SAFETY AND QUALITY FORUM
The Institution of Engineers (India)

20th SAFETY CONVENTION

Theme: "Back to basics for strengthening EHS & Sustainable Foundation"

12.09.2023

Technical Session-IV | Transportation Safety

TITLE: TRANSPORT SAFETY IN AN INDUSTRIAL COMPLEX

Introduction

Transport Facilities inside an industrial complex / warehouse involves pedestrians, slow moving vehicles, passenger vehicles, freight vehicles and emergency vehicles.

1. **Transport Safety** risks occur wherever **transportation by various modes occurs** and **these risks can be mitigated by meticulous planning and implementation**.

2. The major components that affect the **traffic movement in an industrial complex are entry and exit from work place, traffic movement within the complex, loading & unloading location** and its process, **officials & visitors' vehicles, parking of officials and freight vehicles**,

3. Major Conflicts occurs at **Intersections among vehicles and pedestrian-vehicles conflicts**

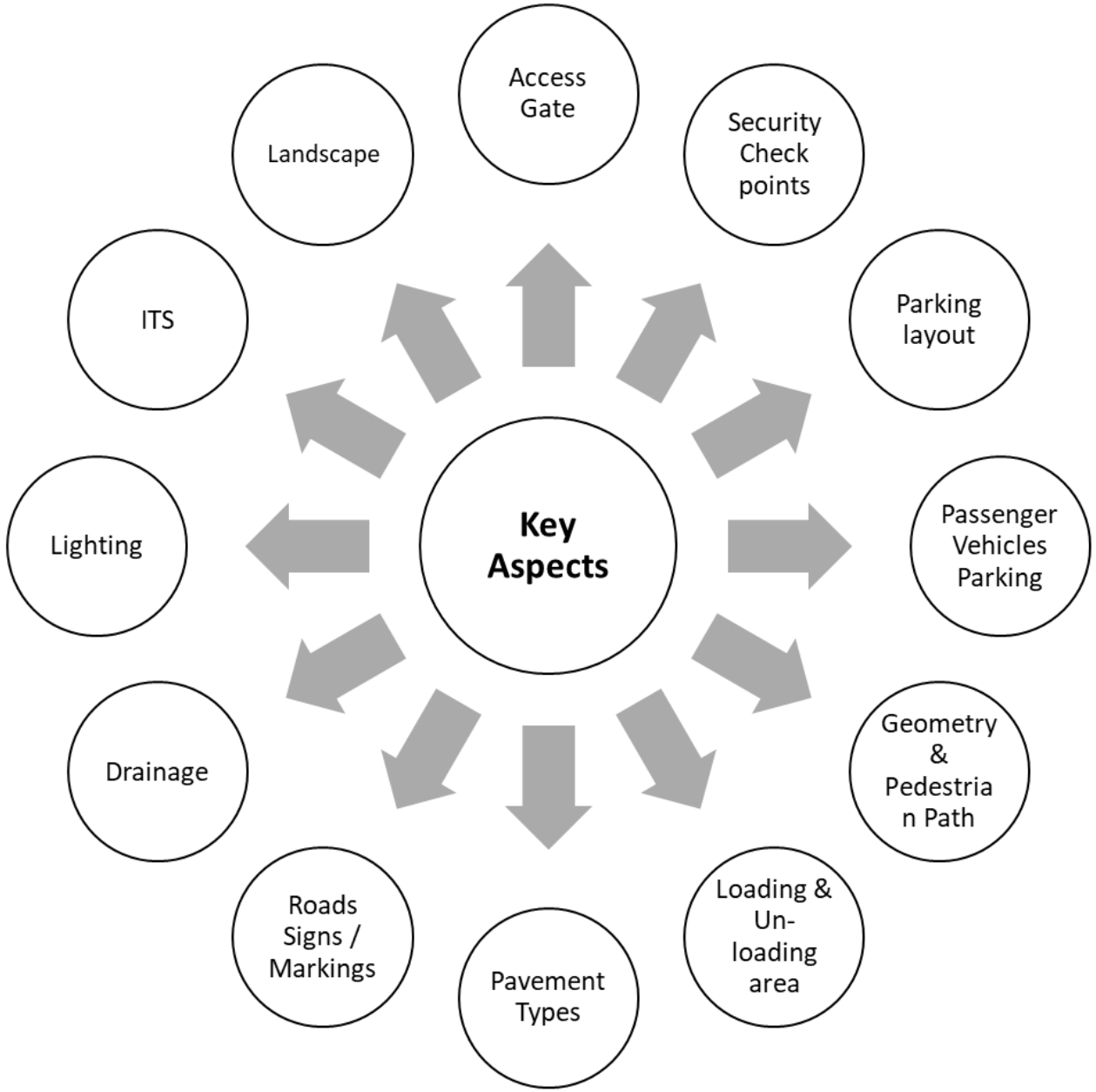
Key Aspects

The key aspects to be considered and **designed to provide optimum efficiency in traffic operations with maximum safety at a reasonable cost**

What Causes Accidents/Crash?

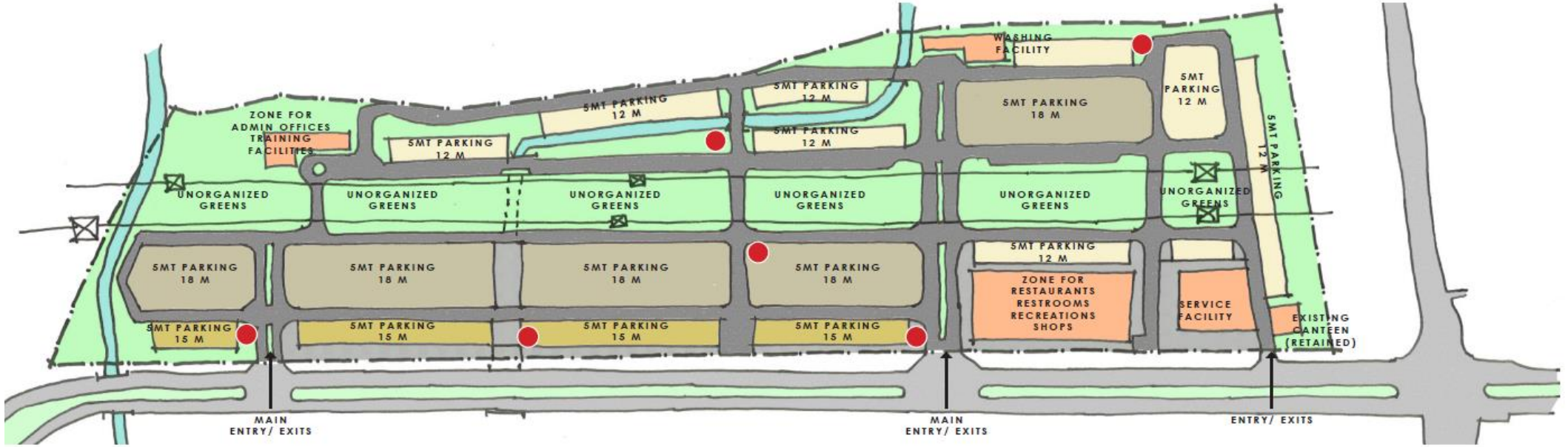
The **collision of one road user with the other road user or with the fixed object lying within the roadway or running off from the roadway is termed as road crash.**

The key design elements like road geometrics, parking layout, pedestrian infrastructure, operational safety, and truck operations at parking spot plays an important role in mitigating the risks involved



Why Accessibility, Safety and security?

