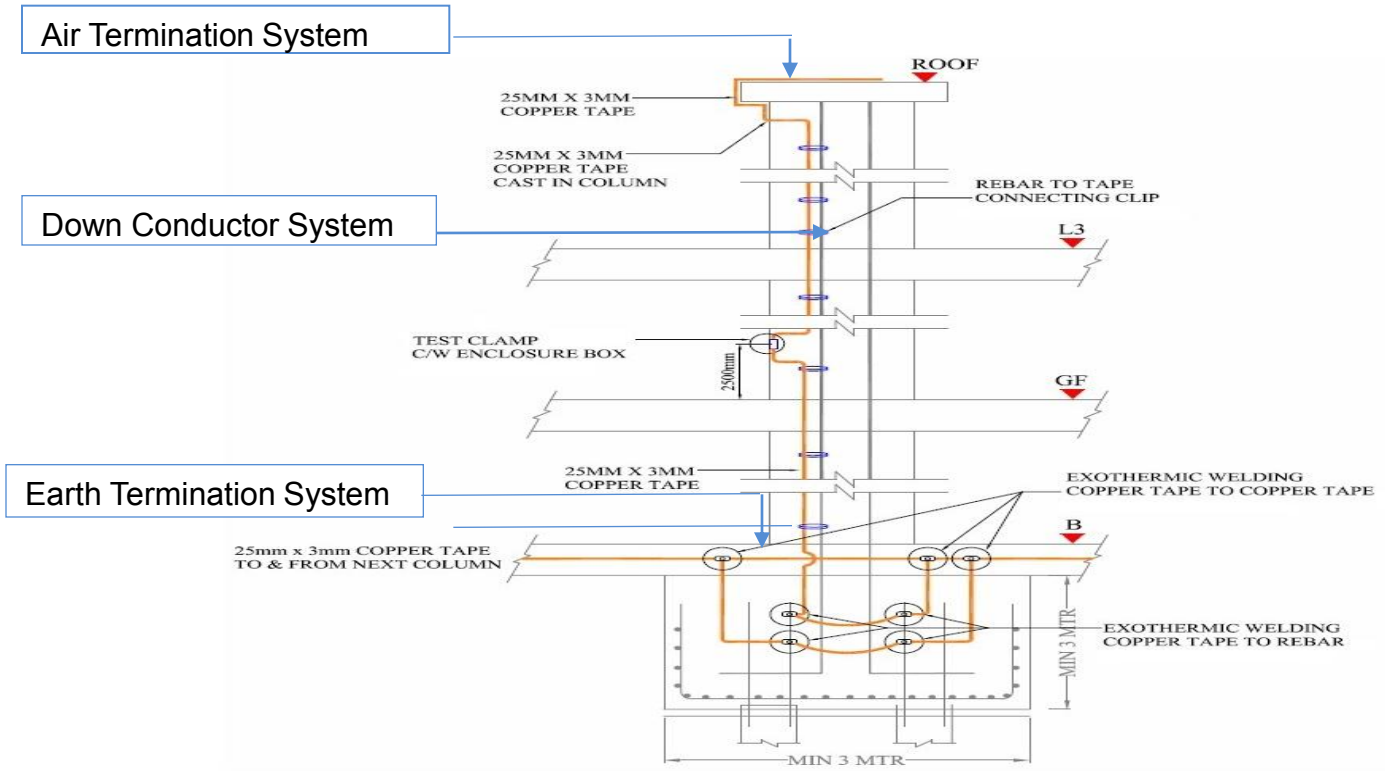
Fig.10.10 : Overall Lightning Protection System



Overall Lightning Protection System

TERIMA KASIH

Fig.10.1 : External Lightning Protection System

		
Example of Air Termination System	Example of Down Conductor System	Example of Earthing System

