

## Highway Engineering

### Expressways

An expressway is proposed for a road corridor under the following situations;

- A road corridor connecting several highly urbanized centers with ribbon-type of development of commercial, business and industrial establishment.
- A road corridor with high traffic demand

### National Roads

National Roads are roads continuous in extent that form part of the main trunk line system; all roads leading to national ports, national seaports, parks or coast-to-coast roads. National arterial roads are classified into three groups from the viewpoint of function, i.e. North-south backbone, East-West Laterals and Other Strategic Roads.

The elements to consider when planning Expressways are:

- No frontage access;
- Development set well back from the highway;
- Grade separated intersections for extremely high flows and other intersecting expressways;
- Number of intersections to be minimized and
- Where necessary or for emergency purposes, parking/stopping to be provided clear of the main carriageway.

The elements to consider when planning National Roads are:

- Limited frontage access
- Development set well back from the highway
- All access to premises provided via provincial roads
- Number of intersections to be minimized
- Suitable at-grade channelized intersections for minor flows and other elements
- No roadside vendors

Provincial Roads are roads connecting one municipality with another; all roads extending from a municipality or from a provincial or national roads to a public wharf or railway station; and any other road to be designated as such by the Sangguniang Panlalalwigan.

The main elements to consider when planning Provincial Roads include:

- Limited frontage access. In exceptional circumstances, large individual developments may have direct access when a high level intersection is provided
- Development set back from the highway;
- Most development to be given access via intersections with local distributor roads;
- All intersections will normally be at-grade;
- Turning traffic should be separated out from the through traffic;
- Separated pedestrians/bikeways remote from the carriageway;
- Pedestrian crossing points should be clearly defined and controlled;
- Parking on the road should not be permitted;
- Bus stops and other loading areas ( only permitted in exceptional circumstances) should be in separate well designed lay bys;
- Regular stopping places for paratransit vehicles (i.e., private, non-corporately run public transport operating vehicles smaller than buses or AUV's) should be identified and safe stopping places established; and,
- No roadside vendors.

### City/ Municipal Roads

City Roads - these roads / streets within the urban area of the city to be designated as such by the Sangguniang Panglungsod.

Municipal Roads - these roads / streets within the poblacion area of a municipality to be designated as such by the Sangguniang Bayan.

City I Municipal Roads serve to feed traffic onto and off the main road network at the beginning and end of trips. These roads serve local traffic only.

Main points to consider in planning City/Municipal roads are as follows:

- The road is only for local traffic; through traffic is adequately accommodated on an alternative more direct main road;
- Where possible, an industrial traffic route should not pass through a residential area;



- Vehicle speeds should be kept low so long straight roads should be avoided;
- Parking is allowed, but alternative off-road provision should be made if possible;
- Non-motorized traffic is of equal importance to motor traffic and separate route should be provided if possible;
- Where non - motorized traffic needs to use a local distributor it should be separated from motorized traffic;
- The road width can be varied to provide for parking or to give emphasis to crossing points depending upon traffic flows;
- Bus stops and other loading areas ( only permitted in exceptional circumstances) should be in separate well designed lay bys;
- Through-movements should be made awkward and inconvenient to discourage them; and,
- No roadside vendors.

### Route Planning Through Existing Communities

Where a bypass cannot be justified, countermeasures should be implemented to slow down the speeds of through traffic as it passes through the community or trading centers as follows:

- Warning signs and rumble strips can be used to alert drivers about speed-reducing devices ahead;
- A series of road humps increasing in height from 40mm to around 80mm can be used gradually to slow down traffic in pedestrian predominated areas;
- Road narrowing (with due regard for capacity needs) can be used to induce lower speeds as traffic passes through the community; and,
- In order to alert drivers that they are entering a community, it is generally regarded that some form of gateway treatment on the approaches is beneficial (e.g., substandard curve, tree lining, or even non-rigid gate structure).

Bypasses around communities are countermeasures aimed at improving safety and reducing the volume of through traffic inside the community. In the Philippines, this is a common practice particularly around the countryside. However, building bypasses is just an alternative countermeasure of discouraging

traffic to pass within the community. Other countermeasures can be devised depending on economic and budgetary constraints.

Where a bypass can be justified, the most important considerations are:

- The opportunity should be taken to reinforce the road hierarchy by down-grading the old road to discourage through traffic;
- Access to the bypass should be restricted to only a few points where safe intersections and spur roads can be provided to link to the existing network. Direct access from frontage land should not be permitted; and,
- Provisions should be left for future expansion or development of the community but such developments should be served by service roads and spur roads.

### Design Speed

When choosing a design speed, the following factors need to be considered:

- Function of the road
- Anticipated operating speed.
- Anticipated speed limit.
- Economics.

### Current Speed Limit

**80kph** - On open country roads with no "blind comers" not closely bordered by habitation, the maximum speed for passenger cars and motorcycles

**50kph** - On open country roads with no "blind comers" not closely bordered by habitation, the maximum speed for motor trucks and buses

**40kph** - On "through streets" or boulevards clear of traffic, with no "blind corners", when so designated, the maximum speed for passenger cars and motorcycles

**30kph** - On "through streets" or boulevards clear of traffic, with no "blind corners", when so designated, the maximum speed for for motor trucks and buses,

**30kph** - On city and municipal streets, with light traffic, when not designated "through streets", the maximum speed for passenger cars, motorcycles, motor trucks and buses



**20kph** - Through crowded streets, approaching intersections at "blind corners", passing school zones, passing other vehicles which are stationary, or for similar dangerous circumstances, the maximum speed for passenger cars, motorcycles, motor trucks and buses

**40 kph** - High Risk Pedestrian Areas

**60 kph** - Low risk pedestrian areas

**40 kph** - speed limit would also be appropriate on roads where there are no footpaths and pedestrians are required to walk on the road

**80kph** - speed limit would be appropriate on a high standard duplicated carriageway road where there is only occasional access from adjoining properties.

**100 kph** - speed limit would only be appropriate on very high standard expressways, which have a low crash rate. These expressways should have a high standard geometry and should be free of roadside hazards. If hazards exist and they cannot be removed or modified, they should be shielded with a safety barrier.

At the start of a new speed zone, a speed limit sign should be erected on the left and right sides of the road. Then within the first kilometer, there should be two (2) farther pairs of repeater speed limit signs. After that, repeater signs should be placed at **one kilometer** spacing.

**80kph or 90kph** - speed limit may also be appropriate on lower standard expressways.

**Road Capacity**, - is the maximum number of vehicles, which have a reasonable expectation of passing over a given section of a lane or a roadway in one direction or in both directions during one hour under prevailing road and traffic conditions

**The capacity of a route can be affected by the following factors:**

- Number of Lanes;
- Lane and shoulder width;
- Terrain and road gradient;
- Traffic composition;
- Side friction such as the presence of road furniture and pedestrians; and
- Intersection capacity (priority of movements, traffic signal phasing, number of lanes etc.).

**2,000 vehicles/hour** - Ideal capacity of a road

**Vulnerable road users include:**

- Pedestrians
- People with disabilities
- Non-motorized vehicles
- Motorcycles

**Parking Near Intersections**

Vehicles parked near intersections can obstruct the flow of turning traffic. Thus, parking should be prohibited within the following minimum distances from the boundaries of intersecting roads:

- Parallel parking - 6m on both approach and exit sides
- Angle parking - 12m on approach side, 9m on exit side

### Angle Parking

**The following guidelines should be observed for angle parking:**

- The words "Angle Parking" shall be indicated on the parking signs as well as the angle of parking to the curb;
- Pavement marking of parking bays is desirable, particularly where the required angle is not 45 or 90 degrees; and
- Angle parking shall not be installed where visibility restrictions would create a hazardous operating environment, such as the inside of a bend or on a crest.

### Parking Adjacent To Barrier Lines

**When considering parking adjacent to barrier lines the following factors should be considered:**

- If parking maneuvers can be made clear of through lanes. Generally, at least 3 meters needs to be available for moving traffic between the parked vehicle and the barrier line for a single lane of traffic.
- The loss of capacity during parking maneuvers if the maneuvers are not completely clear of through lanes.
- The safety and potential of vehicles crossing the barrier line to pass a vehicle in a parking or



unparking maneuver even though this is an unlawful maneuver.

## Safety Design

The first aim of safe road design is to ensure that road users remain safely on the road. This depends on the following factors:

- a sound road surface;
- an adequate width or cross-section;
- horizontal and vertical alignment;
- good visibility/sight distance;
- delineation and signing;
- provision for pedestrians, pedal cyclists and people with disabilities;
- management of traffic conflicts at intersections; and,
- speed management.

The areas where the state of the road surface condition and good texture of the road surface is particularly important are where vehicles are required to brake or maneuver suddenly such as:

- On the approach to traffic signals
- At roundabouts
- Around tight curves
- On downhill slopes.

Other aspects that could contribute to loss of control on curves are:

- Adverse superelevation;
- Poor sight distance; and
- Poor surface condition.

## Sight Distance

The provision of safety sight distance depends on the characteristics of the driver, the vehicle and the environment:

### Driver

- Alertness of driver
- Recognition of the hazard
- Actions available to the driver - to stop or to change direction

### Vehicle

- Type of vehicle - car or truck
- Friction between the tire and the road

- Eye height of the driver
- Speed of vehicles

## Environment

- Road geometry - grade and curvature sight limitations
- Road surface - sealed or unsealed, smooth or rough
- Road illumination at night

## Type of Sight Distance Elements

- Driver Eye Height is the observed eye height of a driver;
- Object Height is a possible object in the path of a vehicle; and
- Sight Distance is dependent on design speed and vehicle type. It is a major road safety design control when determining the horizontal and vertical geometric alignment for a new or rehabilitation design.

## Stopping Sight Distance (SSD)

There are two components in stopping sight distance:

**Reaction Distance** - the distance traveled while the driver perceives a hazard, decides to take action, then acts by starting to apply the brakes to start slowing down; and

**Braking Distance** - the distance required for the vehicle to slow down and stop

The reaction time to be used for road safety design is **2.5 seconds**. This value is applied to the whole range of design speeds.

## Circular Curve Alignment

**Superelevation runoff ( $S_{ro}$ )** is the length of superelevation development from zero cross slope to full design superelevation ( $e$ ).

**Tangent runout ( $T_{ro}$ )** is the length of superelevation development from the normal cross slope to the zero cross slope point on the tangent.

## Vertical Curves

**Minimum K value vertical curves should be selected on the basis of three controlling factors:**



- Sight distance is a requirement in all situations for driver safety;
- Appearance is generally required in low fill and flat topography situations; and
- Riding comfort is a general requirement with specific need on approaches to a floodway where the length of depression needs to be minimized.

#### Four different criteria used for the establishment of sag vertical curves:

- Headlight sight distance
- Passenger comfort
- Drainage control
- General appearance

#### Shoulder paving is a valuable method of providing:

- integrity of the pavement;
- width to place edgeline pavement markings;
- additional safety to prevent vehicles skidding or drivers losing control in gravel; and
- low maintenance costs compared with unpaved shoulders.