1. **Accessibility, safety and security** of an complex **depends on choice of the external Road network**
2. **Accessible Industrial sites includes safe & universal access to vehicles**
3. Safe accessibility to Industrial sites ; Implies
   - **Safety in Geometric design**
   - **Holding lengths**
   - **Parking layout**
   - **Pedestrian walkways**
   - **Traffic Calming**



Access (Entry/Exit) Gate Location

The **access gate location** in terms of **inbound and outbound** traffic with respect to the external road network is an important aspect considering the **right turns (median opening location) and U-turns on external road network**.

Types of traffic access an industrial complex as follows:

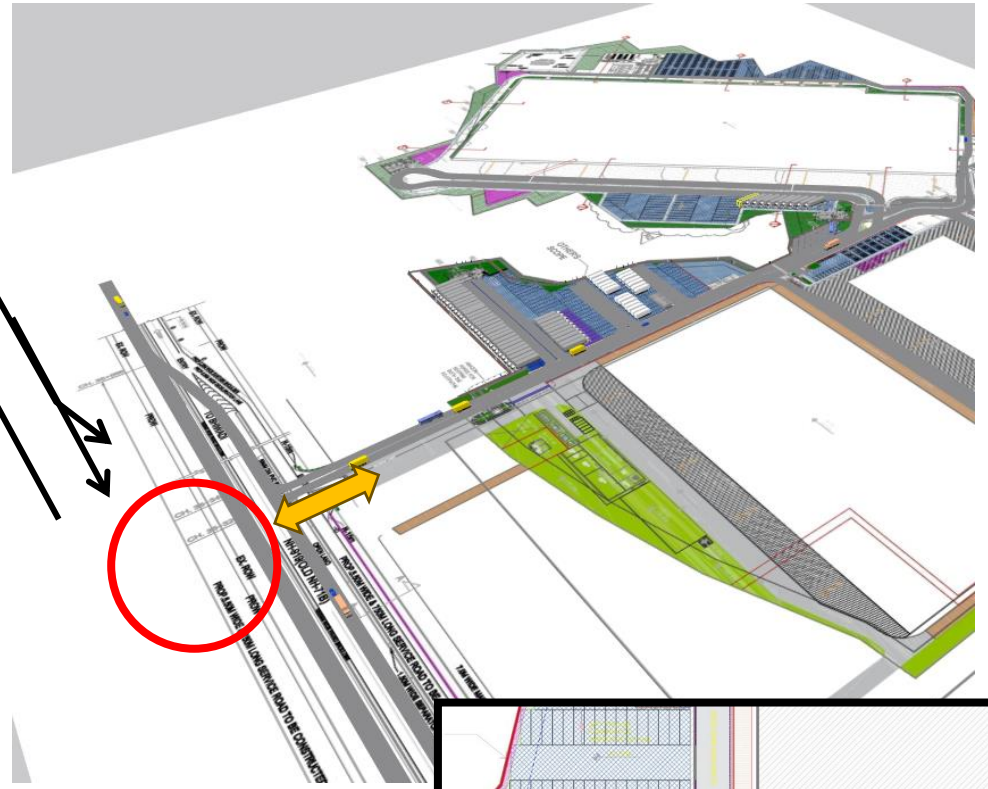
i. **Freight Traffic carrying raw material inside the industry and finished products from the Industry**

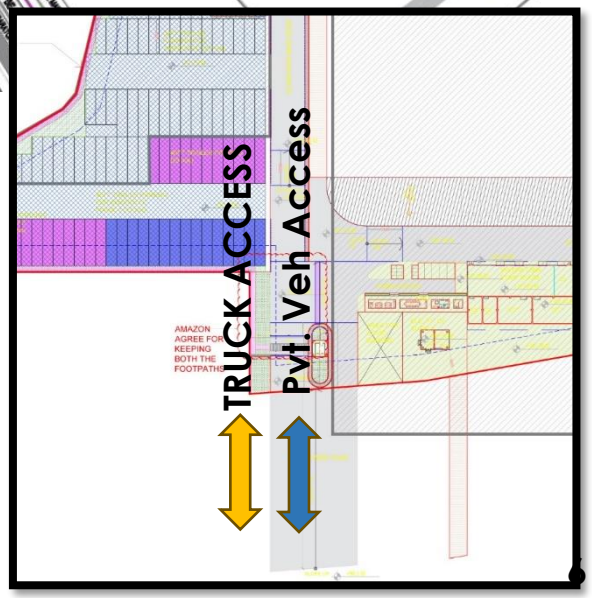
ii. **Passengers traffic carrying officials/workers and visitors'**

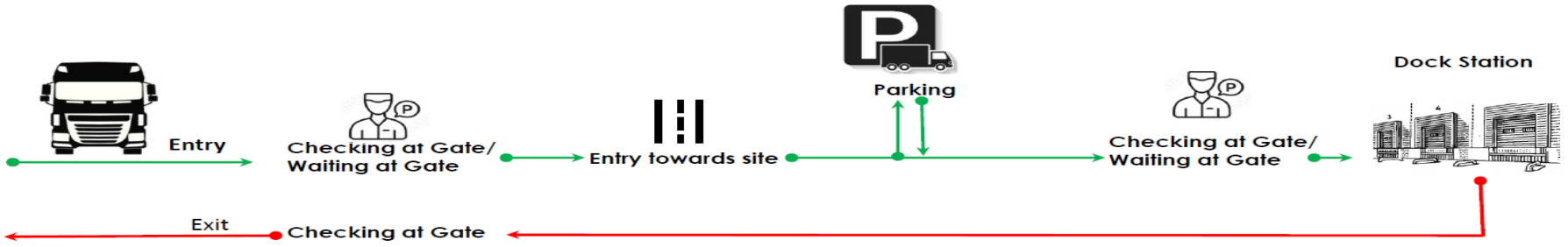
The access for both kind of traffic can be planned **single or dual depending upon volume of traffic of different modes.**

Freight traffic **having large volume of trucks and trailers subjected to through security check** will create delays and congestion, **so separate entry/exit shall be planned**

The access gates should be planned considering **the access location of adjoining industry, median openings, external road alignment, required U-turn / right geometry and existing junction locations**.