Fig.10.2 : Air Termination System For Concrete/Slate Roof

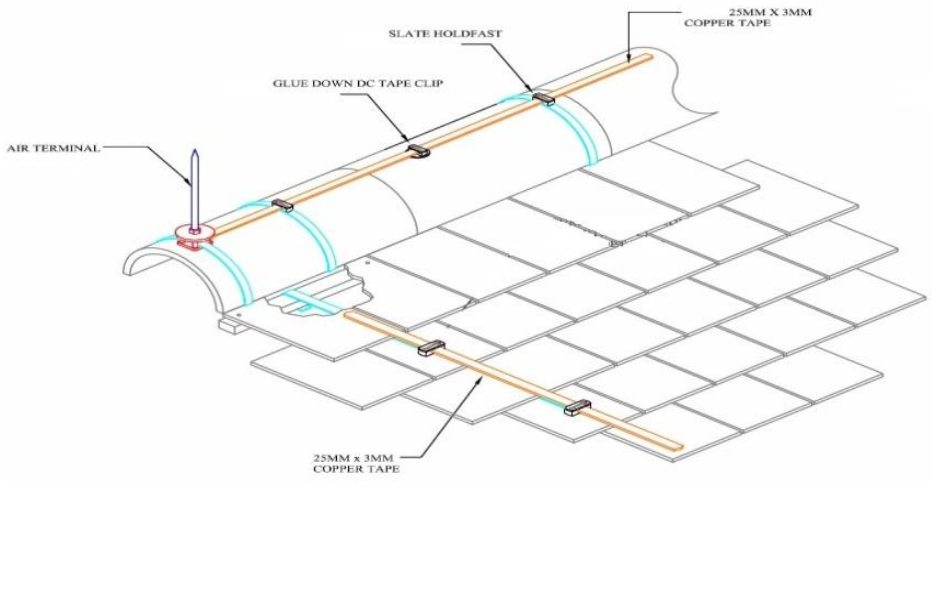
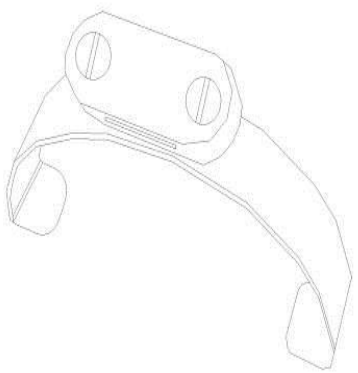
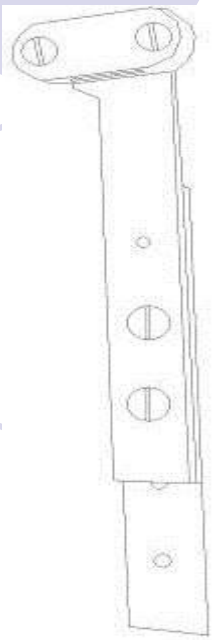
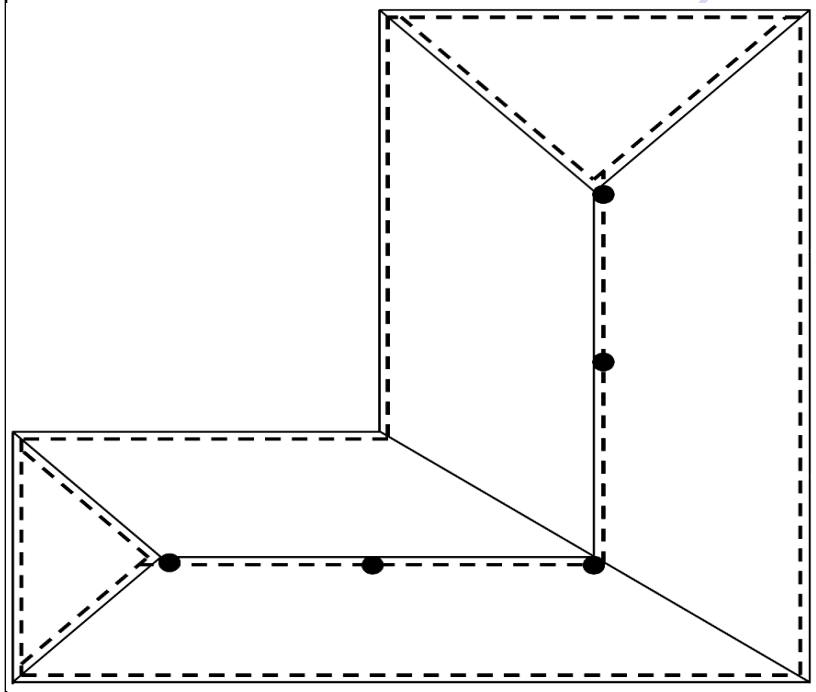
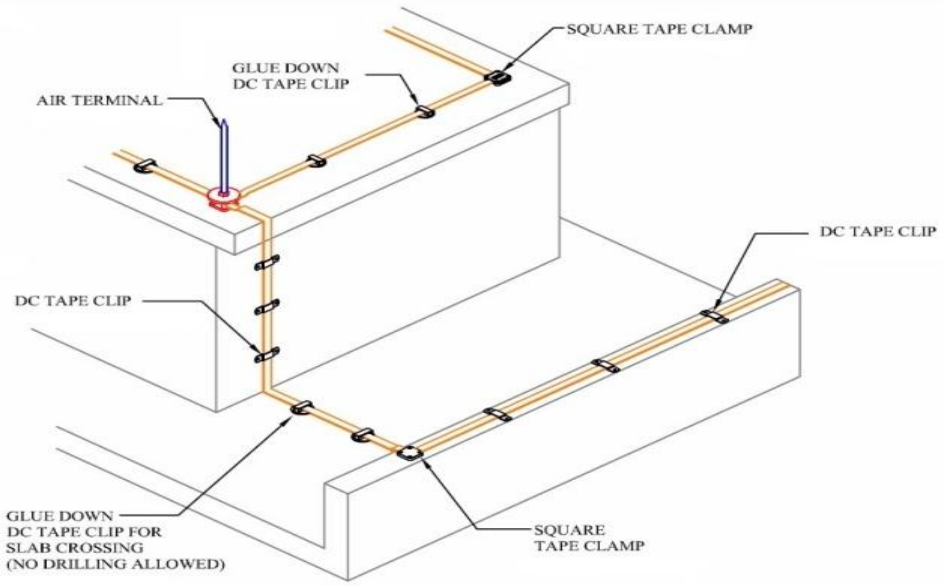
		