#### Types of Curb and Gutter

- Barrier Curb & Gutter
- Barrier Curb
- Mountable/ Drop Curb & Gutter Mountable/ Drop Curb

The barrier curb types are suited for the edge of the traveled way where it is generally considered that drivers should not mount the curb or sidewalk. The barrier curb types are used for areas where operating speeds are generally less than **60 kph** and where parking of vehicles is allowed.

The mountable / drop curb types provide less vaulting of the errant vehicle on impact with the curb, less likelihood of the driver losing control and less damage to occupants of the vehicles compared to barrier curbs. The drop curb I mountable type shall be used for all traffic islands, medians and the right side of the roadway where operating speeds are **greater than 60 kph**.

**Longitudinal drainage ditches** - essential part of any road that is not on fill and must be incorporated into the road cross section. These are designed to accommodate the expected rainfall but can often be hazardous to vehicles that run off the road. Adequate attention must therefore

be given to the safety considerations of drainage facilities when designing and upgrading highways.

#### The most important criteria to consider are:

Actual reconnaissance survey during wet weather to identify the natural run-out locations;

Slopes on the side nearest the road should not be steeper than and preferable flatter as this will minimize accident severity. The slope farthest from the road may be as steep as **1 in 3** as the ground will permit;

A pedestrian bridge adjacent to the bridge used by vehicles can be an option where insufficient width is available for pedestrians. This can be cantilevered off the structure of the road bridge. A **minimum width of 1.5 meters** should be provided, although it may need to be wider for higher pedestrian and cycle volumes. The additional cost will be relatively small if incorporated during the initial design and construction.

#### Overtaking Lanes

**Overtaking lanes** in flat to rolling terrain are used to break up platoons of traffic and to improve traffic flow over a section of road. They provide positive overtaking opportunities and are sometimes the only real chance for overtaking to occur.

**Climbing lanes** can be considered as a special form of overtaking lane but they are only provided on inclines. Climbing lanes form part of the network of overtaking opportunities and will therefore have an effect on decisions associated with the location of other overtaking lanes.

#### Merging and Diverging for Auxiliary Lane

**The design of overtaking lanes and climbing lanes requires the consideration of the:**

Initial diverge taper; Auxiliary lane length; and End or merge taper.

Turn-out lengths of **60 to 170 m for average approach speeds of 30 to 90 kph** respectively and a width of 3.7 m are to be used. Care must be taken to provide adequate sight distance.

#### Four types of escape ramps:

- Sand Pile;
- Descending Grade;



- Horizontal Grade; and
- Ascending Grade.

**Delineation** - Delineation of the road alignment needs to be considered as part of the design process to ensure that adequate guidance is provided to road users. Improving delineation may also be needed to improve safety on a road section experiencing traffic accident problems.

**Delineation is generally provided by the use of the following devices:**

- Pavement Markings
- Signs
- Guide posts
- Reflective delineators
- Lighting
- Curb or other physical devices
- Pavement Markings

### Signal Controlled Intersections

**Traffic signals improve safety and simplify decision making.**

- Separate vehicle movements in time. This minimizes conflicts.
- Minimize delays at an intersection;
- Enable vehicles from a side road to cross or enter the major road; and
- Assist pedestrians in crossing the road.

### Types of intersections

- Unflared and unchannelized intersections (without widening or traffic islands);
- Flared and unchannelized intersections (with widening but without traffic islands); and,
- Channelized intersections (traffic islands to guide traffic).
- Common types of intersection are cross intersections, T-intersections, Y-intersections, other multi-legged junctions and roundabouts.
- Principles of good design to reduce the likelihood of traffic accidents include:
  - Minimize the speed of vehicles at potential collision points;
  - Separate movements and points of conflict by channelization, or in some situations, prohibit

certain movements (and provide for them at other intersections along the route);

- Control movements to reduce the possibility of conflict; and
- Clearly define vehicle paths by use of pavement markings.

**Traffic Control Devices** - Traffic can be controlled at intersections by regulatory signs, traffic signals, roundabouts.

**Stop or Give Way signs** facing the minor road approaches at an intersection are used to give priority to the major road. Safety at an intersection is improved by assigning clear priority to inform drivers of their responsibilities.

A **Stop sign** is installed on the minor road if the visibility to traffic on the major intersecting road is below specified distances relative to the major road operating speed. Otherwise a **Give Way sign** is used.

The Highway Safety Design Standards Part 2: Road Signs and Pavement Markings Manual, Sections 2.6.1 and 2.6.2 provide details on the visibility requirements for the use of Stop and Give Way signs.

**Traffic signals improve safety and simplify decision making.**

- Separate vehicle movements in time. This minimizes conflicts.
- Minimize delays at an intersection;
- Enable vehicles from a side road to cross or enter the major road; and
- Assist pedestrians in crossing the road.

### Control of Conflicts

**A conflict point occurs where two travel paths interact or cross. Safe intersection design uses the following principle**

- Minimizing the number of conflict points;
- Minimizing the area of conflict;
- Separating points of conflict;
- Giving preference to major movements; and
- Minimizing relative speed of conflicting movements

### Control of Speed

**The speed of vehicles through an intersection depends on:**



- Alignment;
- Road environment;
- Traffic volume and composition; and
- Traffic control devices.

**Low relative speed conditions at intersections can be obtained by:**

- Choosing a layout where conflicting movements cross at angles less than or equal to 90 degrees;
- Providing a layout or alignment that slows down approaching vehicles; and
- Providing deceleration lanes.

### Right and Left Turning Lanes

The safety of an intersection can be improved by provision of right and left auxiliary turning lanes. Turning lanes also improve intersection capacity and traffic flow. They are particularly important if the volume of traffic making these moves is high or if the through or oncoming traffic flows are high.

**Provision for turning lanes can generally be provided in the following ways:**

- Shared turning and through lane;
- Flaring and taper; or
- Separate lane for deceleration and storage

### Right Turn Slip Lanes

**Right turn slip lanes are provided to minimize the delays for right turning vehicles and to make the right turn movement easier and safer.**

**A traffic island is provided with this treatment to:**

- Guide traffic into defined paths;
- Separate through, turning and opposing traffic movements;
- Give advance warning of the intersection to approaching drivers;
- Provide refuge for pedestrians; and,
- Prohibit undesirable or unnecessary traffic movements.

**Types of slip lane arrangements**

- High entry angle slip lane; and
- Free Flow Slip Lane.

### Roundabout

**Roundabout (or rotunda)** is one of the safest type of intersection treatments.

**Roundabouts may be appropriate in the following situations:**

- At intersections with high accident rates
- When physical control of speed is desirable
- When the flows on each approach are balanced and capacity analysis indicates that volumes can be managed;
- When the volume of left turners is significant
- If traffic signals may be inefficient e.g. due to a large number of phases; and
- For multi-legged intersections

**Roundabouts may not be appropriate in the following situations**

- Where satisfactory geometric design cannot be provided due to insufficient space of unfavorable topography;
- Where unbalanced flows with high volumes are on one or more approaches;
- Where a major road intersects a minor road and a roundabout would result in unacceptable delay to the major road; or
- Where there is considerable pedestrian activity and due to high traffic volumes it would be difficult for pedestrians to cross at the intersection.

The maximum design speed through the roundabout should generally be **40 kph in urban areas** and no greater than **50 kph in rural areas**.

**Things to Avoid**

- Straight approaches on high speed roads;
- Central island too small to provide deflection
- Unbalanced traffic flows.

### Safety Of the Roadside

The first objective in road safety is to keep road users safely on the road pavement with a reasonable width, a sound road surface, a predictable alignment and good delineation and signs.



However, it must be recognized that drivers and riders are only human and will sometimes make mistakes and lose control of their vehicles.

**The reasons that they might lose control are many, for example:**

- Excessive speed;
- Fatigue or inattention;
- Alcohol or drugs; or
- Road condition.

**Some typical road environment hazards are:**

- Poles;
- Trees;
- Steep side slopes;
- Water courses, dams;
- Culvert endwalls;
- Fences and encroaching buildings; and
- Bridge piers and abutments;

### Treatment of Hazards

**The options for treating roadside hazards are:**

- Remove the hazard.
- Move the hazard outside the clear zone.
- Modify the hazard so that it is not so dangerous.
- Replace the hazard with something that it is not so dangerous
- Shield the hazard with a barrier system.
- Roadside barriers are used to shield errant vehicles from running into hazards that cannot be relocated or made more frangible.

**In accordance with the National Corporate Highway Research Project 350 (NCHRP350) procedures, there are six test levels to provide a range of restraint requirements and impact severity conditions (refer to Table 20.2). The criteria are based on:**

- Structural adequacy of the barrier system;
- Occupancy risk and the impact velocity and ride down acceleration limits; and
- Vehicle trajectory after impact

### Different Types of road safety barrier

- Flexible Wire Rope Safety Barrier Systems
- Semi Rigid Systems:
- Rigid Systems:
- Road Work Systems:

- Location of Curb Adjacent to Barriers

**The location of safety barriers in the vicinity of curb and gutter is to be considered carefully. If curb and gutter is essential in high speed locations, the face of curb should be located:**

- At least 3m from the face of concrete safety barriers;
- At least 3m from W-beam and wire rope safety barriers for concrete barrier curb;
- At least 3.0m from W-beam safety barrier or wire rope safety barrier for concrete mountable I drop curb & gutter; and
- In areas where the operating speed is less than 70 kph, an offset of 0.2 to 0.3m can be tolerated to minimize damage to vehicles.

### Warrant

**The warrant for the use of safety barriers can be established considering:**

- Fore slope or back slope steepness and height;
- Unforgiving hazards within the dear zone; and
- Water hazards within the clear zone.



## Types of Signs

**Traffic signs** - device mounted on a fixed support or portable support whereby a specific message is conveyed by means of words or symbols placed or erected for the purpose of regulating warning or guiding traffic

**Regulatory signs** - signs that inform road users of traffic laws and regulations which, if disregarded, will constitute an offense

**Special instruction signs** - signs that instruct road users to meet certain traffic rule requirements or road condition

**Warning signs** - warn road users of condition on or adjacent to the road that may be unexpected or hazardous

**Guide sign (Informative Signs)**- inform and advice road users of directions, distance, routes, the location of services and points of interests

**Roadwork signs** - warn or advise if temporary hazardous conditions that could endanger road users or the men and equipment engaged in roadwork

**Overhead signs** - signs which provide means of displaying essential traffic information on wide multilane roads, where some degree of lane use control is required or where side of road clearance is insufficient to accommodate a road side sign

**Barriers** - highway appurtenances designed to prevent vehicular penetration from the travel way to areas behind the barrier such as to minimize damage to impacting vehicles and their occupants and to reduce the risk of injuries to pedestrians and workers

**Flashing lamps** - warning devices use to supplement either controls and devices necessary to alert motorist of construction and maintenance activities of obstruction in roadway

**Delineator** - light retro reflecting devices mounted at the side of the roadway in series to indicate the roadway alignment

**Traffic Cones** - devices which may be conical in shape or tubular shaped capable of performing channelization o traffic which may be set on the surface if the roadway or rigidly attached for continued use

**Temporary Curbing** - roadwork devices consisting of pre cast concrete sections, sandbag and others which, may be used to guide traffic at the construction site

**Flexible Post or Bollard** - device used in place of rigid barrier posts or traffic cones with a minimum of 450mm by 50mm wide with alternate bands of contrasting color as seen by approaching traffic for delineation of traffic

## Classification of Signs

Signs are classified in the following groups according to their use.