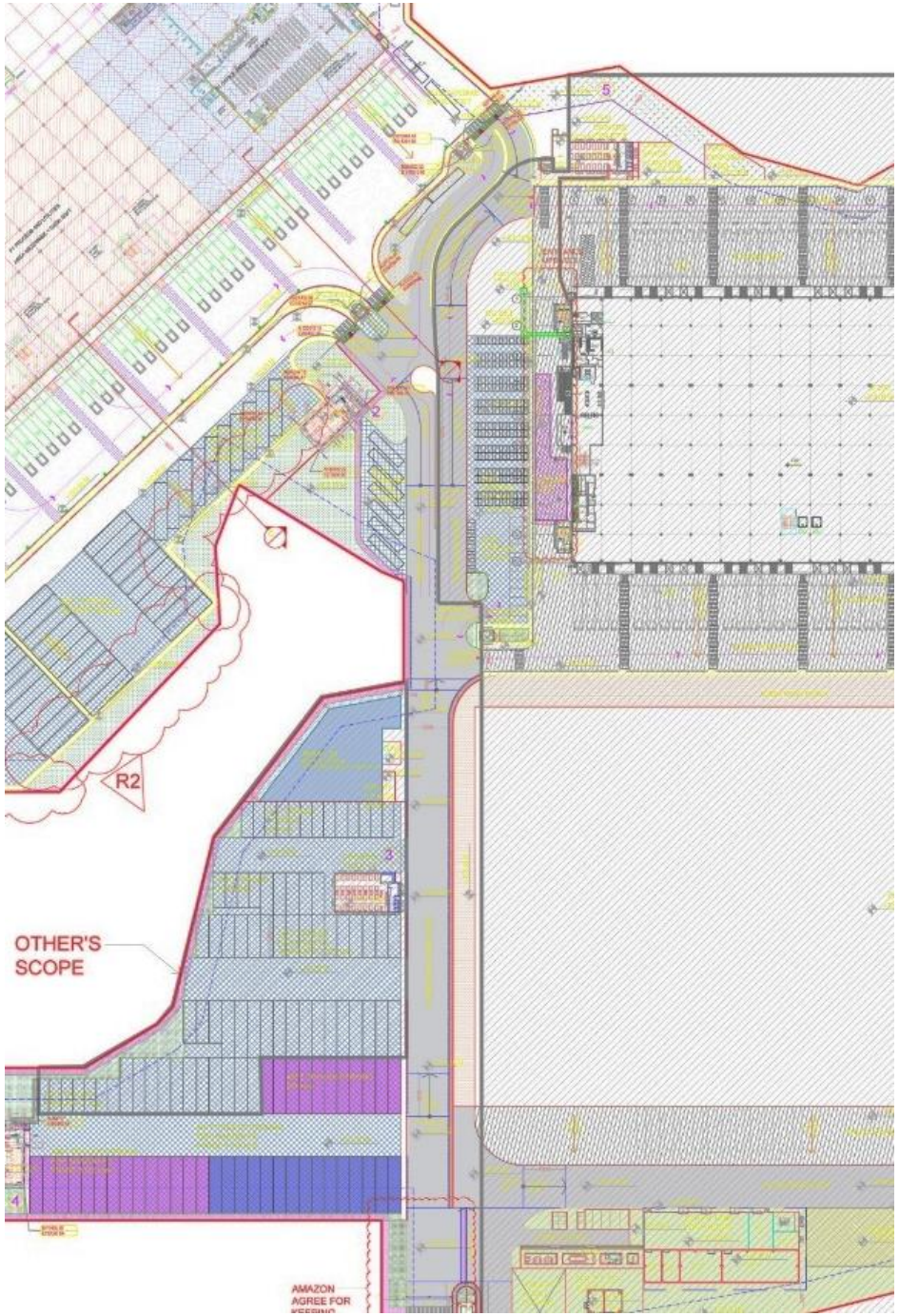




Traffic Within Complex

- **Traffic studies play a major role** in assessing the road network requirement in an industrial complex.
- **The carriageway width, pavement type and its composition** are determined based on volume of traffic and loads carried by freight traffic.
- Detailed traffic studies should be conducted/estimated for **classified traffic volume counts at entry/exit, mode share of traffic within complex, and Internal OD (traffic distribution within the site**)

Truck type	Dimension (ft)	Bay Size
6 wheel	24	3.75m X 12m
10 wheel	31	3.75m X 12m
14 Wheel	32	3.75m X 12m
12 wheel	34	3.75m X 12m
14 Wheel	34	3.75m X 12m
16 wheel	38	4.0m X 15m
22 Wheel	42	4.0m X 15m
18 Wheel	48	5.0m X 18m
18 wheel	52	5.0m X 18m
14 Wheel	52	5.0m X 18m
22 wheel	52	5.0m X 18m



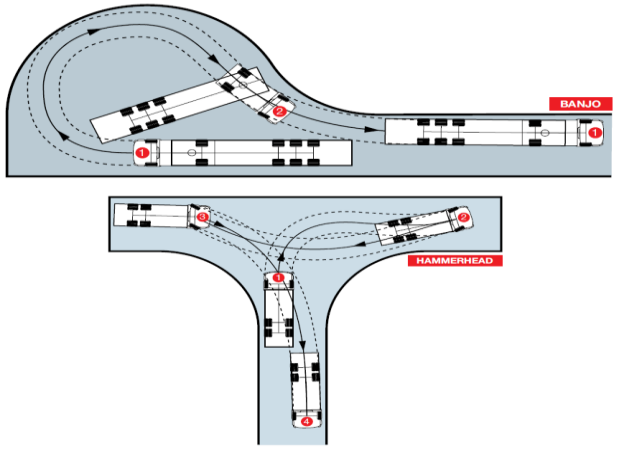
Driveway Planning and Design

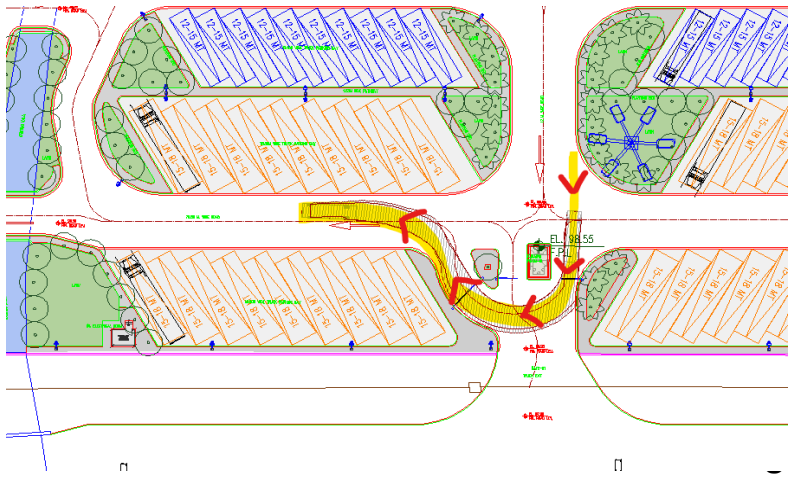
Major Traffic Movement undertaken within Industrial Complex

- Trucks from **Entry to Parking to Raw Material Yard/Store to Exit**
- Trucks from **Entry to Parking to Finish Product Yard/Store Material to Exit**
- **Movement of Raw Material from Yard/Store to manufacturing units to Finish Product Store**
- **Movement of Passengers vehicles from Entry to Parking to Exit**
- Movement of **Passengers vehicles from Parking to administrative blocks and manufacturing units to Parking Lot**
- Requirement for movement of **emergency vehicle such as fire tenders, ambulances, etc**.

Driveway Design

- Max. Design Speed **30 km/hr**
- Carriageway **width 5.5m (one way movement) and 7m for two way movement**)
- **Intersections design with adequate visibility preferably roundabouts**
- **Design of Cul-de-sac** in one-way traffic movement on dead ends
- Design **Pavement composition for the expected loading**





Driveway Road Surface/Pavement Type

- **Independent design for various type of pavement shall be provided** in driveway, parking, loading/unloading area, pedestrian pathways, etc.

- Various types of surfaces are **bituminous, concrete, Paver blocks, PCC boomed Surface, stone blocks (smooth/uneven), chequered tiles, etc. depending upon site requirements**

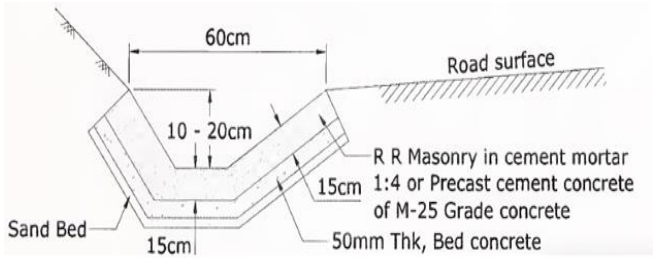
- **Road Crust shall be designed for expected vehicle loading**

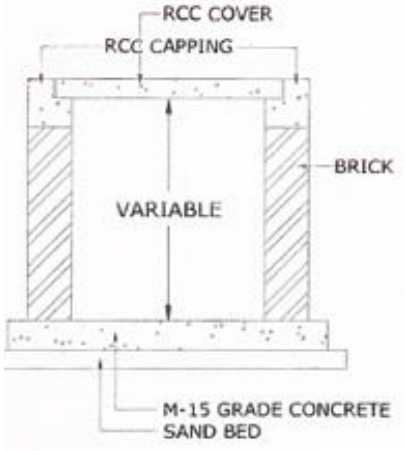
- Riding surface, **shall be strong, non-slippery, potholes**, etc.