Air Termination Installation with fixing components	Roofing mount support hook	Slate Holdfasts support hook

Fig.10.3 : Air Termination Network

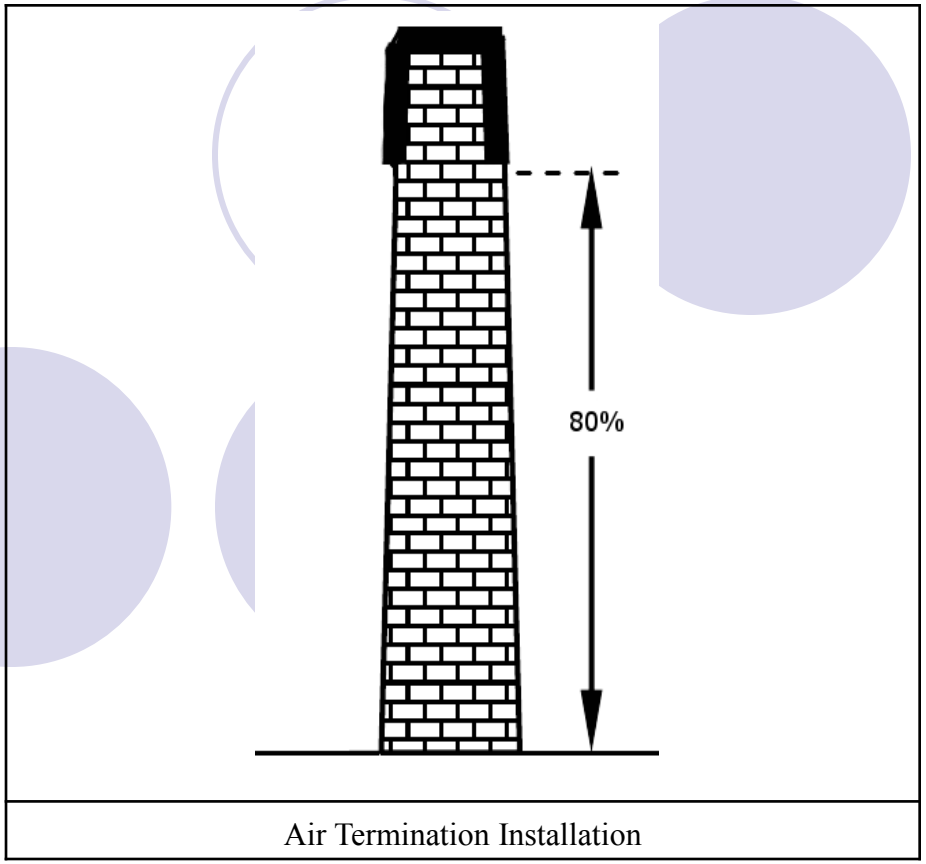


Example of air termination network on roof tiles(Top view)