- Regulatory Signs (Type R);
- Warning Signs (Type W);
- Guide Signs or Informative Sign (Type G);
- Signs for Expressways (Type GE);
- Signs for Special Purposes (Type S); and,
- Hazard Markers (Type HM).

## Standard Application

Uniformity of application is as important as standardization with respect to design and placement. Identical conditions should always be treated with the same type of signs so that road users can readily anticipate the course of action required.

To be effective, the road sign should meet the five basic requirements:

- Fulfill a need;
- Command attention;
- Convey a clear, simple message;
- Command respect; and,
- Give adequate time for proper response

## Standard Sign Shapes

The **octagon** is reserved exclusively for the **STOP sign**;

The **equilateral triangle**, with one point vertically downward is reserved for the **GIVE WAY Sign**;

The **circle symbol** is mainly used for **regulatory signs**;

The **circle symbol** may sometimes be mounted on a rectangular base either for easy recognition or **for additional information**;

The **equilateral triangle** with one point vertically upward is used for **warning signs**;



The **rectangle**, usually with long axis horizontal is used for **directional signs, service signs, road work signs, signs for special purposes, and supplementary plates for warning signs**;

The **rectangle**, usually with long axis vertical is generally used for **facility information signs, instruction signs, guide signs, and destinations of point of interest**;

The **pentagon**, with point up is used only for **pedestrian and school crossing sign**.

## Color

The standard colors for signs are as follows:

**Red** is used as a background for **STOP signs**, as border color on **GIVE WAY signs**, warning signs and prohibitive signs in the regulatory type.

**Black** is used as legend color for signs having white, yellow, orange, fluorescent orange, fluorescent yellow green background and as chevron for **hazard markers**.

**Yellow** is used as background color for **roadwork signs**.

**White** is the background color for most signs and legends for **some colored background**.

**Fluorescent yellow green** is used as background color for signs related to **pedestrian movement, school zones, and road work hazard markers to give additional emphasis and guidance to vehicle operators**.

**Fluorescent orange** is used as background color for **roadwork signs whose legends relate to personnel working**.

**Green** is used as background color for **direction signs**.

**Blue** is used as background color for **service signs**.

**Brown** is reserved as background color for all **tourist facility directional and information signs**.

## Letter Series

There are **six series** of letters and numerals, ranging from the narrow series A to the broad series F

**Modified series E (E mod)** - mainly used in directional signs, is also included in this manual in Appendix A of the Standard Specification for Road Signs.

**Series A and B letters** - not used on signs which have to be used for moving vehicles as the legibility distances are small.

**Series C** - only used in special cases.

**Series D and E (E mod)** - are commonly used as they provide the best legibility and aesthetics.

**Series F** - not often used on large signs due to the wide space required.

**narrow; medium; and, wide** - Standard letter tables given in Appendix D for capital letters comprise 3 steps of spacing

**Wide spacing** - always used for lower-case letters.

**160 DM** - would mean 160mm series D letters at medium spacing.

**90 LC** - would mean 90mm lower case letters that are always at wide spacing

It should be noted that when all sign rules have been followed, some visual judgment must be exercised in adjusting sign elements.

The following general rules are to be applied when designing the sign face.

- Cramping of legend is to be avoided;
- Avoid large areas of blank panel, particularly blank areas not symmetrically disposed across the panel;
- If there are two list of legends side by side (e.g., as on Reassurance Signs) it is necessary to left justify the left list and right justify the right list; and,
- Elements such as arrows and symbols may sometimes have to be larger than the principal legend would normally require. For example, an arrow relates to several lines of legends on a direction sign

Generally, there should not be more than one signs of a particular type on each post, except where one sign supplements another, or where route or directional signs must be grouped. Where it becomes necessary to convey two or more different messages at one location, separate signs located at a minimum of **0.6Vm apart (where V is the 85th percentile speed in kph)** should be used.

## Overhead sign

The following conditions should be considered in the erection of overhead sign displays:



- Traffic volume at or near capacity;
- Complex or closely spaced interchanges;
- Three or more lanes in each direction;
- Restricted sight distance;
- Multi-lane exits;
- Large percentage of trucks;
- Street lighting background;
- High speed traffic;
- Consistency of sign message location through a series of interchanges: and,
- Insufficient space for ground mounted signs.

### Classification of Regulatory sign

- Priority Signs
- Direction Signs
- Prohibitive or Restrictive Signs
- Speed Signs
- Parking Signs
- Miscellaneous Signs

### Four Sizes for Regulatory Signs

- Size A for urban low speed roads;
- Size B for rural roads with speed limits between 60 and 70kph;
- Size C for high speed rural highways; multi-lane urban roads
- Size D for Expressways.

### Warning Signs

**Warning Signs** - used to warn motorists of potentially hazardous conditions on or adjacent to the road.

### Classification of Warning Signs

- Horizontal Alignment Signs
- Intersection and Junction Signs
- Advance Warning of Traffic Control Device Signs
- Road Width Signs
- Road Obstacle Signs
- Pedestrian and School Signs
- Railway Level Crossing
- Supplementary Signs
- Other Warning Signs

In urban areas advance warning signs should be placed at **not less than 30.0m or more than 100.0m** in advance of the hazardous area

In rural areas the signs should be placed at **not less than 75.0m nor more than 225.0m** in advance of the hazardous area.

### General size of Horizontal Alignment Signs

- Size A is usually for use in urban low speed roads;
- Size B for rural roads with speed limits between 60 and 70kph.
- Size C for high speed rural highways.

### Types of Horizontal Alignment Signs

- Sharp turn
- Reverse turn
- Curve turn
- Reverse curve
- Winding road
- Hairpin curve.

### Intersection and Junction Signs

- cross Road
- Staggered side Road Junction
- Skewed Intersection
- T junction
- Y Junction
- Side Road Junction
- Roundabout Ahead
- Priority Junction
- Priority Merging
- Priority Cross

### Signs that may be used in advance of intersections

Cross Road sign - used in advance of an intersection where two roads cross at a common point.

T-Junction sign - used in advance of a T-junction of the road that forms the stem of the T

Y Junction sign (W2-5) is used in advance of a road path on that approach which forms the stem of the Y

Roundabout (Rotunda) sign - used on all approaches to a rotunda.

These signs inform the motorist that the road he travels on is a **priority road** with the junction intersection in front of him being controlled either by a STOP or GIVE WAY sign.



## Supplementary signs

- Advisory Speed
- On side road
- Distance m
- Distance km
- When wet
- Blind
- Aged
- Playground
- School
- Disabled

## Types of supplementary Sign

**Advisory Speed sign** - used only in conjunction with another warning sign to indicate the desirable speed in good weather, traffic and road conditions.

**ON SIDE ROAD sign** - used as a supplement other signs such as FLOOD or RAIL CROSSING to warn the road users of a hazard on a side road in close proximity to the through road.

**(Distance) ... m and (Distance) ... km signs** - used in conjunction with a warning sign where an indication of distance to the hazard is desired.

**When Wet** - This sign is used in conjunction with the Slippery Road warning sign

**Blind; Aged Playground School Disabled** -used in conjunction with the PEDESTRIAN and CHILDREN Crossing signs (W6-1) and (W6-2).

## Vertical Clearance

The CLEARANCE signs shall be rectangular in shape and **not less than 1500mm x 600mm in size with the long axis horizontal**. They shall be black letters on white reflectorized background.

The LOW CLEARANCE sign shall be rectangular in shape and **not less than 1950mm x 600mm in size with the long axis horizontal**. It shall be installed on all bridges, underpasses and other structures where the vertical clearance above the road pavement is **4.80m** or less to warn motorist of the restricted height of the approaching structures. Vertical clearances shall be reckoned from the highest flood level.

## Guide Signs

**Guide signs** inform road users about the direction and distances of destinations on the route they are following or along other roads that intersect their route.

## Classification of signs in the Directional Signing

- Those installed in advance of the intersection.
- Those installed at the intersection.
- Those on departure from the intersection.
- Those installed on expressways.

## Classification of Guide Signs

- Advance Direction Sign
- Intersection Direction Sign
- Reassurance Direction Sign
- Finger Board Direction Sign
- Street Name Signs
- Town Name and Geographical Feature Signs
- Service Signs
- Tourist Information and Tourist Destination Signs
- Route Markers

## Color

The background color should be easily recognizable by motorists as being applicable to the particular category of guide signs for which it is used. The color combinations, which shall be used are as follows:

- **Black legend on white background:** Information signs, street name signs and kilometer posts;
- **White legend on standard green or blue background:** Advance direction signs, intersection and special direction signs, and re-assurance direction signs, including signs giving directions to expressways from the adjacent road and street system;
- **White legend on blue background:** Signs indicating roadside facilities, services and legends used. The size adopted will depend on the required letter size, the number of words in the legend, symbols used and the general arrangement;
- **White legend on brown background:** Tourists interests;

## Amount of Legend

The principal legend on a guide sign should be limited to the number of words a driver can read and in time he can turn his attention from the road to the sign.



Desirably, a guide sign should carry not more than **three lines of legend or three destination names**. However, up to five lines or names may be used in special cases.

**When distances are shown on guide signs, the following rules shall apply:**

- The distance shall be shown in meters for distance up to 999m;
- The distance shall be shown in 0.1 km increments for distances from 1km to 4.9km;
- The distance shall be shown in 0.5km increments for distances from 5km to 9.5km; and,
- To the nearest kilometer for greater distances.

### Reflectorization and Illumination

Signs more than 2.0m high normally require both top and bottom lighting.

Location

Generally, roadside guide signs should be located on the **right side of the road** where a driver would expect to see them. In some circumstances the sign may be mounted above the carriageway

### Advance Direction Signs

Advance Direction signs should usually be erected:

- in advance of intersections where two arterial roads meet or cross; or on an arterial road crossing a feeder road;
- in advance of intersections where the arterial road turns;
- on feeder road intersecting arterial road; or,
- in advance of intersections where arterial road may be confused with another road.

### Shape, Color and Reflectivity

Advance direction signs shall be **rectangular in shape, normally with long axis horizontal**. They shall have **reflectorized white legend**, symbols and border on **reflectorized green background**.

### Types of Advance Direction signs

1. Stack
2. Diagrammatic.

**Stack sign** i- the type normally used. Such signs list destinations together with appropriate direction

arrows, and if required road names and route markers.

**The vertical sequence of panels should be as follows:**

- Straight ahead arrow - top of sign;
- Angled arrows above horizontal arrows; and,
- Alternate panels to have arrows at opposite ends of the sign.