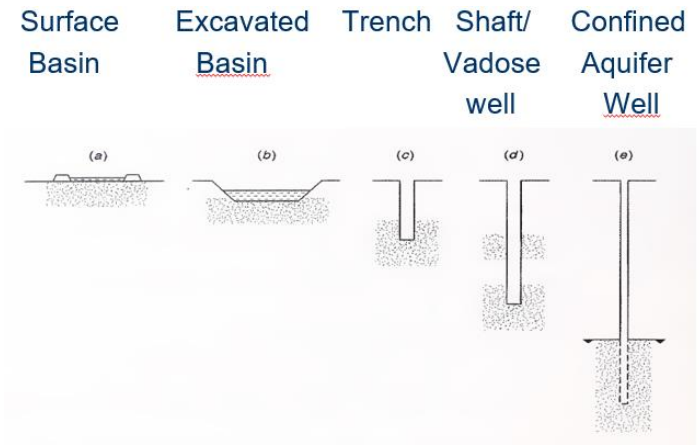
- **Provide good skid resistance** to facilitate the **braking and steering manoeuvres reasonably** for a particular site

Drainage and Ground Water Recharge

- **Drainage is a process of removing and controlling excess surface** and sub-soil water on the roadway
- Surface water from the carriageway and shoulder should be effectively drained off without allowing it to percolate into road subgrade
- Longitudinal side **drain provided along driveway/pathways** and should have **sufficient capacity and longitudinal slope to carry away all the surface water** effectively
- **Drainage of Parking area, loading/unloading** area shall be designed to remove storm water at the earliest
- **Integrate drains constructed in the industrial complex with public drains or lead to ground water recharge system constructed in the complex**
- Free flow of the **major drains within complex or at entry/exit of complex and adequate cross drainage structures shall be provided.**
- On the basis of the shape of drain, **the road side drain may be rectangular, trapezoidal, triangular or semi-circular**
- The type of drain may be angular drain, saucer drain or kerb and channel

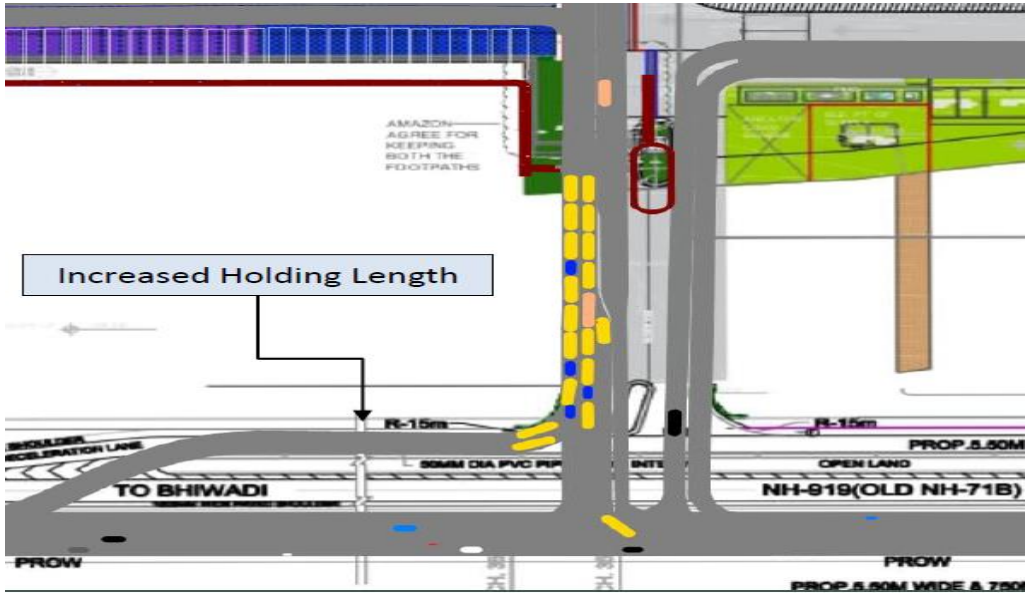






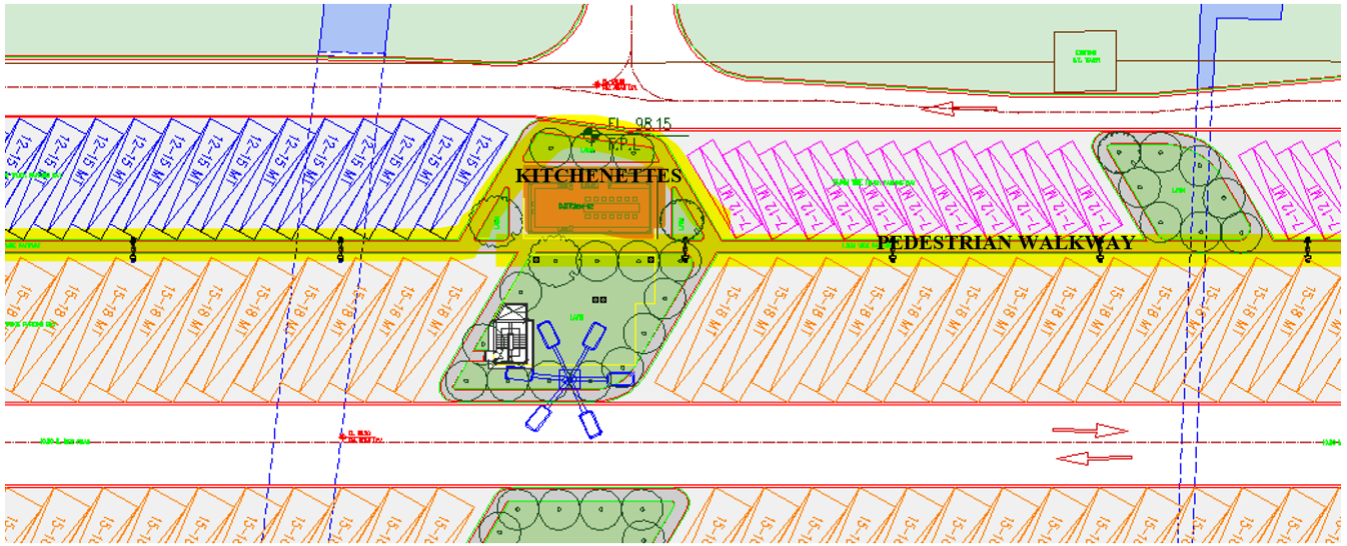
Security Check Points

- **Security check may be entry location only or at both entry/exit location**
- The location of checkpoints shall be decided based on **security check duration for which a vehicle need to stop**
- Accordingly, **provide sufficient throat length (holding length)** based on security check duration. Efforts should be made to **avoid queue spill over on the external/internal road network**
- The **spill over may cause congestion and safety concerns for vehicles and pedestrian crossing**
- Detailed evaluation for the **holding lengths can be analysed through micro simulation tools**