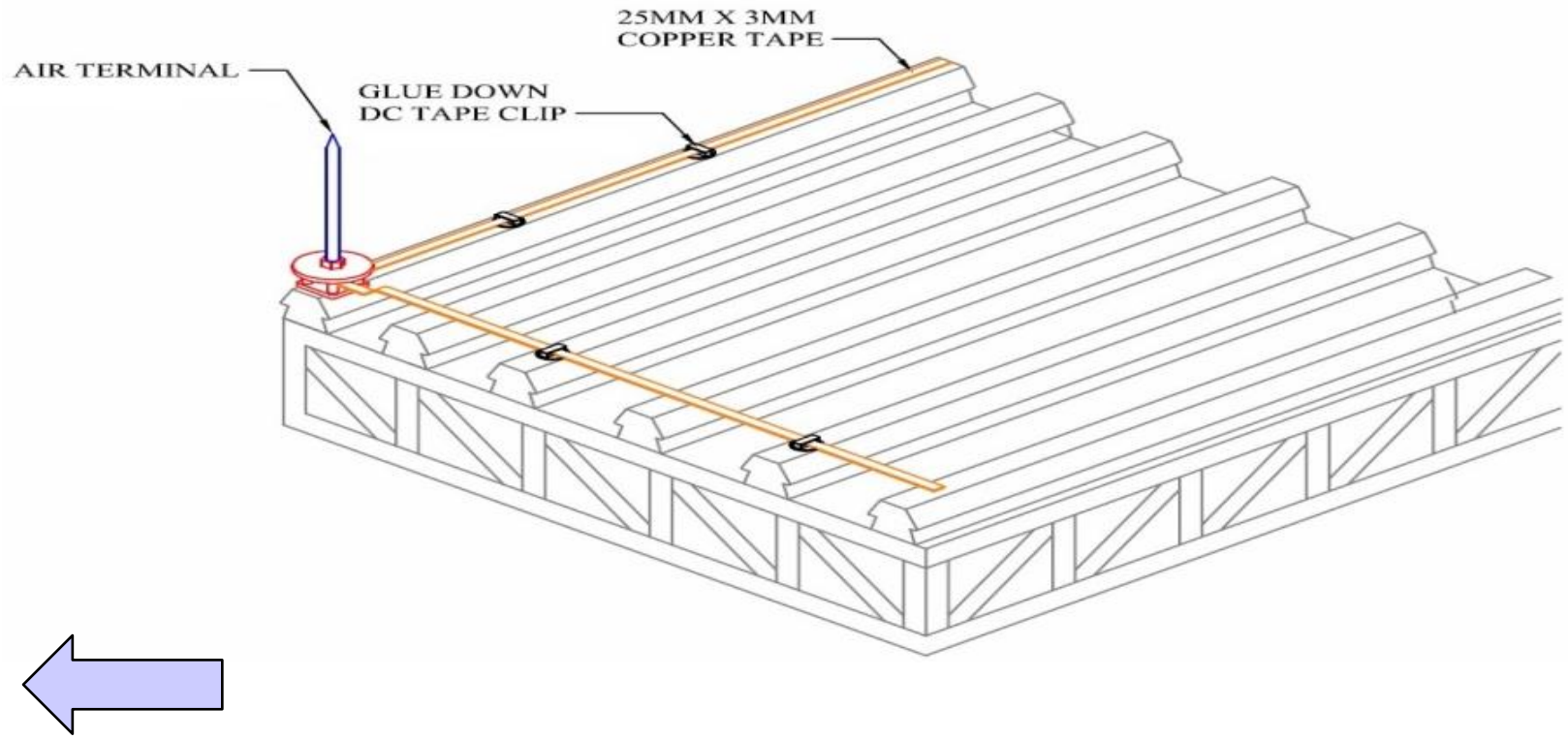
Typical Installation at RC Flat Roof

Fig.10.4 : Air Termination Installation For Structure Higher Than 60m



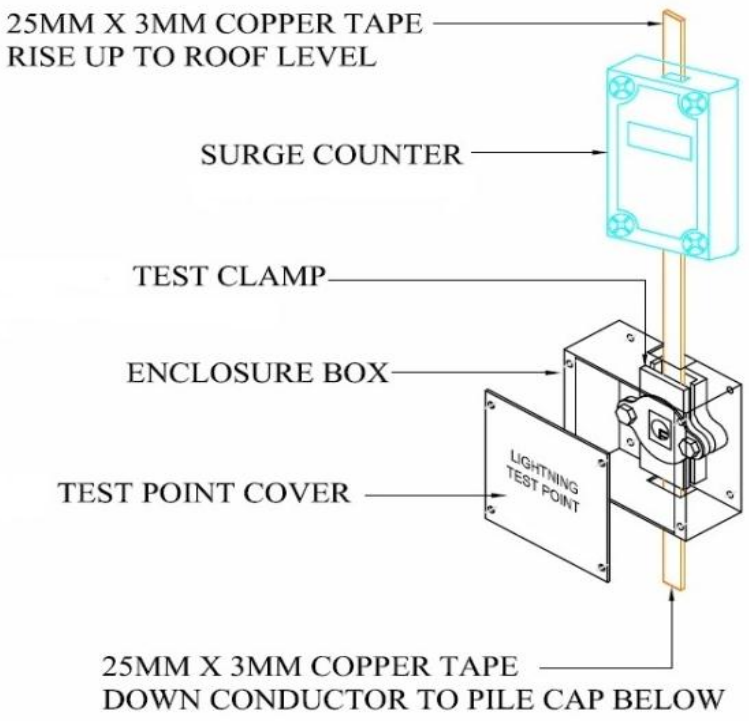
Air Termination Installation

Fig.10.5 : Air Termination System – Installation on metal deck roof



Typical Installation of LPS conductor on Metal Deck Roof

Fig.10.6 : Exposed Down Conductor System Installation



