BUDDHA SERIES

(Unit Wise Solved Question & Answers)

Course – B.Tech (Civil)

College – Buddha Institute of Technology

(AKTU CODE-525)

Department: Civil Engineering

Subject: Railways, Airport & Waterways (KCE 070)

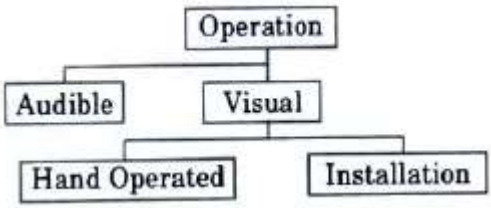
Faculty Name: Ankur Kumar

Unit - 3

Que 1. How the signals are classified ? Explain the different types of signals used in station yards. [AKTU 2022-23, 2017-18, 10 Marks]

Answer : Classification of Signals : Following are the classification of signals :

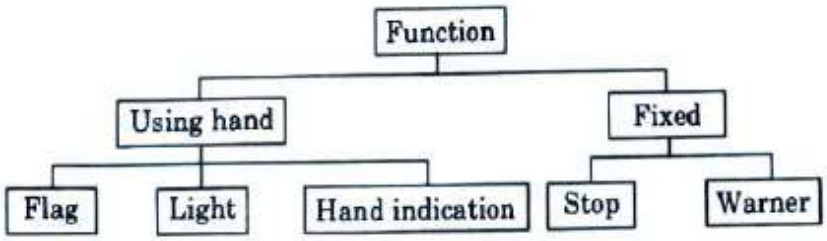
A. **Based on Operating Characteristics** :



Audible Signals :

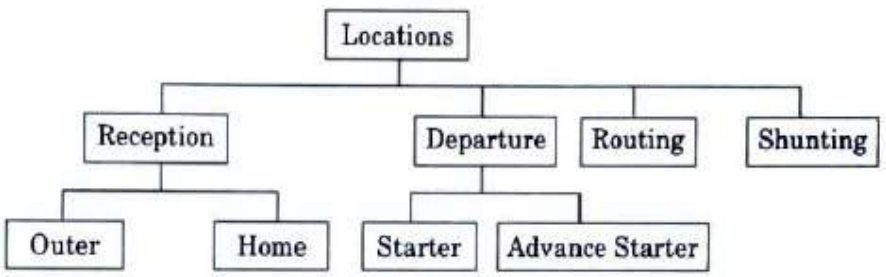
i. It is used during low visibility conditions.
ii. It is fixed to the rails.
iii. It is placed 400 m to 500 m before the signal.
1. Visual Signals: Following are the two types of visual signals:
i. Hand operated : It is operated using hands in many forms.
ii. Fixed installation :
a. It is placed on the top of post.
b. It may be of movable arm type or colour light type or disc type.

B. Based on Functional Characteristics:



1. Using Hand :
i. It has red and green flags.It has red, yellow and green light.
ii. It has hand indications which are used mostly during shunting.
2. Fixed Signals : Following are the two types :
i. Stop signal.
ii. Warner signal.
a. It may be of movable arm type or colour aspect type.
b. It indicates STOP condition and CAUTION condition, respectively.
c. It these are operated using electric current or wires or keys.

C. **Based on Locational Characteristics:**



1. Reception Signal :
i. It controls the reception of trains into a station.
ii. These are of two types :

Outer Signal

a. It is the first stop signal before the entry from block section to station section.
b. It is placed at sufficient distance from the station limit (0.54 km for BG and 0.40 km for MG].
c. This may be provided with a warner signal on the same post.

Home Signal :

a. It is placed just at the door of station.
b. It is provided with multiple brackets depending up on number of lines available at the station.Thus it protects the already occupied sidings.

2. Departure Signals :

i. These signals control the dispatch of trains from the station.
ii. These are of two types :

Starter Signal :

a. It marks the limit up to which the trains stopping at a station should come to a stand.
b. It is separate starter signal, provided for each line.

Advance Starter Signal:

a. These are last stop signals on station limits.
b. It is provided beyond trailing points and switches at a distance 180 m or more.
c. These indicate the movement of a train from station limits to block section.

3. Routing Signals :

i. It depends upon the number of lines existing on the station.
ii. Lowering of any signal indicates the track for which points are set.
iii. Signal for main track is kept at a higher level than other signa1s.
iv. A plate is attached to it which defines the track to be taken up or being set for the train.