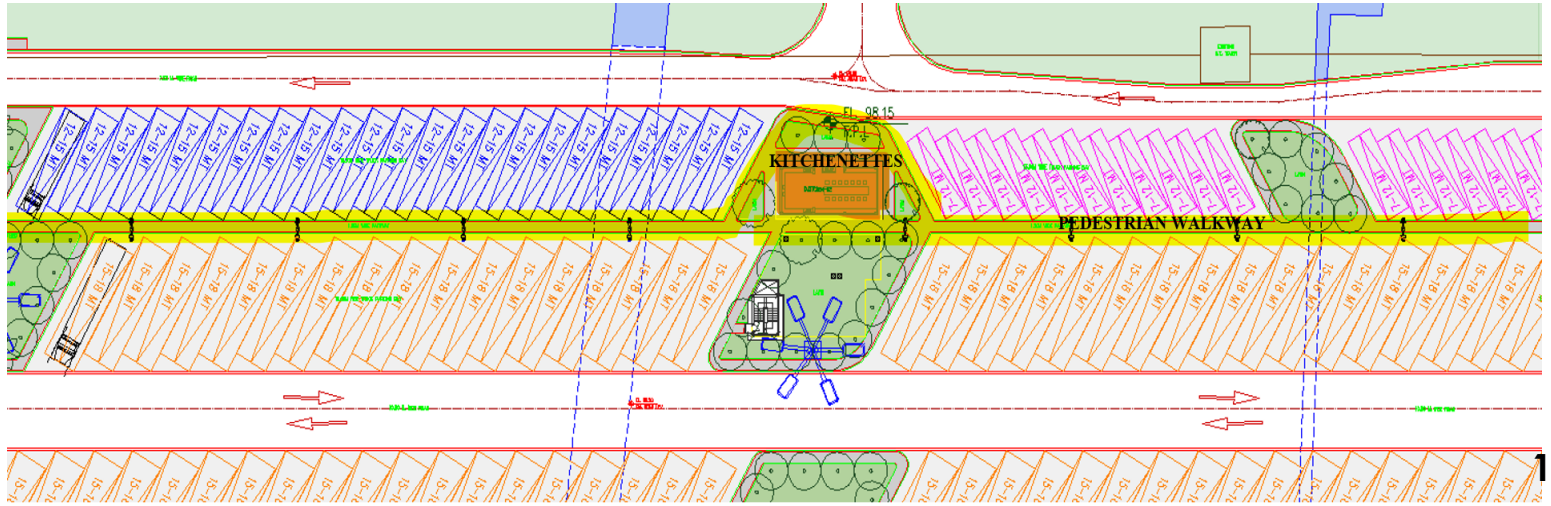
Freight Parking and its Layout

- Parking location, its size and layout depend upon the Parking Load
- **Vehicle layout inside the parking shall be planned considering the Driver movement** (after getting down from vehicle)
- Here **“link and place” is an important concept** to be considered. The **“links” being the driveway for the vehicle** movement and **“place” being the area for driver's movement, street furniture, kitchenettes etc.**
- A **safe passage to be kept either between the parking or along the main driveway for Driver’s movement**
- It is required to **install wheel stoppers to make sure vehicles do not drive into a pedestrian area** and hit the pedestrian



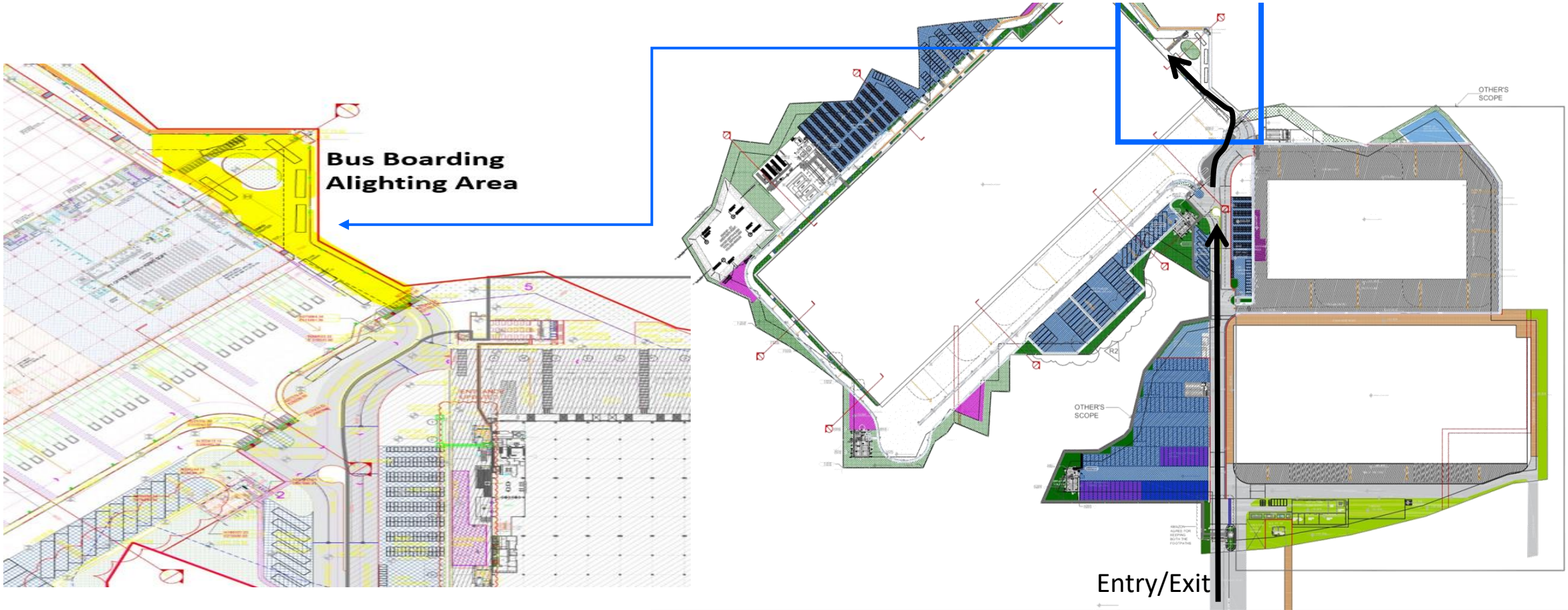
Pedestrian Paths

- Pedestrian pathways shall be **minimum 2m wide** as per IRC 103
- Pedestrian paths can be **standalone or can be provided parallel to driveways**
- Where vehicles and pedestrians share a traffic route, **these must be safely separated**
- Where pedestrian and vehicle routes cross, **well-marked and signposted crossing points should be provided**
- **Provide drop kerbs wherever raised Pedestrian Pathways are provided**
- A **suitable barriers or guard rails shall be provided to enhance safety** such as :
  - At the entrances and exits to buildings
  - At the corners of buildings
  - To prevent pedestrians from walking straight onto roads



Passenger Vehicles Parking

- **Passengers Vehicles Parking holding** period is (**personalised vehicle-Parked for 9-10 hrs**, **visitors' vehicles- parked for 1-2 hrs**, and **public transport for 8-9 hrs for company owned buses and 30 minutes for others**
- **Parking provision shall be planned separately for various categories of vehicles (including private vehicles, cycles, TW)**
- To avoid safety concerns outside the complex, preferably provision of **bus parking, boarding – alighting area and private vehicle parking should be planned within Complex**



Loading / Un-loading Area

Heavy loads, **moving or overturning vehicles and working at height can lead to fatal or serious injuries**

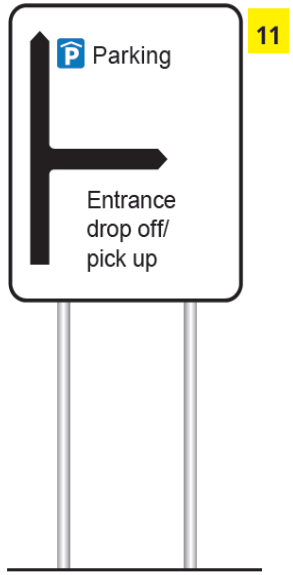
The loading/unloading area is **highly accident prone as workers as they are hit by objects falling from vehicles, getting hit during reversing, etc**.