Installation of Test Point

Example of Exposed Down Conductor Installation

Fig.10.7 : Down Conductor System Installation – Encased in Concrete

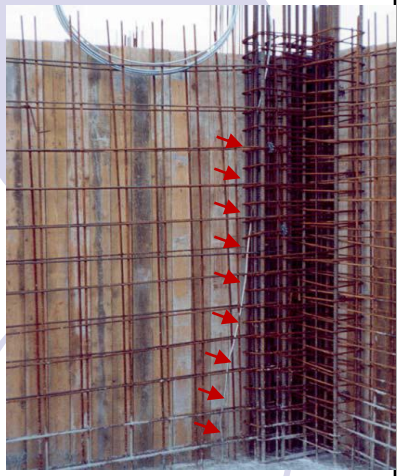
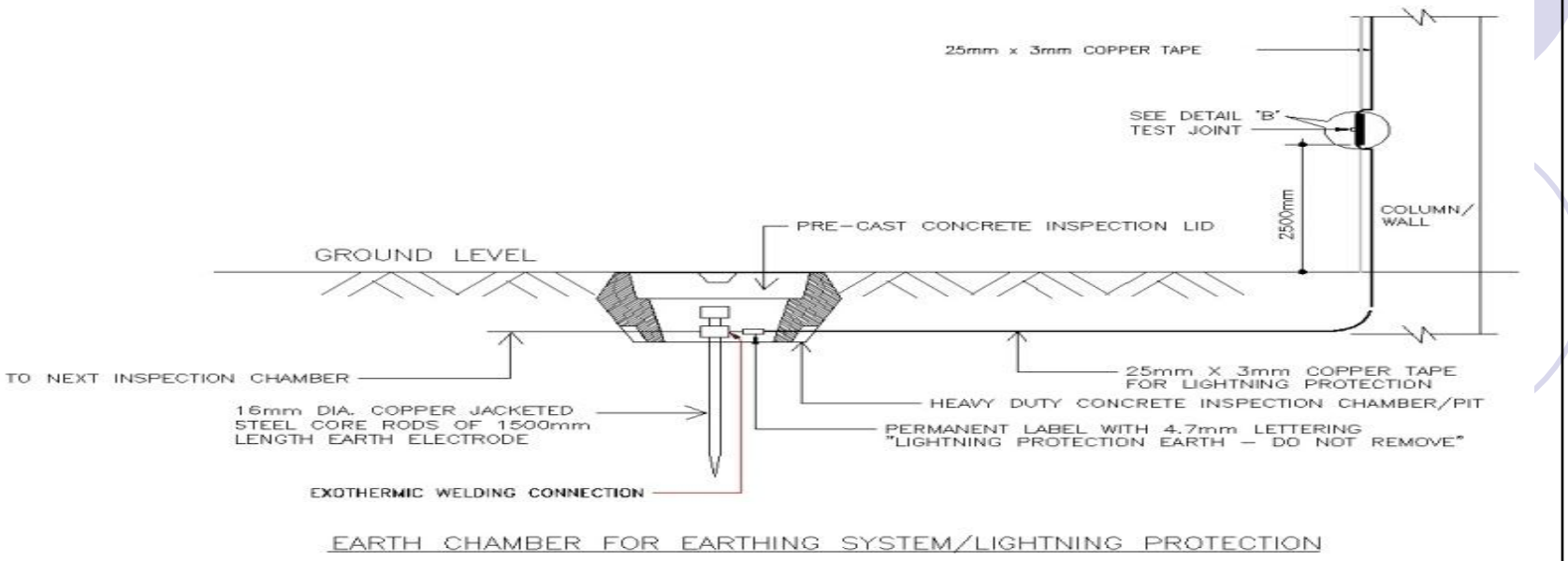
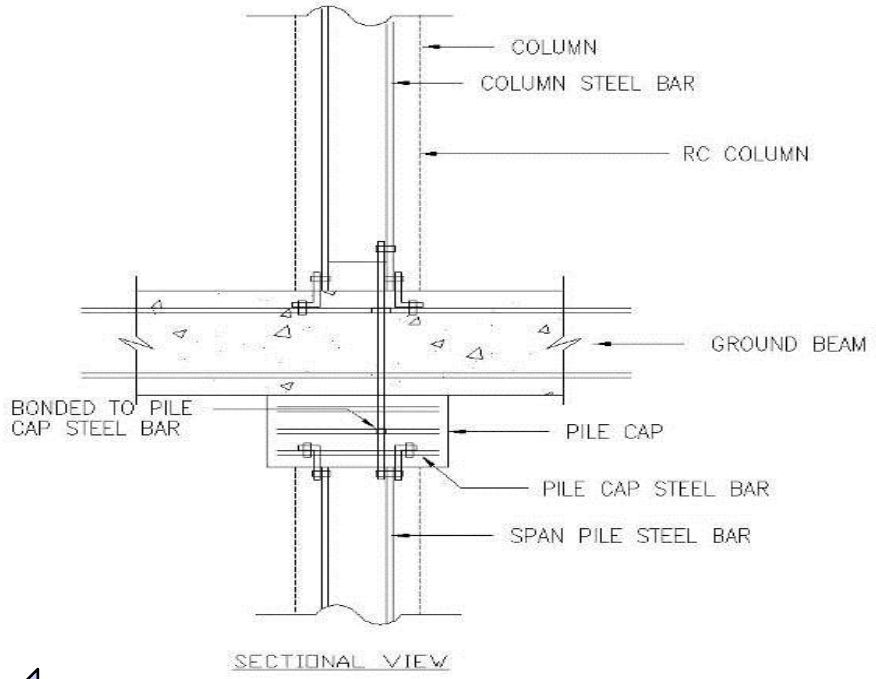
				
Example of Down Conductor installed through the reinforcement.	Example of approved connectors for connecting LPS conductors with the reinforcment. [√] Good Practice	Example of approved connectors for connecting LPS conductors with the reinforcement. [√] Good Practice	Non approved connection between earthing tape and reinforcement. The wire will not be able to withstand the lightning current causing explosion and cracks on the concrete. [X] Bad Practice	Down conductor is driven through the reinforcement without having any bonding. [X] Bad Practice