### Diagrammatic Direction Signs

This type of sign presents a simplified diagram of the intersection layout. It should be used at complex intersections and major roundabouts (rotunda) and for successive closely spaced road junctions or locations where a stack sign can not adequately indicate the complex layout.

**Other factors which may affect the size of letter or sign include**

- Distraction due to road side activities;
- Signs composed of short legends may be enlarged to increase conspicuity;
- Signs containing short and long legends require a balance of legend size to ensure equal visual impact; and,
- The need to emphasize a more important direction by making larger than other names on the sign.

### Standard abbreviation

HWY for Highway; RD for Road; ST for Street; AVE for Avenue; and, EXPRWAY for Expressway.



## Location of Advance Direction Signs

85 <sup>th</sup> Percentile Speed (kph)	Distance from Intersection (m)
<60	75 – 100
60 – 70	100 – 125
71 – 80	125 – 150
81 – 90	150 – 200
>90	180 – 250

## Street Name Signs

### Location and Height

**Street Name signs** should be located on posts as near as practical to the intersection so that they are clearly visible to both pedestrians and drivers. In addition to the name of the street, the sign may also carry the house number range for one block.

Where the signs are erected in the footway, the height should be **not less than 2.2m or more than 3.0m measured to the bottom of the sign.**

### Shape and Size

**Street Name signs** shall be rectangular in shape with their long axis horizontal. The length of the signs should **not be less than 500mm or more than 1.2m.** The vertical dimension is dependent upon the information given on the sign; for signs containing both street name and house numbers, the minimum shall be **200mm while signs having only the street names** should not be less than 150mm.

### Color

**Street Name signs** should preferably have white legend on blue or green background. Other color combinations may be used provided red is not used as a background color. Street name signs should be reflectorized.

### Town Names

Town Names signs and names of local geographical interests such as the name of a river, should be erected on the right side of the road at the boundary or entrance to a town or the location of interest.

## Route Markers

The national highways could be identified by the shield (G9-1) that has black numerals and border on reflectorized white background.

**When erected as an individual sign, the size of the shield should be:**

- 310mm x 360mm, on national roads, and,
- 410mm x 480mm, on expressways.

### Location

The Route Markers should be incorporated in the sign where advance direction signs are erected at an intersection or junction.

**Other Route Markers are located as follows:**

at all intersections and junctions where motorists need to be assured of the route:

- beyond intersections and junctions before which markers have been incorporated in the directional signs;
- beyond all intersections and junctions with important roads to indicate the correct route number of the highway;
- just outside the built-up area leaving a city or town;
- in rural areas at intervals not less than 8 km, except where reassurance signs have been erected beyond junctions located within these limits;
- in urban areas at intervals of not more than 2 km except where reassurance signs have been erected beyond junctions which are spaced less than 2 km apart; and,
- at other locations where reassurance is considered to be desirable.

## Asian Highway Route Markers

The Philippines is one of the 32 member countries of UN-ESCAP. As part of our commitment, Route Markers and Directional Signs shall be put up along the Asian Highway. Our country has been assigned the Asian Highway route number AH26. The route links major seaports and cities in the country comprising mostly of the Daang Maharlika which commence from Laoag-Manila - Legaspi-Matnog - (Ferry) - Allen-Tacloban (- Ormoc-(Ferry)-Cebu ) -



Liloan - (Ferry) - Surigao-Davao (- Cagayan de Oro) - General Santos-Zamboanga. The total length of AH 26 is about **3,517 kilometers**.

The Asian Highway could be identified by the shield (G10-1) that has a white retro reflective letters, numerals and border on retro-reflective blue background.

**When erected as an individual sign, the size of the shield should be:**

- 600mm x 750mm, on national roads, and,
- 720mm x 900mm, on expressways.

**Supplemental arrow board signs can also be installed and shall have black arrows or legend and black border on reflectorized white background.**

**The direction of the arrows on the arrow board will depend on the road or intersection geometry.**

- In rural areas at intervals of not exceeding 10 km and not less than 5 km, except where reassurance signs have been erected beyond junctions located within these limits;
- In urban areas at intervals of not more than 5 km except where reassurance signs have been erected beyond junctions which are spaced less than 2 km apart

### Major Types of Instruction Signs

- Supplementary signs
- Movement Instruction signs.

An Instruction sign should not carry long messages and where possible no more than **five (5) lines** of message should be used.

**Supplementary Signs** - These signs include those which are normally used in conjunction with other signs, either Warning Signs

### Supplementary Sign sizes are as follows:

- Use overpass
- Use pedestrian crossing
- Truck use low gear
- Check Brakes

**Movement Instruction signs included in this series are shown in the following table:**

**REDUCE SPEED** sign may be erected at sites where the approach speed of traffic is high and the majority of drivers must slow down and may be required to stop.

**STOP HERE ON RED SIGNAL** sign shall be used near the flashing signals located at railway level crossings or in any other situation where a vehicle is required to stop at a red signal and the position at which the vehicle must stop is not readily apparent.

**TURN LEFT WITH CARE** may be erected at an intersection controlled by traffic signals where there is no control on a left turn movement and where a separate lane for turns has been provided.

**TURN RIGHT ANYTIME WITH CARE** may be erected at channelized signalized intersections where a right turning lane is segregated by a traffic island. An advance warning of low clearance of a structure ahead (such as a bridge, or an overpass) for high vehicle detour shall be erected in advance of a junction with a detour

The **DETOUR FOR ... VEHICLES** sign is erected at the junction with an alternative route where certain classes of vehicles may be unable to negotiate the through route. The words **HIGH, HEAVY, WIDE** or **LONG** may be used, as appropriate, on the sign.

**GIVE WAY TO PEDESTRIANS** sign is used only at signalized intersections where there is a need to remind drivers of right or left-turning vehicles that although they are still under the control of the intersection signals, they must give way to pedestrians.

**NO RIGHT TURN ON RED SIGNAL** is used at signalized locations where right turn on red signal will cause conflict problems either with through vehicles or with pedestrians.

**SLOW VEHICLES USE RIGHT LANE** and **MABAGAL NA SASAKYAN MAMALAGI SA KANAN** sign shall be erected on the left side of a road at the beginning of the taper leading to a lane for slow-moving vehicles.

**RAK AT BUS MAMALAGI SA KANAN MALIBAN KUNG LULUSOT** sign is used on major roads, particularly where a public utility vehicle lane is installed.



**NO THROUGH ROAD** sign, either S2-8A or S2-8B should be used where there is a possibility that through traffic may enter a dead-end local road in error.

**ROAD CLOSED** sign should be erected in the center of a road that is closed to vehicular traffic. It should be erected in conjunction with a permanent barrier across the road.

sign is used to instruct drivers to form into appropriate number of lanes. It is usually erected in conjunction with **LANE ENDS MERGE LEFT**

**Alternative Route** sign is used to indicate an alternative for some types of vehicles when the normal

### Types of Markers

- One way hazard markers
- Two way hazard markers
- Width Markers
- Obstruction Marker

**One-Way hazard markers** indicate to the approaching driver the direction to be followed if the marker appears in the driving path. They may point to the left or right as appropriate and are used as follows:

- to delineate an abrupt narrowing of pavement, for example, at a lane drop;
- at exposed ends of raised median islands where traffic is required to pass to one side;
- on central island of a roundabout facing entering traffic; and,
- to delineate the curve approach just prior to entering an intersection.

### Chevron Sign

**Chevron Signs** - used to guide drivers through a change in horizontal alignment of the road.

It is recommended that the spacing of the chevrons signs should allow the driver to see at least three **(3) signs** in view while negotiating the curve, until the change in alignment eliminates the need for the signs.

### Types of Chevron Signs

	Type		Typical Size	Application
a.	HM-1A	-	450mm x 600mm	≤ 60 kph design speed with no visible problem
b.	HM-1B	-	600mm x 800mm	> 60 kph design speed and/or with no visibility problem (e.g. fog)

**Two-Way Hazard Markers** - used where it is necessary to delineate an exposed obstruction on a traffic island nose at which traffic may pass to either side. This sign can be used on a wide column of an overpass structure, or a median island separating the carriageway with traffic proceeding in the same direction

**Width Markers** are used at approaches to road bridges:

- where clearance to bridge curb from the edge of the running lane is less than the shoulder or curb width of the approach road;
- where there are non-frangible vertical obstructions less than 600mm clear behind the bridge curb; and,
- where any bridge less than 2m wider than the approach pavement or running portion of the carriageway.

### Size of markers to be used is as follows:

- A size - rural area where average traffic volume is less than 300 vehicles per day; and,
- B size - all other cases.

**Guide posts** - used to mark the edge of the road formation. They assist the road users by indicating the alignment of the road ahead, especially at horizontal and vertical curves.

Guide posts should be erected at or near the edge of the road formation with a uniform distance from the pavement edge. The nominal spacing of guideposts on a straight section of road shall be **150m**, with posts in pairs, one on each side of the formation.

**On curves, the spacing in meters to be used is given as follows:**

- Curve radii up to 150m Spacing =  $0.3R + 5$
- Curve radii over 150m Spacing =  $0.6R$ , Where R = curve radius in meters



**Delineators** - small reflective panels or buttons mounted on guideposts or guard fence as an effective aid to delineate the roadway for driving at night.

- made of reflective materials capable of reflecting light clearly visible under normal atmospheric conditions from a distance of 300-500m when illuminated by the upper beam of a standard automobile head lamp.

**Pavement markings have definite limitations:**

- They are subject to traffic wear and require proper maintenance;
- They may not be clearly visible if the road is wet or dusty (e.g., near shoulder edge or median);
- They may be obscured by traffic;
- Their effect on skid resistance requires careful choice of materials; and,
- They cannot be applied on unsealed roads.

### Types of Pavement and curb markings

- **Longitudinal lines** which are those laid in the direction of travel. These include: Center Line; Lane Line; Double Yellow Line; 'No-Passing' Zone Markings; Pavement Edge Line; Continuity Lines; and, Transition Line;
- **Transverse Lines** which are laid across the direction of travel. These include Stop Line; Give Way Lines; Pedestrian Crossing Markings; and, Roundabout Holding Lines;
- **Other lines**, which include: Turn Lines; Parking Bays; Painted Median Islands; and, Bus & PUJ Lane Lines; and,
- **Other markings** which include: approach markings to islands and obstructions; Chevron marking; diagonal markings; Markings on Exit and Entrance Ramps; Curb markings for Parking restrictions; Approach to Railroad crossing; Messages and Symbols; and, Pavement Arrows.

**Object Markings**

- Object within the roadway; and,
- Object adjacent to the roadway.

### Reflectorized Markings

- Retro-Reflector Raised Pavement Markers;
- Hazard markers
- Delineators

### Color of Pavement Markings

**The color of pavement markings shall be white except for the alternative uses of yellow as specified below:**

**Double yellow no-passing lines:**

- Unbroken portion of no-passing lines;
- Curb markings for prohibition of parking;
- On islands in line of traffic;
- Bus and PUJ lanes; and,
- Keep Intersection Open markings.