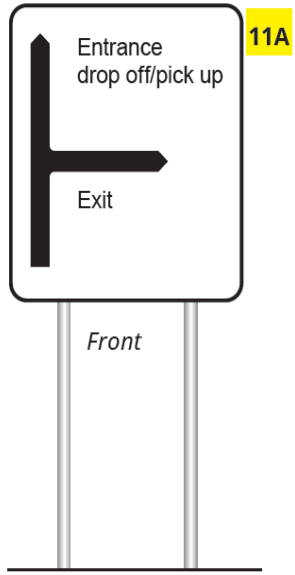
Design of loading and unloading areas shall be as follows:

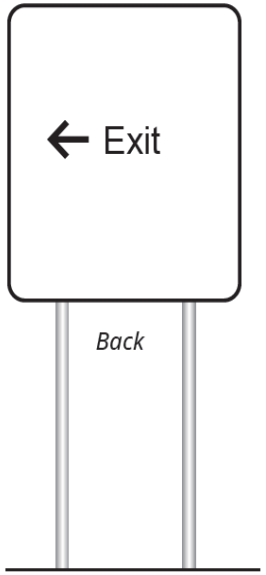
- **Clear of passing traffic, pedestrians and other people who are not involved in loading or unloading**
- **On levelled/flat to maintain stability vehicles and their trailers**
- **Free from potholes or debris, which could make vehicles unstable**

Road Signs

- **Road Signs speak language of the road** and required **for guidance of motorists on the driveway**
- Road Signs installed at appropriate locations to **controls the driving behaviours to enhance safety**
- Road signs shall be of **High Intensity Prismatic Grade Sheeting Type III/IV as per IRC 67 and in the language mostly spoken/understood by road users**
- The various types of sign provided are Regulatory Sign, Warning Signs, Object Markers, Conventional Road Guide Signs, General Service Signs Sizes, etc.







Intelligent Transport System

1. Intelligent Transport Systems (ITS) refers to efforts that apply **information, communication and sensor technologies to vehicles and transportation infrastructure in order to provide real time information for road users and transportation system operators**

2. ITS is widely used for **traffic management at entry/exit, parking management, incident detection and warning System, emergency response system, speed management, automatic traffic control for vehicles and pedestrians**

3. Install **PTZ CCTV Pan Tilt Zoom CCTV Camera, capable to remote directional and zoom control with video surveillance system**

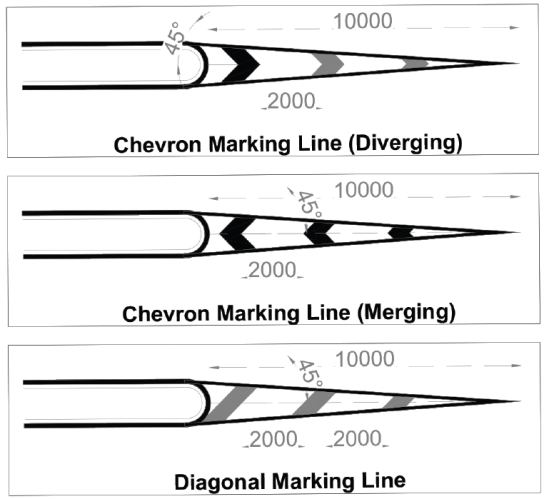
4. Install automatic **boom barrier** at entry/exit **with in-built loop, parking incident detection system (VIDS)** to detect wrong direction traffic movement and unusual traffic at the Entry/exit or parking

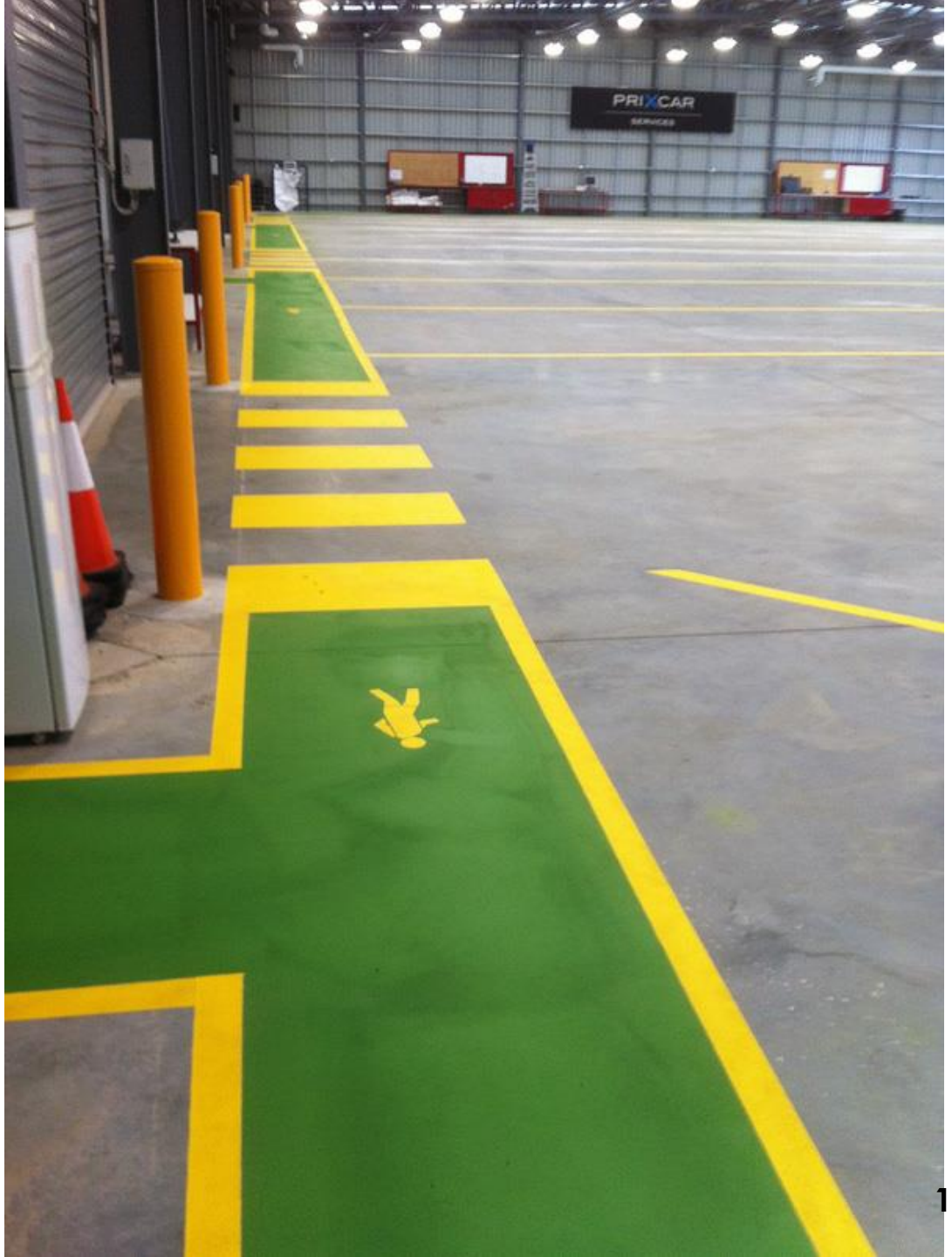
Parking Guidance Systems (PMS) is a **convenient solution to facilitate drivers to vacant space** with the help of signages and sensor combination.