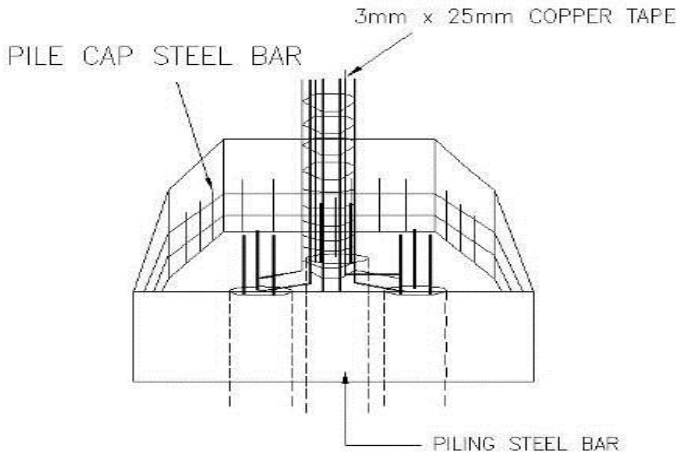
Fig.10.8 : Earth Termination System



Example of earthing system c/w inspection chamber

Fig.10.9 : Earth Termination System : Foundation Earth Electrode





Detail connection at pile electrode

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Fig.10.11 : Foundation earth electrode (Top view)

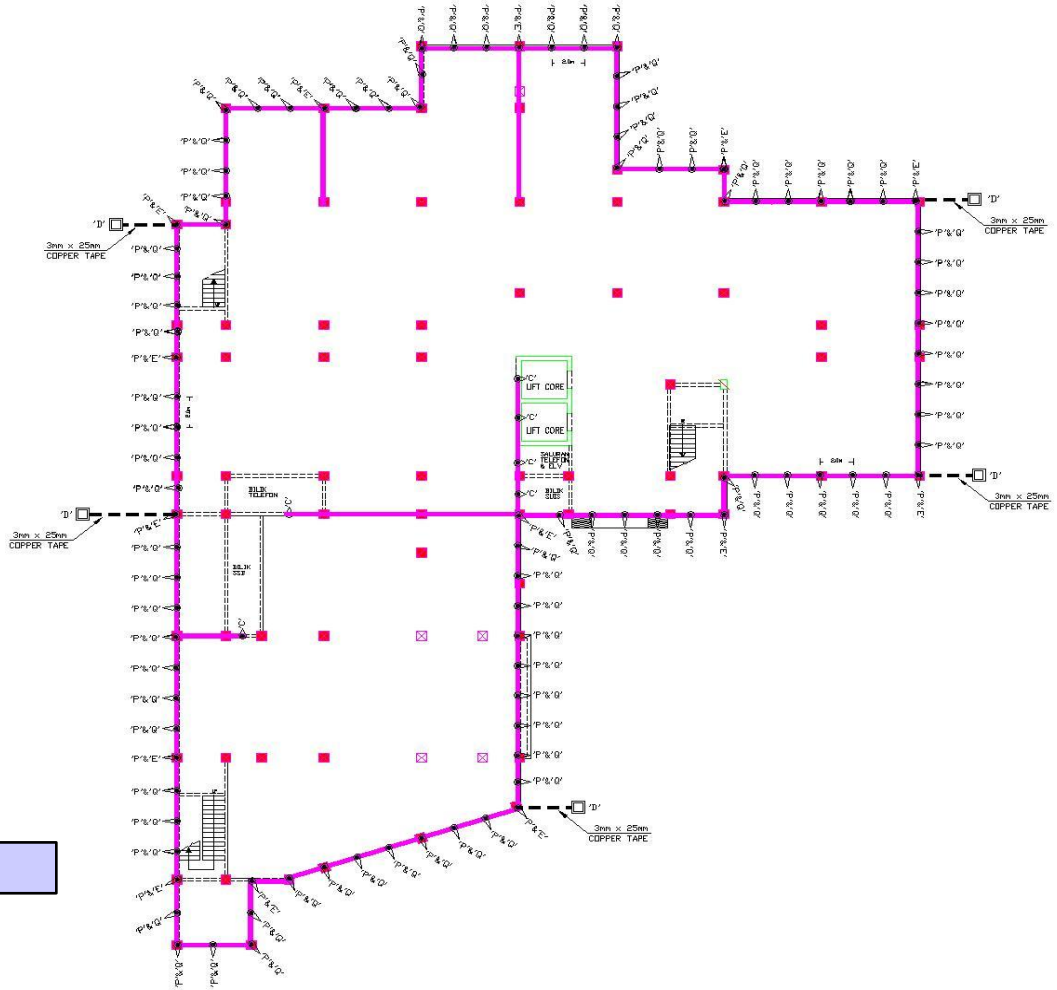

Table 10.1 : Minimum Thickness of Metal Sheets/Metal Pipes in Air Termination System.