**Red shall be used in:**

- No Loading/Unloading Zone; and,
- Fire lane zone.

**Black may be used** in hazard markers to warn road users at locations where the protruding objects such as bridge piers, traffic islands and other permanent objects on or near the roadway.

### Types of Lines

**Broken Line** - a type of line that consist of line segments with equal lengths separated by uniform gaps. The speed of vehicles on the section of road or in the area in question should be taken into account in determining the lengths of the line strokes and of gaps between them.

**Solid Unbroken Line** -a type of line that used where crossing of the line is either discouraged or prohibited. It is generally used to replace or supplement a broken line where required e.g., barrier lines, and center lines. Solid lines may be either yellow or white depending whether or not crossing the line is legally prohibited.

**Width**

The width of solid or broken lines varies from **100mm to 300mm** depending on the usage of the specified line.

**Definitions**

**Road Markers** - means any traffic control device marked on the surface of the carriageway used to regulate traffic or to warn or guide road users. They are used either alone or in conjunction with other signs or signals



to emphasize or clarify their meaning. Median islands are not classified as road markers.

**Road** - means the entire surface of any street open to traffic, including shoulder and sidewalk.

**Highway** - shall mean any public thoroughfare, public boulevard, and avenue, but shall not include roadway upon grounds owned by private persons, colleges, universities, or other similar institutions.

**Carriageway**- means the part of the road normally used by vehicular traffic.

**Lane** - means one of the longitudinal strips from which the carriageway can be divided, whether or not defined by longitudinal road markings.

**Intersection** - means any level crossroad, junction, including open areas formed by such crossroad.

**Built-Up Area** - means an area with entries and exits especially sign posted as such or otherwise defined in domestic legislation.

**Domestic Legislation** - is the entire body of national or local laws and regulations in force in the country.

**Motor Vehicle** - shall mean any vehicle propelled by any power other than the muscular power using the public highways, except heavy construction equipments, trolley cars, street sweepers, sprinklers, lawn mowers, amphibian trucks, and tractors, trailers and traction engines of all kinds used exclusively for agricultural purposes.

**Standing** - a vehicle is said to be standing if it is stationary for the time needed to pick up or set down persons or to load or unload goods.

**Parked** - a vehicle is said to be parked if it is stationary for the period during which the vehicle is not limited to the time needed to pick up or set down persons or goods.

**Driver** - shall mean any and every licensed operator of a motor vehicle.

**Road Users** - shall mean any persons using the road including drivers, pedestrians, cyclists, and commuters.

**Urban Roads** - roads where speed limit is **60 kph or less**.

**Rural Roads** - roads where speed limit is **over 60 kph**. Although there are high-speed roads in the urban area, for the purpose of line marking, they are defined as rural roads.

## LONGITUDINAL LINES

**Center line** - used to separate opposite traffic movements of an undivided roadway and is generally placed centrally on all roads and bridges 6.0m or more in width. Under some circumstances this line may be placed off-center (e.g., where an extra uphill traffic lane is provided or parking on one side of the road only).

**A center line may be marked on an urban or rural road if one or more of the following conditions are met:**

- Two lane road (greater than 6m in width) carrying an Annual Average Daily Traffic (ADT) in excess of 1000 vehicles;
- Two lane road (less than 6m but more than 5m in width) carrying an ADT in excess of 300 vehicles; and,
- Winding roads with widths of 5m or more. Irrespective of these warrants, marking of other sections may be desirable where one of the following conditions is present:

### Center Line on Rural Roads

The center line on a two-lane two-way rural road or any other road where the 85th percentile speed (or speed limit) is greater than 60 kph, shall be a broken line, with a minimum width of 150mm and 3m long with gaps of **9m** spacing. A solid white line of 200mm wide may be used in the cases as specified for Urban Roads

### Center Lines at Bridges

**Where approaches to bridges are lined marked, they shall be marked as follows:**

- If bridge is **5m or more between curbs**, center lines (or separation line) shall be **continued across the bridge**;
- If bridge is **less than 5m** between curbs, center lines shall be **discontinued 30m from the bridge abutments**

**Lane Line** -A line is used to separate adjacent lanes of traffic moving in the same direction.

Lane lines on roads with an 85th percentile speed (or speed limit) of 60 kph or less shall have a minimum width of 150mm and 3m long with **6m gaps**.



Lane lines on roads with 85th percentile speed (or speed limit) in excess of 60 kph shall be 150mm wide, 3m long and **9m gaps**.

**Lane lines must not be continued on the following cases:**

- Across signalized intersections. However, lane lines of low priority road must be discontinued at the intersection;
- Across side street entrances unless the street is one-way street (going in only); and,
- Past the start of the taper at which a multi-lane road narrows down.

**As a guide, lane lines should be used in the following cases:**

Where the road is wide enough for two or more lanes of traffic in one direction with a two way annual average daily traffic (AADT) of 8000 or more (depending on whether parking is permitted);

- At approaches to widened or signalized intersection; and,
- On divided roads.

### Barrier Lines

Barrier lines may consist of either:

- two unbroken yellow lines;
- single unbroken yellow line; or,
- single yellow line with a broken white line.

**Double unbroken yellow lines** - should only be used where overtaking from both directions of the road and all crossing movements are prohibited. Vehicles must always keep to the right of the double yellow lines.

**Single unbroken yellow line** - should be used where overtaking from both directions of the road are prohibited. However, crossing movements are permitted. Vehicles must always keep to the right of the double yellow lines.

**The following are the cases where barrier lines should be used:**

- As center lines on approaches to signalized intersections;
- As center lines of multi-lane roads where overtaking must be prohibited, because of sight restrictions;

- 'No-Passing' zones where there is a restricted sight distance due to horizontal or vertical curves, or both; and,
- As center lines on approaches to railway crossings

### No-Passing Zones

The methods and procedures applied to marking of 'No-Passing' zones are as follows:

- Vertical and horizontal curves on a two-lane sealed road shall be marked as 'No-Passing' zones in accordance with Table 11.2;
- Barrier lines shall not be marked unless the sight distance available falls below the appropriate minimum sight distance for at least the length shown in the tables
- If the length of road, with sight distance below the minimum sight distance, is less than the minimum length of barrier line shown in the tables, the additional length of the marking shall be added to the beginning of the zone (column 4); and,
- Where the distance between the end of one barrier line and the beginning of the next barrier line restricting traveling in the same direction is less than that shown in the tables, the barrier lines shall be joined to form one continuous barrier line

### Edge Lines

**Edge Lines** - line used to delineate the edge of the traveled way to distinguish it from the shoulder area. It should be a solid white line between 100mm and 200mm wide.

**The purpose of installing edge lines is generally based on the following:**

- to discourage travel on road shoulders;
- to make driving safer and more assured, particularly at night and during inclement weather by providing a continuous guide for the driver;
- to act as a guide past objects which are close to the edge of pavement and which constitute a hazard; and,
- to prevent parking at or near intersections.

**Recommended Width of Edge lines**



Road Type	Outer Lane Width	Edge Line Width
Urban	3.5m	100mm
Rural	3.5m >3.5m	100mm 150-200mm
Expressway	4.0m	300mm

### No Parking Zones

The road curb for No Parking Zones shall be painted yellow

### No Loading / Unloading Zones

Road curb for No Loading / Unloading Zones shall be painted red.

**Continuity Line** - is used to indicate that portion of a carriageway assigned to through traffic. It is intended to be crossed by traffic turning at an intersection, or entering or leaving an auxiliary lane at its start or finish

**Transition Lines** are used to guide traffic safely past obstructions on roadways such as islands, median strips, bridge piers or indicate changes in the width of the traveled portion of the roadway and an increase or reduction in traffic lanes.

### Transverse lines

**Transverse lines** are markings across the carriageway. Because of the low angles at which the markings are viewed, it is necessary that all transverse lines be proportionally widened to give visibility equal to that of longitudinal markings or to avoid apparent distortion where longitudinal and transverse lines are combined in symbols or letterings.

**Transverse lines may be classified into the following types:**

- stop lines
- give way lines
- pedestrian crossing markings
- roundabout holding lines

Stop lines may be supplemented by the word "Stop" marked on the carriageway. The distance between the word STOP and the stop line should be between **10 to 25m**.

### Type of Pedestrian Crossing Markings

Two types of pedestrian crossings are **zebra and crosswalk**

**Zebra (non-signalized crossing)** - The marking consists of a series of longitudinal bars 300mm or 600mm wide and generally not less than **4m long**.

**Crosswalks (signalized crossing)** - Crosswalks are defined by a pair of solid white lines across the road surface **not less than 4m and not more than 8m apart, 150-300mm in width**.

**Turn Lines** -line may be used to guide vehicles through a turning movement at intersections. Turn lines, if used, should be so designed as to indicate the proper course for turning vehicles without being needlessly confusing to through traffic or the traffic making other turns.

### Parking Bay Lines

There are two types of parking bays, **parallel parking and angle parking**.

**To ensure that the flow of turning traffic is not impaired, parking near intersections should be prohibited within the following distances from the boundaries of lateral roads:**

- Parallel Parking - 5m on both approach and exit sides
- Angle Parking - 12m on approach side and 9m on exit side.

On approach to intersections where traffic signals are operating, a minimum distance of **20m** from the traffic signal post is recommended.

### Painted Median

**Painted median islands** - used on wide roads where light traffic volume cannot justify the installation of solid curbed median island.

The painted outline of the median shall be at least 100mm wide with a minimum median width of 2m. No painted median should be installed on roads less than **10m wide**.

### Bus and PUJ Lane Line

The Bus and PUJ lane line is an unbroken yellow line 150-300mm wide used to separate other vehicles from buses and PUJ's. The Bus and PUJ lane line can be supplemented by raised pavement markers on concrete pavements. The line is tapered at the approach to the signalized



intersection. The distance between the taper and the stop line should be determined according to the capacity of the intersection and should generally be less than 100m

### Markings

**Chevron markings** - markings that are often used to guide traffic into the right turning lanes separated by an island, such as corner island at a signalized intersection

**Diagonal markings** - markings which are placed on sealed shoulders or other sealed portion of the road where traffic is not desired. Such markings are of the same bar width as other diagonal markings. The spacing between bars is generally 6m.

**Rumble strips** - type of thermoplastic Lane marking designed to aid and provide motorist with visual, audio and motion warnings on the road

### Messages And Symbols

- Messages when painted on pavement should be limited to **three words or less**.
- Messages are **white** in color.
- Letters or numerals used on roads in urban areas shall be at least **2.5m**.
- On high speed highways, they must be at least **5m**

### Pavement Arrows

Length of Pavement arrows are used for lane use control they are generally **5m in length on urban roads** and **7.5m on high-speed roads**.

### Obstruction within the roadway

Obstructions in the roadway, if not illuminated shall be marked with reflectorized hazard markers.

For additional emphasis it is advisable also to mark obstructions other than islands with reflectorized white paint with no less than **five** alternating reflectorized black and white stripes.