These system reduce the **vehicle travel, simplify the operations, ease of information, reduce duplication of trips and enhance safety by reducing traffic volume on driveways and within parking complex**

Road Markings

- Channelising Traffic (vehicle and pedestrians)
- The **co-ordination of pavement markings with road signs is essential to convey definite message to road user and enhance overall safety on the road**
- Markings provided are **Centre line, Edge lines, Chevron lines, Stop lines, Zebra markings, direction arrows, Kerb paintings, etc.**
- **Road studs can be fixed to enhance the night visibility further**.





Lighting

1. Lighting of the complex including driveway is required to **ensure** security of complex and **safe movement of traffic on driveway, parking, loading/unloading area, pedestrian pathways**, etc.

2. The minimum illumination of lux as per statutory or activity specific shall be provided**. On driveway, parking, loading/unloading area, pedestrian pathways a minimum of 40 lux shall be provided**

3. Provision of Electro Mechanical timers for **auto switching on/off**

4. **Solar lights** are preferable

"BE SEEN BE SAFE"

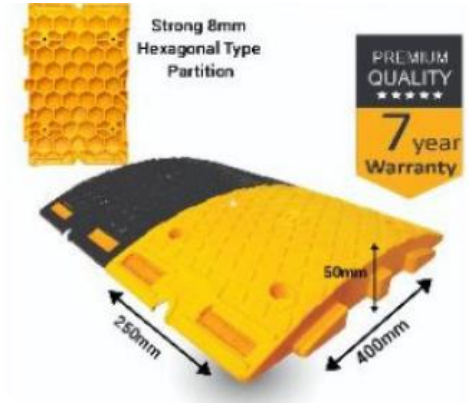
Traffic Calming Measures

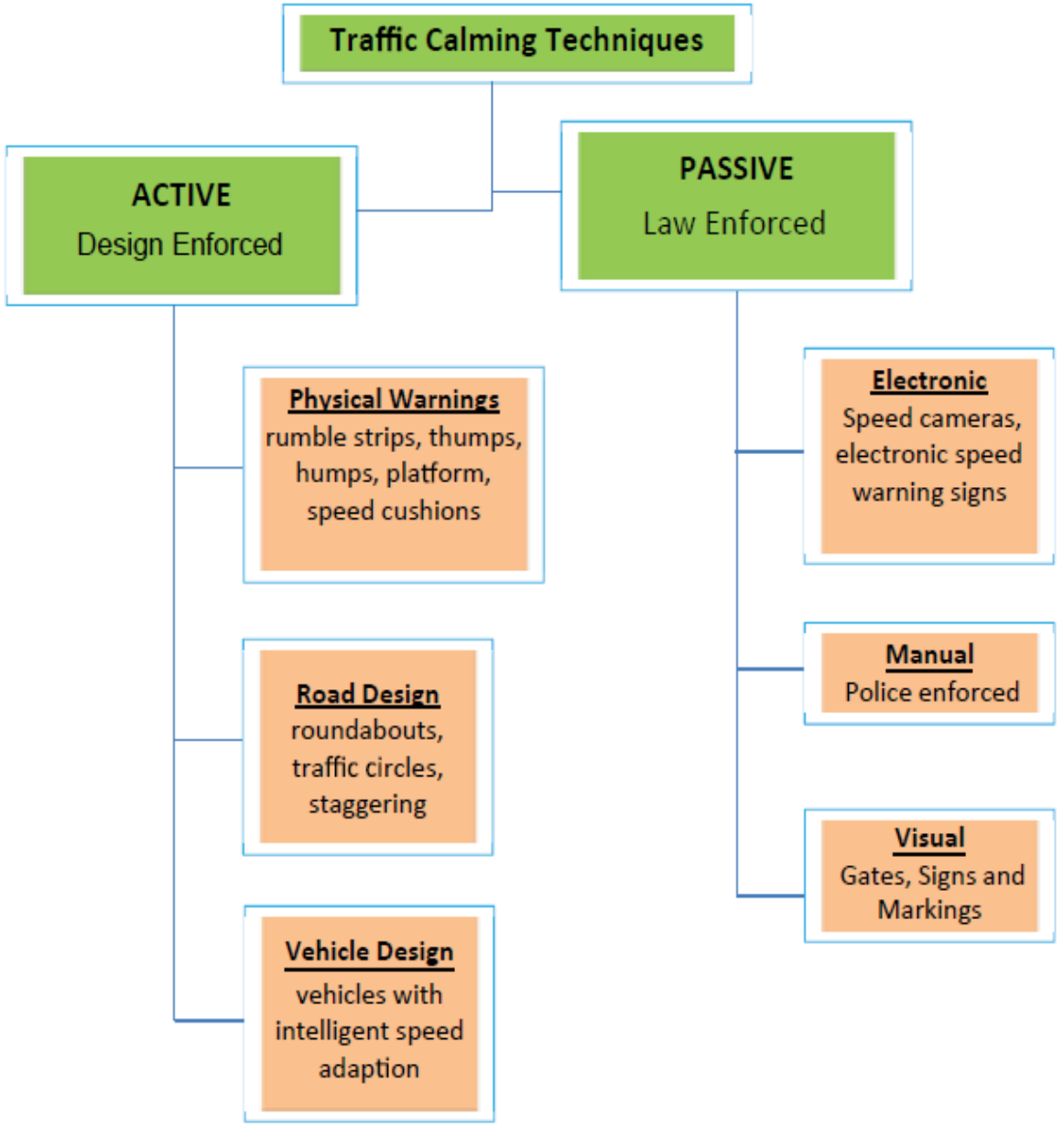
- The basic principle of **Traffic Calming remains universal, that is to lower the vehicle speeds in order to reduce accidents, and enhance liveability of surrounding areas**

- Although, the driveways are designed for 30 km/hr or lower speeds but drivers tend to speed up Therefore, **speed calming measures are required at entry/exit from complex, security check points, intersections of driveways and with pathways,** etc.

- Traffic calming measures can be active or passive

- Measures such as **road narrowing, roundabouts and road humps, reduce the negative effects of motor vehicle use, and alter driver behaviour and improve conditions for pedestrians.**