Material	Thickness[1] t (mm)	Thickness [2] t' (mm)
Lead	-	2.0
Steel (stainless, galvanized)	4	0.5
Titanium	4	0.5
Copper	5	0.5
Aluminum	7	0.65
Zinc	-	0.7

Notes :

(1) Thickness t to prevents puncture, hot spot or ignition

(2) Thickness t' only for metal sheets if it is not important to prevent puncture, hot spot or ignition problems

(3) Electrical continuity between the various parts shall be made durable (e.g by means of brazing, welding etc)

(4) They shall not clad with insulating material

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Table 2 – Maximum values of rolling sphere radius, mesh size and protection angle corresponding to the class of LPS

	Protection Method		
Class of LPS	Rolling sphere radius *r* m	Mesh size *W* M	Protection angle α°
I	20	5 x 5	See figure below
II	30	10 x 10	
III	45	15 x 15	
IV	60	20 x 20	

Table 2 – Maximum values of rolling sphere radius, mesh size and protection angle corresponding to the class of LPS (cont.)

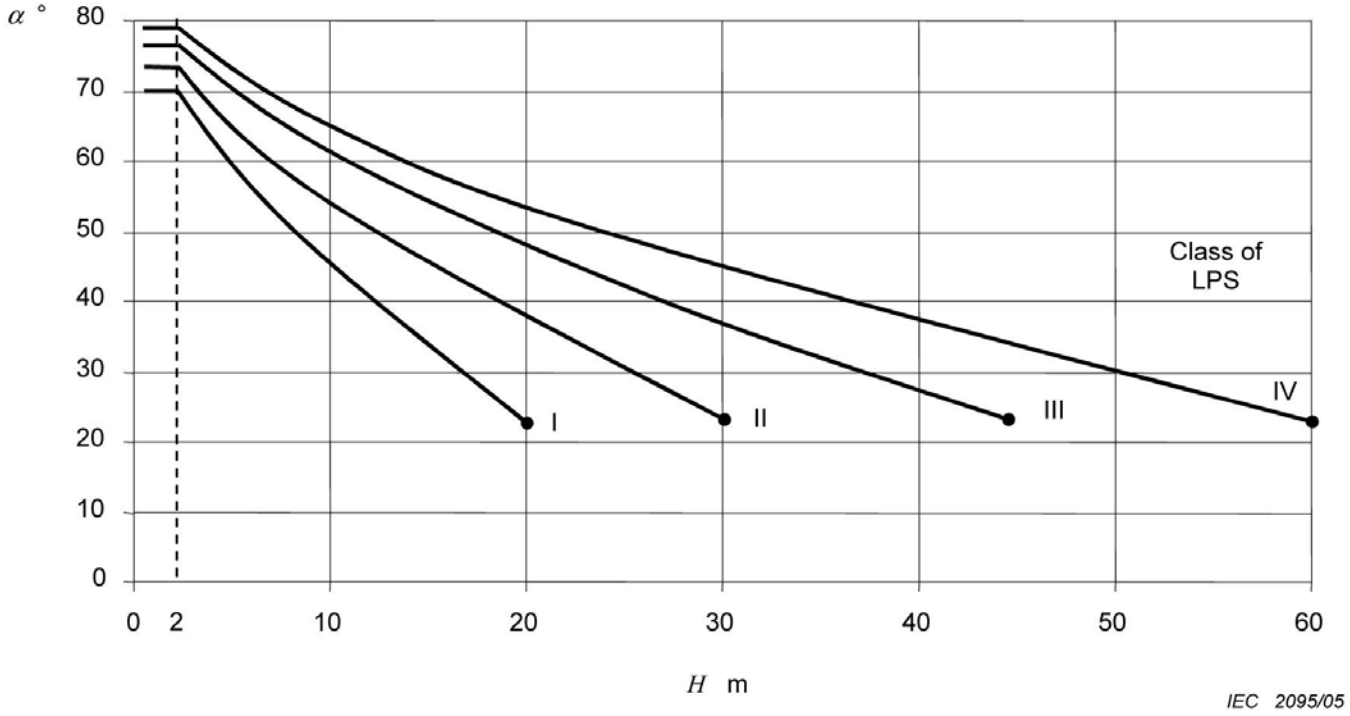

Table 3 – Typical values of the distance between down conductors and between ring conductors according to the class of LPS

Class of LPS	Typical Distance m
I	10
II	10
III	15
IV	20