### Objects Adjacent to the Roadway

Reflective markers placed at regular intervals in gaps along a line may help to define the line particularly at night or under foggy or wet conditions.

- The lines usually treated in this manner are: Center lines; and, Edge lines

Hazard markers either as signs or painted markings are to be used on objects so close to the edge of the road Way as to constitute definite hazard. These include such encroachments as underpass piers, abutments, culverts headwalls, utility poles and ornamental buildings.

Other adjacent objects which are not likely to be hit unless a vehicle runs off the road, such as guardrails, trees and rocks must be painted **reflectorized white**.

### Raised Pavement Markers

**Raised Pavement Markers** - small devices which are fixed to the concrete pavement surface to stimulate or supplement painted pavement markings.

### Type of raised Pavement of markers

**Double faced raised pavement markers** are placed on undivided roadway

**single faced raised pavement markers** are placed on divided roadways

**Yellow raised pavement markers** are used for yellow pavement markings

**White markers** for white pavement markings.

**Because of the high cost of installation and maintenance, use of raised pavement markers may be considered only in the following condition:**

- In hilly areas where fog and rain are frequently the causes of traffic accidents; and,
- In winding roads and accident-prone areas.

Markers supplementing center or lane lines may be placed in the gaps mid-way between the line segments at a spacing of **9m** where fog or heavy rain occurs in the built-up areas.

A spacing of **12m** shall be used where there is less likelihood of fog and where there is no street lighting in the rural environment.

### Supplementing painted lines

### Pavements



**Flexible Pavements** - a flexible pavement is constructed with asphaltic cement and aggregates and usually consists of several layers. The lower layer is called the subgrade.

**Rigid Pavement** - a rigid pavement is constructed with Portland cement concrete and aggregates as shown with flexible pavements, the subgrade (the lower pavements), the base layer is optional.

**Sub grade** - the layer of natural soil over which the pavement road is laid

**Base** - the component of the road structure which receives the traffic load and transfer it to the subgrade

-the top surface of a road structure

**Wearing Surface** - soil stabilized roads with cement/lime cannot be used

**Surface Dressing** - one or more layers of crushed aggregate, which are bonded by bituminous materials and a seal coat laid on top

**Bitumen carpet** - a 20 mm thick premix bitumen layer over which is laid a seal coat

**Asphaltic Concrete** - a layer consisting of properly designed mix of coarse aggregate, fine aggregate, a filler and a bituminous binder

**Mastic asphalt** - a mixture of bitumen, fine aggregate and filler in suitable proportion heated to about 200°C in special cooker and laid

**Pavement** - the layered structure placed over a soil subgrade for forming a road

**Flexible** - a pavement which has negligible flexural strength

**Wearing coarse** - the layer in a road pavement which provides resistance to wear and tear due to traffic

**Sub base** - the part of the road structure which is immediately above the subgrade and composed of stone boulders or superior soil

**Water bound macadam** - a road made of coarse aggregate mechanically interlocked by rolling and bonded together with screening dust

**Tack coat** - an application of hot bitumen material given to the old surface to provide adhesion to the old and new road surface

**Prime coat** - a layer of stone chipping coat laid over a hot to make the surface water proof conditions

**Surface Dressing** - the application of one or two layers of bituminous material over a prepared base each layer covered with an application of cover material and rolled

**Seal coat** - a very thin surface applied over a bituminous pavement to make it impervious

The time for mixing of ingredient for a concrete cement road should be done for at least **1.5 min**

**14 days** - the number of days final curing for a concrete cement pavement

### Joins in concrete pavements

**Construction joint** - joints provided in concrete cement pavement is suspended

**Traverse joint** - joints provided in concrete cement pavements at right angles to the centre line of the pavement

**Base courses** - this normally consists of aggregates such as gravel and crushed rock

### Types of Rigid Pavements

**Plain concrete pavement** - a type of rigid pavement, which has no temperature steel or dowels for the load transfer. This type of pavement is used mainly on low volume highways or when cement stabilized soils are used as sub material

**Simply reinforced concrete pavement** - a type of rigid pavement having dowels for the transfer of traffic load across joints with these joints spaced at larger distance than with plain pavements ranging from 10 m to 30 m. Temperature steel is used throughout the slab

**Continuously reinforced concrete pavements** - a type of rigid pavement, which has no transverse joints, except construction joints or expansion joints when they are necessary at specific positions such as at bridges. This type of pavement is typically used on high-volume, high-speed roadways

**Pavement roughness** - the measurement of the extent to which a road surface deviates from the plane



**Pavement distress** - refers to the condition of a pavement in terms of its general appearance

**Pavement deflection** - refers to the structural adequacy of the pavement section

**Skid resistance** - describes the effectiveness of a pavement to prevent or reduce skid related crashes

**Types of stresses that are developed in rigid pavements**

- Stress induced by traffic loads
- Stress due to temperature changes
- Stress induced by bending

## Cracking

**Alligator cracking** - a series of interconnected of interfaced cracks caused by fatigue failure of the asphalt concrete surface under repeated traffic loading

**Block cracking** - cracks forming large interconnected polygons, usually with sharp corners or angles. These cracks are generally caused by hardening and shrinkage of the asphalt and/or reflection cracking from underlying layers such as cement treated base

**Longitudinal cracking** - cracks approximately at right angles to the pavement center line. These are caused by poorly constructed construction joints and shrinkage of the asphalt concrete surface; they may also be reflective cracks

**Transverse cracking** - cracks approximately at right angles to the pavement center-line. These may be caused by shrinkage or differential thermal stress of the asphalt concrete, or may be reflective crack

**Raveling** - wearing away of the pavement surface caused by the dislodging of aggregate particles and binder

**Drip track raveling** - progressive disintegration of the surface between the heel paths caused by dripping of a gasoline or oil from vehicles

**Bleeding or flushing** - the exuding of bitumen onto the pavement surface causing a reduction in skid resistance

**Faulting** - elevation difference between adjacent slabs at traverse joints. This is usually the result of pumping and is a major source of Portland concrete pavement

**Blowups** - localized upward buckling and shattering of the slabs at traverse joints or cracks

**Settlement** - local sagging in the pavement caused by differential settlement, consolidation, or movement of the underlying earth mass

**Joint spalling** - the breakdown or disintegration of slab edges at joints or cracks, usually resulting in the loss of sound concrete and the progressive widening of the joint or crack

**Surface attrition or surface abrasion** - abnormal surface wear, usually resulting from poor quality surface mortar or coarse aggregate

**Surface polish** - loss of the original surface texture due to traffic action



**Density** - it is defined as the number of vehicles per unit distance occupying a thsection of roadway at a given instant time and is usually measured in vehicles per mile or per km

**Flow** - defines as the number of vehicles per unit time passing a point in space and is usually expressed in vehicles per hour

**Volume** - number of vehicles counted in a specified time interval

-maximum number of vehicles, passengers or the like, which can be accommodated by a given facility or system under given conditions at a given level of service

**Traffic volume** - the number of vehicles moving in a specified direction on a given lane or roadway that pass a given point during specified unit time and is usually expressed as vehicles per hour or vehicle per day

**Traffic capacity** - the ability of a roadway to accommodate traffic volume. † is expressed as the maximum number of vehicles in a lane or a road that can pass a given point in unit time, usually an hour, that is vehicle per hour per lane or roadway

**Basic capacity** - the max number of passenger cars that can pads a given point on a lane or roadway during one hour under the most nearly ideal roadway and traffic conditions which can possible be attained

**Possible capacity** - the max number of passenger cars that can pass a given point on a lane or roadway during one hour under prevailing roadway and traffic conditions

**Practical capacity** - the max number of vehicles that can pads a given point on a lane or roadway during one hour without traffic density being so great as to cause unreasonable delay hazard or restrictions to the driver's freedom to maneuver under the prevailing roadway and traffic

**Weaving** - the process by which a vehicle first merges into a stream of traffic obliquely crosses that stream, then merges in to a second stream moving in the same direction

**Spot speed** - the instantaneous speed of a vehicle at a specified section or location

**Average speed** - the average of the spot speeds of all vehicles passing a given point in the highway

**Space mean speed** - the arithmetic mean of speed of vehicles occupying a relatively long section of street or highway at given instant

**Time mean speed** - the arithmetic mean of the speeds of vehicles passing a point on a highway during an interval of time

**Running speed** - the average speed maintained by a vehicle over a particular stretched of road, while the vehicle is in motion. This is obtained by dividing the distance covered by the time during which the vehicle is in motion

**Time headway** - the time interval between the passage of successive vehicle is moving in the same lane and measured from head to head as they pass a point on the road

**Space headway** - the distance between successive vehicles moving in the same lane measured from head to head at any instance

the distance between the front of a vehicle and the front of the following vehicle

**Expressway** - divided arterial highway for through traffic with full or partial control of access and generally with grade separations at major intersection

- An expressway with full control of access

**Parkway** - an arterial highway for non-commercial traffic with full or partial control of access and usually located within park

**Stopping sight distance** - minimum sight distance required for a driver to stop after seeing an object in the vehicle's path without hitting that object

**Passing sight distance** - minimum sight distance required on a two lane, wo way highway that will permit a driver to complete a passing maneuver without colliding with an opposing vehicle and without cutting off the passed vehicle

**Super elevation run off** - the length of super elevation development from zero cross slope to full design super elevation in a circular curve alignment



**Tangent run out** - the length of super elevation development from the normal cross slope to the zero cross slope point on the tangent

**Vertical alignment** - the longitudinal profile along the centerline of the road. It is made up of a series of grades and vertical curves

### Fundamentals of Traffic Flow

**Perception time** - time required for transmission of the sensations received (through eyes, ears and body) to the brain and the spinal chord by the nervous system, to a particular traffic situation

**Intellection** - after perception occurs, the formation of new thoughts and ideas, recalling old memories of similar occasions to a particular traffic situation

**Emotion** - the time linked with the two stages perception and intellection based on a particular traffic situation like fear or anger which has a vital influence on the final message or decision sent by the brain to the muscle

**Reaction time** - the total time required for perception, intellection, emotion and volition that is from the instant the object comes in the line of sight of the driver to the instant he arrives a decision say to slow down or overtake, under normal circumstance

**Volition time** - the time taking a decision to produce action to a particular traffic situation

**Braking distance** - distance traveled by the vehicle after the application of the brakes until it will stop

**Lag distance** - distanced traveled by the vehicle during the total reaction time

### Space Mean Speed -Time Mean Speed, Mean Free Speed

**Capacity** - the maximum sustained 15 min rate of flow, expressed in passenger cars per hour per lane, which can be accommodated by a uniform freeway segment under prevailing traffic and roadway conditions in one direction

**Road capacity** - the maximum number of passenger cars that can pass a given point on lane or roadway during one hour under the most nearly ideal roadway and traffic conditions which can possibly be attained

**Time headway** - the difference between the time the front of a vehicle arrives at a point on the highway and the time the front of the next vehicle arrives at the same point

**Space headway** - the distance between the front of a vehicle and the front of the following vehicle

**Time mean speed** - the arithmetic mean of the speeds of vehicles passing a point on a highway during an interval of time

**Space mean speed** - the arithmetic mean of speed of vehicles occupying a relatively long section of street or highway at given instant

**Mean free speed** - the maximum speed that can be attained on a highway as the flow tend to be zero

**Merging** - the process by which a vehicle in on traffic stream joins another traffic steam moving in the same direction such as a ramp vehicle joining a freeway stream

**Diverging** - the process by which a vehicle in a traffic stream leaves that traffic stream, such as a vehicle leaving the outside lane if an expressway

### Average Daily Traffic-Accident Rates

**Average annual daily traffic** - the average of 24 hour traffic counts collected every day in the year.

### Queue

**Queue** - formed when arrivals wait for a service or an opportunity sich as the arrival of a acceted gap in a main traffic stream, the collection of tolss at a tollbooth or of parking fees at a parking garage.