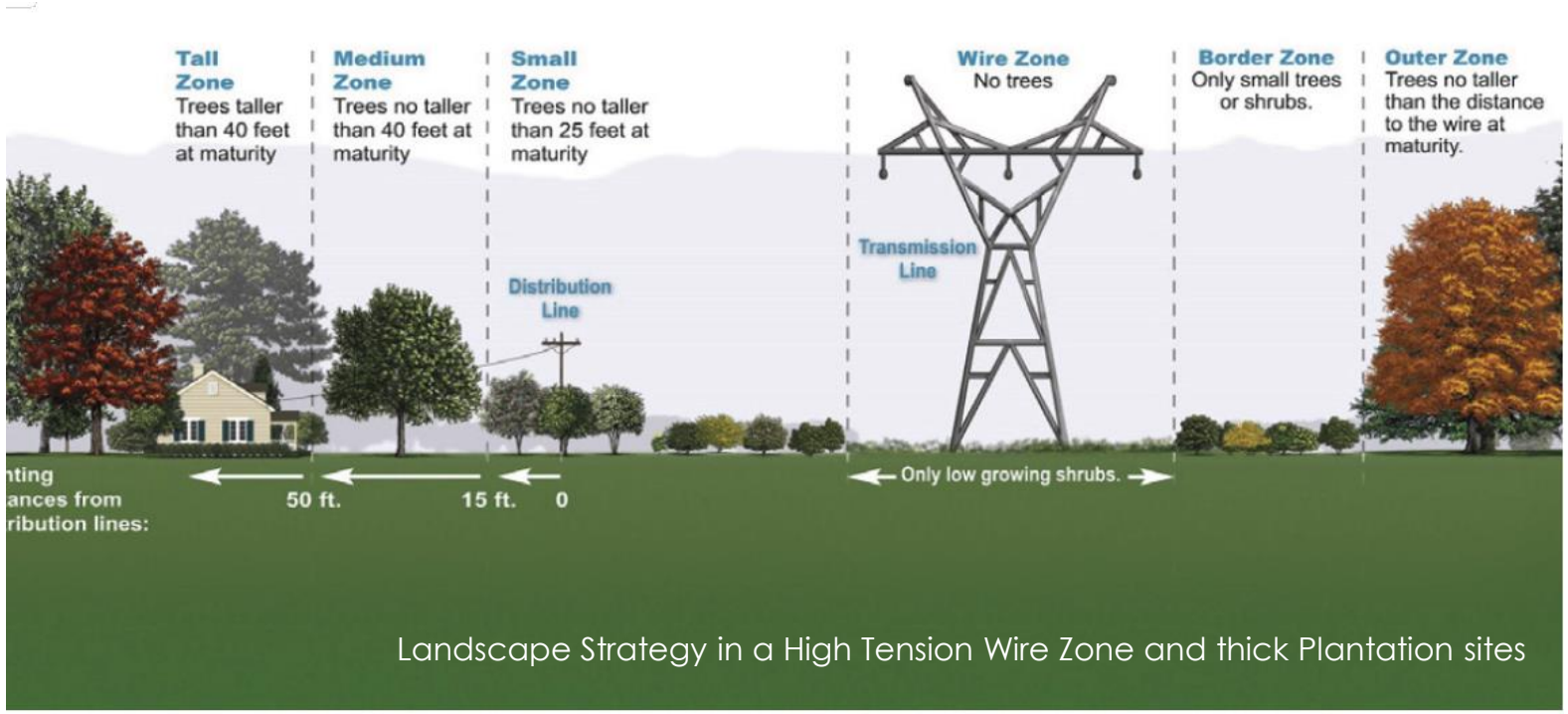


Landscaping

1. The landscape of industrial complex, driveways, pathways, parking, etc. shall be developed.

2. **Safety during the truck manoeuvring shall be given high importance to avoid damaging of the vehicle or the landscape.**

3. **Pruning of trees** is an important activity to maintain clear sight vision**.**



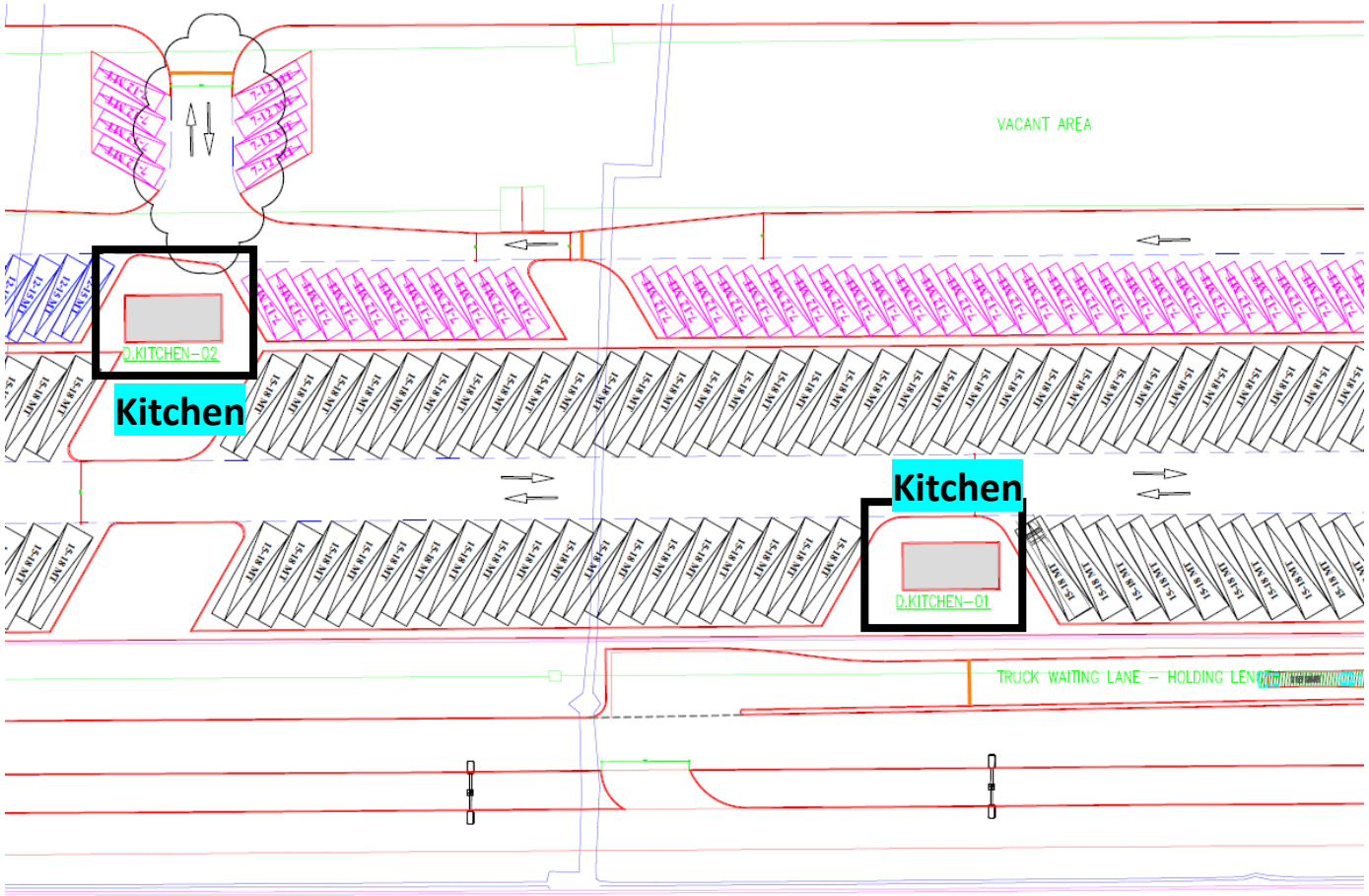
Landscape Strategy in a High Tension Wire Zone and thick Plantation sites

Miscellaneous

1. The employer should circulate the **operational guidelines** applicable for all the users of the campus

2. Proper **induction training** to all the employees and drivers should be performed. Visitors shall be briefed about the traffic and safety norms appliable in the complex

3. Drivers should be provided with **rest rooms, cooking area, canteen and sitouts.** The cooking area and rest areas should be included in planning to discourage the activities to happen in open parking zones under the trucks.



Conclusions

A detailed study and design of transport network in industrial complex shall be undertaken to finalise the **driveways, intersections, entry/exit, parking, road surface, signs, markings, ITS and landscape for an efficient and safe transport system.**

THANK YOU

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