-a delay which results when the demand for a facility exceed its capacity



## Ports and Harbor

**Harbor** - A protected water area to provide safe and suitable accommodation for ships for the transfer of cargo, refueling, repairs, etc. Harbors may be subdivided into:

- a. **Natural harbors:** harbors protected from storms and waves by the natural configuration of the land.
- b. **Semi-natural harbors:** harbors with both natural and artificial protection.
- c. **Artificial harbors:** harbors protected from the effect of waves by means of breakwaters, or harbors created by dredging.

**Port** - A sheltered place where the ship may receive or discharge cargo. It includes the harbor with its approach channels and anchorage places. Ports may be subdivided into:

- a. **Ocean ports:** ports located on coasts, tidal estuaries or river mouths where the port can be reached directly by ocean-going ships.
- b. **Inland waterway ports:** ports located on navigable rivers, channels and lakes.

## Marine Structures

1. **Berth** - A place where the ship can moor. In the case of a quay or jetty structure, it will include the section of the structure where labor, equipment and cargo move to and from the ship.

**Berth structure** - An artificial landing place for the loading and unloading of ships. Berth structures can be subdivided into:

- a. **Wharf** - A continuous structure built parallel to along the margin of the sea or alongside riverbanks, canals, or waterways where vessels may lie alongside to receive or discharge cargo, embark or disembark passengers or lie at rest.
- Wharf** - a platform built parallel to the shore or breakwater within the harbor to berth vessel

**Quay** - this term can be substituted to wharf when applied to great solid structures in large ports.

**Quay** - a platform built in the harbor parallel to the shore and backed up by ground

-A sheltered place where the ship may receive or discharge cargo. It includes the harbor with its approach channels and anchorage places

In stability calculation of gravity type quaywall, the following matters should be examined:

- (a) Sliding of the wall
- (b) Bearing capacity of foundation
- (c) Overturning of the wall
- (d) Circular slip and settlement

**Relieving platform** - a platform or deck structure built below the top deck level and supported on bearing piles. The main function of the platform is to reduce the lateral soil pressure over the upper portion of the sheet wall

**B. Pier** - Any structure built into the sea but not parallel to the coastline and includes any stage, stair landing place, landing stage jetty, floating barge, and pontoon, any bridge or other works connected there with.

-a berth structure projecting out from the shoreline

**C. Sea island** - a berth structure with no direct connection to the shore, at which the ships can berth. Berthing can take place on either one or both sides of the structure

**D. Dolphin:** a berth structure for mooring the ship on the open sea; An isolated piled or gravity structure used either to maneuver a ship or to facilitate holding it in position at its berth.

## Types of dolphins

**Dolphins** - marine structures for mooring vessels

**Breasting dolphins** - Type of dolphins which are designed to take the impact of the ship when docking and to hold the ship against a broadside wind. Therefore, they are provided with fenders to absorb the impact of the ship and to protect the dolphin and the ship from damage.

**Mooring dolphins** - type of dolphins which are not designed for the impact of the ship, as they are located in back of the face of the dock where they will not be hit. They are located about 45 m off the bow and stern.

2. **Dry Dock** - a type of dock consisting of a rectangular basin dug into the shore of a body of water and provided with a removable enclosure wall or gate on the side toward the water, used for major repairs and overhaul of vessels.



-an artificial basin for vessels when the basin is pumped out

### Coastal Protection Structures

**Bulkhead** - a structure for retaining or to prevent earth or fill from sliding into water

**Groin** - a shore protection structure usually built perpendicular to the coastline to retard littoral transport of sedimentary materials

**Jetty** - a landing stage or small pier at which boats can dock or be moored.

- a solid structure, which projects into the sea perpendicular to the shore to berth vessels

**Breakwater** - the structure that protects harbor from stormy waves and permits calm in the harbor

- rubble mound and or a concrete structure that protects the harbor area from wave action

- a berth structure which projects out into the water from the shore or a berth structure at some distance from the shoreline

**Bathymetry** - the physical configuration of the seabed, the measurements of depths of water in the ocean, etc. and also information derived from such measurement

### Marine Structures

**Fixed mooring berth** - A marine structure consisting of dolphins for tying up the ship and a platform for supporting the cargo handling equipment.

**Mole** - A breakwater is a structure constructed for the purpose of forming an artificial harbor with a water area so protected from the effect of sea waves as to provide safe shipping. When a accommodations for breakwater supports a roadway

### Mooring and Bollards

**Bollard** - a vertical post to which the eye of a mooring line can be attached

- the mooring fitting for mooring ships during a storm installed at the outside or outside/inside of the berth far from the waterline

**Bitt** - the mooring fitting for mooring ships during a storm installed close to the water line of the berth

### Types of Mooring Bollard

**Single and double pillar** - A type of mooring bollard which is suitable for warping ships along berths a single pillar type is used with lines from one ship only. General mooring application where rope angle is not steep. It has a normal max. working capacity of 200 tons.

**Tee head** - A type of mooring bollard where all general mooring applications including steep rope angles. Any one bollard should preferably be allocated to lines from one ship only. It has a normal maximum working capacity of 150 tons.

**Sloping robe** - A type of mooring bollard where all general mooring applications including steep rope angles and lines from two ships may be attached without interference. It has normal max. capacity of 200 tons.

### Wind

**Wind** - the circulation of masses of air more or less parallel to the earth's surface

**Monsoon** - prevailing winds which are seasonal blowing in one direction over part of the year and in the opposite direction the remainder of the year

**Beaufort's Scale** - an instrument use to measure intensity of wind

### Direction of wind

**Windward side** - the side of a structure facing the direction from which the wind

**Leeward side** - the opposite side of a structure facing the direction from which the wind comes

**Wind rose** - the graphical representation of the direction, frequency and intensity of winds at a particular location over period of time

### Tides

**Tide** - waves formed by gravitational attraction of the moon and sun

-the periodic rise and fall of the ocean waters produced by the attraction of the moon and sun

**Age of the tide** - Owing to retardation of the tidal wave in the ocean by frictional force, as the earth revolves daily around its axis and as the tide tends to follow the direction of the moon, the highest tide for each location



is not coincident with conjunction and opposition but occurs at some constant time after new and full moon. This interval which may amount to as much as two and a half days

**Bay of Fundy** - the highest tides in the world where a rise of 100 ft has been recorded

**Ebb tide** - the falling tide

**Spring tides** - the highest tide which occurs at intervals of half a lunar month

- The type of tide which will occur at or near the time when the moon is new or full that is when the sun, moon and earth fall in line and the tide generating forces of the moon

- In many parts of the world, the high waters reach their greatest height and the low waters at the least height, soon after the time of full and new moon

**Neap tides** - the lowest tide of the month when the line connecting the earth with sun and the moon form a right triangle that is when the moon is in its quarters

- when the lines connecting the earth with the sun and the moon form a right angle, that is the moon is in her quarters, then the actions of the moon and sun are subtractive, and the lowest tides of the month

- When the daily high waters are usually at their least height and the daily low waters their greatest height soon after the moon is in quadrature.

**Diurnal tides** - tide which occurs only one high tide a day

**Semi diurnal tides** - tides that occur twice its lunar day

**Mixed diurnal tides** - if one of the two daily tide is incomplete that is it does not reach the height of the previous tide, then the tides

**Diffraction** - the spread of energy along a wave crest

-The flow of energy along the wave crest in a direction at right angles to the direction of wave travel

**Refraction** - the bending of waves as they slow down

**Tidal bores** - high crested waves caused by the rush of flood tide up river or by meeting of tides

**Tides and Abnormal Water Level**

**Astronomical tide** is the periodic rise and fall of sea level

in response to the gravitational attraction of the sun and moon as modified by the earth's rotation. The essential parameters to characterize the tide are:

**Design Low Tide** - the water level that guarantees about 98% of the tide is safe to ships seems to be suitable from the expression of the technical resolution of the international Water Wave Congress

## Tidal Datums

**Mean higher high water** - the average height of the higher high waters over a 19 year period

**Mean high water** - the average of the high water over a 19 year period

**Mean low water** - average of the low water a 19 year period

**Mean lower low water** - the average height of the lower low waters over a 19-year period

**MLLW** - the datum line for design of port facilities in accordance with charts which is being used by the Philippines Ports Authority.

**Higher high water** - the higher of the two high waters if any diurnal tide day

**Highest high water** - the highest height of water of spring tides

**Mean Sea level** - the mean of the height of mean high water above mean low water

**Lower low water** - the higher of the two low waters if any diurnal tide day

**Lowest low water** - the lowest height of water of spring tides

**Diurnal range** - the difference in height between the mean higher high water and the mean lower low water

**Mean range** - the height of the mean high water above mean low water

## Waves

**Seiche** - a very long-standing wave on a large but limited body of water (lake) generated by occurring when a storm dies down after producing a wind tide



**Fairway** - an open water with navigable depth

**Wakes** - waves formed by moving ship or boats

**Clapotis** - the pressure against a vertical wall due to waves

**Tsunamis** - waves created by large, sudden impacts, such as earthquakes, volcanoes or landslides that ends up in ocean.

- Waves formed by earthquake disturbance

- waves with an extremely long period that mainly occur when there is a sudden large scale sea floor movements associated severe, shallow focus earthquake

**Storm Surge** - an abnormal rise of the sea level that occurs when a typhoon passes by. This rise above normal level on this open coast is due to atmospheric pressure reduction as well as due to wind stress.

**Sea** - waves under the influence of the winds that generated them

**Swell** - waves that have propagated beyond the initial winds that generated them

**Swells** - waves generated by storms occur outside area of observation

### Waves Characteristic

**Wave length** - the length between two consecutive crests

**Wave period** - the wave form travels over the water surface and the time for two consecutive crests to pass a point

**Wave height** - the elevation of the crest above the trough of the wave

- the distance between the highest point and the lowest point of the wave

- the vertical distance of the wave crest and the wave trough

**Wave Crest** - the highest point of the wave

**Wave trough** - the lowest point of the wave

**Amplitude** - the height between the trough and the crest of a wave

**Velocity of wave propagation** - the speed of the wave form which travels over the water surface for a certain wave

**Period** - the interval of time for two wave crests to pass the same position in space

**Steepness** - the ratio of the wave height to its wave length

**Significant wave height**- the arithmetical mean value of the highest, one-third of the waves for a stated interval

### factors that affect the size of a wave

**Fetch** - the distance that the wind blows over the sea in generating the waves

- the horizontal extension of the generating area in the direction of the wind

**Duration** - the time that a wind blows across the water

**Wave refraction** - A change in the direction of travel of the wave with change in depth of water which distributes wave along energy the seashore unevenly

### Types of Waves

**Swell waves** - created in the deep ocean distance from the port site and the wind that created them may be too distant to be felt in the port or may have stopped blowing or changed, its direction by the time the wave reach the port

**Wind waves** - waves generated by wind that are acting on the sea surface bordering on the port site.

**Seiche waves** - waves of this type have very long periods, typically from 30 sec. up to the tidal period of 12 hr. 25 min. and are mostly found in enclosed or semi-enclosed basins such as artificial port basins or bays.

**Gravity waves** - Waves are formed by the frictional drag of wind across the water surface. This is a process of transferring energy from wind to water. Water particles are moved from their position by the wind, and then returned to the original position by gravity, which is a restoring force.

**Deep water waves** - waves in which the ratio of water depth to the wavelength is greater than 0.5



**Immediate water waves** - waves in which the ratio of water depth to the wave length is less than 0.5 but greater than 0.40

**Shallow water waves** - waves in which the ratio of water depth to the wave length is equal to or less than 0.40.

- waves which occur in water having a depth less than one half of the wave length and the influence of the bottom changes the form or orbital motion from circular to elliptical or near-elliptical.

**Shallow water wave** - a type of wave where the depth is less than  $\frac{1}{2}$  wave length

**Transitional water wave** - a type of wave where the depth is less than  $\frac{1}{2}$  of wave length but greater than  $\frac{1}{25}$  of the wave length

**Breaking waves** - waves which fall forward since the forward velocity of the crest particles exceeds the velocity of propagation of the wave itself. In deep water, this normally occurs when the wave length  $L$  is less than 7 times the wave height  $H$  ( $L < 7H$ ) and in shallow water when the depth  $d$  is approximately equal to  $1.25 H$

**Deep water waves** - a wave at a point where the water depth is equal to  $\frac{1}{2}$  of the wavelength or greater to be expressed in terms of the parameters of significant wave

**Significant wave** - A hypothetical wave having a wave height and period equal respectively to average values of the wave height and period of the largest  $\frac{1}{3}$  of all waves in the train as counted in the order of greater wave height.

**Highest wave** - A maximum wave height and wave period of the maximum wave height in wave train.



**Facility oriented organization** - primarily involved in planning designing, constructing, maintaining, and operating fixed facilities

**Operating organization** - known as carriers, primarily concerned with operating fleets to provide transportation services

**Traffic congestion** - a major challenge for the transportation system and the transportation engineering profession because it undermines the effectiveness and efficiency of the system

- demand exceeds the capacity of the transportation system

**Traffic safety** - continuing challenge for the transportation engineering profession because of public expectations that safety will continue to improve.

**Stopping sight distance** - the distance required to see an object 150 mm high on the roadway

**Passing sight distance** - the distance required to see oncoming vehicle of a certain minimum

**Design speed** - defines as the maximum safe speed that can be maintained over a specified section of highway when conditions are so favorable that the design features of highway govern

**Estimates** - these includes cost estimates for various parts of the project and are used too evaluate the acceptability of bids and financial feasibility of the project

**Plans** - these refer to drawings, usually accompanied by notes, of various aspects or components of the design

**Specifications** - these are written instructions detailing how the facility is to be constructed

**4 basic elements of standard plans** -plan view, profile, geometric cross section super elevation

**Plain view** - this is a drawing of the facility as it would look to an observer directly above it

**Profile** - this view has elevation as its vertical axis and horizontal distance, measured perpendicular to the centerline, as its horizontal axis

**Geometric cross section** - this view has elevation as its vertical axis and horizontal distance, measured perpendicular to the centerline, as its horizontal axis

**Superelevation diagram** - this applies to curved facilities, such as highways or railways, only. It consists of a graph with roadway or railway cross slope versus horizontal distance

**Profile grade** - line representing the facility on the profile

**Elevation** - these are in meters above some datum; usually this datum is mean sea level, but it may be any arbitrary scale

**Cross slope** - these are normally specified in m/m or in percentages. In railway practice, cross slopes may be expressed in millimeters that the high rail is above the low rail, since there is a standard horizontal distance maintained between rails

**Grade** - expressed as decima fractions or as percentages

**Drainage** - primary consideration in the design of geometric cross sections for highways, runways, and taxi ways ( CE MAY NOV 2017)

**Shoulders** - these are intended primarily as a safety feature. They provide for accommodation of stopped vehicles, emergency use, and lateral support of the pavement

**Vertical curve** - these are normally parabolas centered about the point of intersection of the vertical tangents they join

**Horizontal alignment for linear transportation facilities such as highways and railways**

- **Horizontal Tangents**
- **Circular curves**
- **Transition curves**

**Horizontal Tangents** - these are described in terms of their lengths and their direction

**Circular curves** - these are usually laid out in the field by occupying the tangent to curve point TC with a transit and then establishing successive points by turning deflection angles and measuring chords

**Transition curves** - these are used to connect tangents to circular curves



**Superelevation or banking of curves** - the purpose of this is to counteract the centripetal acceleration produced as a vehicle round a curve

**Superelevation transition** - this involve modification of the roadway cross section from normal crown to full superelevation, at which point the entire roadway width has a cross slope of  $e$

**Superelevation run off**

**Vehicle dynamic** - this determines the length of the superelevation run off of transitional curves

- waves formed by moving ship or boats

**Compound curve** - these result when two curves of differing radius join one another

**Broken back curve** - these consist of two curves in the same direction separated by a short tangent

**Geometric design of transportation facilities must provide for the resolution of traffic conflicts**

- Merging conflicts
- Diverging conflicts
- Weaving conflicts
- Crossing conflicts

**Merging conflicts** - this traffic occurs when vehicles **enter** a traffic stream

**Diverging conflicts** - this traffic conflict occurs when vehicles **leave** the traffic stream

**Weaving conflicts** - this traffic conflict occurs when vehicles **cross paths by first merging and the diverging**

**Crossing conflicts** - this traffic conflict occurs when they **cross paths directly**

**Basic ways of resolving crossing conflicts in traffic**

- Time sharing
- Grade separation
- Space Sharing

**Time sharing** - these traffic solutions involve assignment of the right of way to particular movements for particular time

**Grade separation** - these traffic solutions eliminates the crossing conflicts by placing the conflicting traffic

streams at different elevations at their point of intersection

**Earthwork** - these quantities are normally expressed as volumes, in metric units, they are given in cubic meters

**Cut or excavation** - the existing ground is above the construction section

**Fill or embankment** - the existing ground is above the construction section

**Catch point** - the points at which the cut or fill slopes intersect the existing ground

**Shrinkage and swell** - defined as proportional change in volume of the material, relative to the volume it occupied in its natural state

**Mass diagram** - calculation of optimum haul strategies and earthwork costs is done

**Haul** - the product of a volume of materials times the average distance it is hauled

**Free haul distance** - the cost of excavation normally includes the cost of removing the material from its existing state, hauling it up to some specified distance

**Cost of borrow** - this is the cost of any material that has to be obtained off job site in order to make a fill

**Limit of economic haul** - the longest distance material should ever be hauled

**Pavements** - consist of the following...

- Base courses
- Surface courses
- Subbase
- Subgrade

**Concrete** - this term refers to any material consisting of a mixture of aggregates, such as sand, gravel, or crushed stone, fastened together by cement

**Base courses** - this normally consists of aggregates such as gravel and crushed rock

**Subbases** - these are usually local aggregate materials. They may consist of either unstabilized compacted aggregate or stabilized materials

**Geotextiles** - these are sometimes used in constructing pavements. These are used to add strength, control



moisture, and prevent the movement of fine materials into drainage layers

**Structural number** - determined based on the traffic loads, soils support, and other design factors

**Alligator cracking** - a series of interconnected of interfaced cracks caused by fatigue failure of the asphalt concrete surface under repeated traffic loading

**Block cracking** - cracks forming large interconnected polygons, usually with sharp corners or angles. These cracks are generally caused by hardening and shrinkage of the asphalt and/or reflection cracking from underlying layers such as cement treated base

**Longitudinal cracking** - cracks approximately at right angles to the pavement center line. These are caused by poorly constructed construction joints and shrinkage of the asphalt concrete surface; they may also be reflective cracks

**Traverse cracking** - cracks approximately at right angles to the pavement center-line. These may be caused by shrinkage or differential thermal stress of the asphalt concrete, or may be reflective crack

**Raveling** - wearing away of the pavement surface caused by the dislodging of aggregate particles and binder

**Drip track raveling** - progressive disintegration of the surface between the heel paths caused by dripping of a gasoline or oil from vehicles

**Bleeding or flushing** - the exuding of bitumen onto the pavement surface causing a reduction in skid resistance

**Type of pavement distress affecting Portland cement concrete pavements**

**Faulting** - elevation difference between adjacent slabs at traverse joints. This is usually the result of pumping and is a major source of Portland concrete pavement

**Settlement** - local sagging in the pavement caused by differential settlement, consolidation, or movement of the underlying earth mass

**Blowups** - localized upward buckling and shattering of the slabs at traverse joins or cracks

**Joint or crack spalling** - the breakdown or disintegration of slab edges at joints or cracks, usually resulting in the

loss of sound concrete and the progressive widening of the joint or crack

**Surface attrition or surface abrasion** - abnormal surface wear, usually resulting from poor quality surface mortar or coarse aggregate

**Surface polish** - loss of the original surface texture due to traffic action

**Delay** - difference between the actual travel time and a given segment of a transportation system and some ideal travel time for that segment

**Flow** - defines as the number of vehicles per unit time passing a point in space and is usually expressed in vehicles per hour

**Headway** - the reciprocal of flow is the average time separation in the traffic stream and is usually measured in seconds

**Speed** - rate of change of distance with respect to time and is usually measured in either miles per hour or feet per second depending on the application

**Distance gaps** - defined as the fraction of time that vehicles are present at a point in space

**Distance separation** - the reciprocal of density which is usually measure in vehicles per mile or per kilometer

**Occupancy** - defined as the fraction of time that vehicles are present at a point in space

**Macroscopic** - these models of traffic flow describe the relationship among flow, speed and density

**Microscopic** - these models of traffic flow describe the motion of individual vehicles and their interactions with one another

**Batching** - process of proportioning cement, water, aggregates and additives prior to mixing concrete

**Curing** - the process of providing the required water and maintaining a favorable temperature for a period of time after placing concrete

**Gap** - Th headway in a major stream, which is evaluated by a vehicle driver in a minor stream who wishes to merge into the major strea