4. Shunting Signals :

i. It is used for shunting operations in station yards.
ii. Where semaphore signals are used, these are provided in circular disc shape.
    a. Disc is provided with a red band on white background.
    b. Provided with two holes, one for red lamp and other for green lamp.
    c. It revolves in a vertical plane.
    d. When red band is horizontal or it shows red light during night then it indicates STOP.
    e. When red band is inclined at 45° or shows green light during night it indicates PROCEED.
iii. Where colour aspect signals are used, these are provided as coloured light signal placed on a post.
    a. It is provided with three light lamps.
    b. When two lights in horizontal plane are on then it indicates STOP.
    c. When two lights in inclined plane are on then it indicates PROCEED.

D. Based on Special Characteristics :

1. Repeater Signal :

i. It provided when a signal is not visible to the driver from adequate distance due to curvature or any other reason or to the guard of the train at the rear end of the platform.
ii. It is located at a suitable position on the platform in rear of main

signal..

iii. This may be semaphore type, colour aspect type or rotating disc type.

iv. It is provided with an 'R' marker.

2. **Co-acting Signal** :

i. It provided when a **signal** is not visible to the driver due to some obstruction such as over bridge, high structure, etc., or to the guard of the train at the rear end of the platform.

ii. It placed preferably on the same post and is exact replica of the original signal.

iii. It works in unison with the original signal.

3. **Calling-on Signal** :

i. It placed on the same post below home signal.

ii. Meant to call the train, which is waiting beyond the home signal.

iii. It helps during the main signal failure for train movement.

iv. If the main signal is in 'ON' position and calling-on signal is in 'OFF' position, then the train is permitted to move cautiously.

4. **Indicators** :

i. **Point Indicators** :

a. It indicates whether the train is taking main line or a turnout.

b. It works as a precaution against bursting of points or running into an occupied line.

c. It is provided with rotating disc which rotates with the change in setting of points.

vi. **Caution Indicator** :

a. It indicates towards a track on which certain restrictions are imposed (temporary/permanent).

b. It is placed 700 m before speed limit.indicator board and 800 m before actual point of any permanent way work.

5. **Terminators-Block Section Limit** :

i. It is defines entry to station limit.

ii. It is placed at 180 m from the home signal.

Que 2. What is signalling ? What are the objectives of signalling? List the types of signals. [AKTU 2022-23, 2018-19, 10 Marks]

Answer

Signalling: Signalling consists of the systems or devices or means by which trains are operated efficiently, and the tracks are used to the maximum extent, maintaining the safety of the passengers, rolling stock and the staff.

Objective of Signals: Following are the objectives of signals:

1. Efficient movement of trains.
2. Ensuring safety of trains moving on crossing tracks.
3. Maximum utilization of track.
4. Safety during shunting operations.
5. Managing train movements during maintenance and repairs.

Que 3. What is the principle of stop signal ? Explain its components with the help of a neat sketch. [AKTU 2018-19, 10 Marks]

OR

How signals are classified ? Explain with neat sketches the working of the semaphore signals.

A Classification of Signals:

B. Semaphore Types or Stop Signals:

1. Working Principle of Semaphore Signal :

i. The ordinary position of signal is horizontal but it can be lowered to an angle by pulling the wire from the signal cabin.

ii. When the signal is in horizontal position, it is said to be in 'ON' position which indicates 'Stop' or 'Danger', when the signal is lowered by pulling the wire at an angle of 45° to 60°, it is said to be 'Off position which indicates "Proceed".

iii. The indications given by semaphore signals are shown in Fig. 3.3.1, and the arm designs for special features of semaphore signals are shown in Fig. 3.3.1.

Table 3.3.1. Indications of Semaphore Signals.

S.No.	Operating Time	Position of arm or Colour of Light	Position of Signal	Indication Given
1.	Day Time	i. Horizontal arm ii. Inclined arm 45° to 60°	"On" position "Off' position	"Stop" or Danger "Proceed" or line dear
2.	Night Time	i. Red light ii. Green light iii. Yellow light	"On" position "Off' position -	"Stop" or Danger "Proceed" or line clear "Proceed Cautiously"
3.	Day or Night	i. No signal (absence of signal) ii. White (unless for shunting signals)	- -	"Danger" "Danger sign"

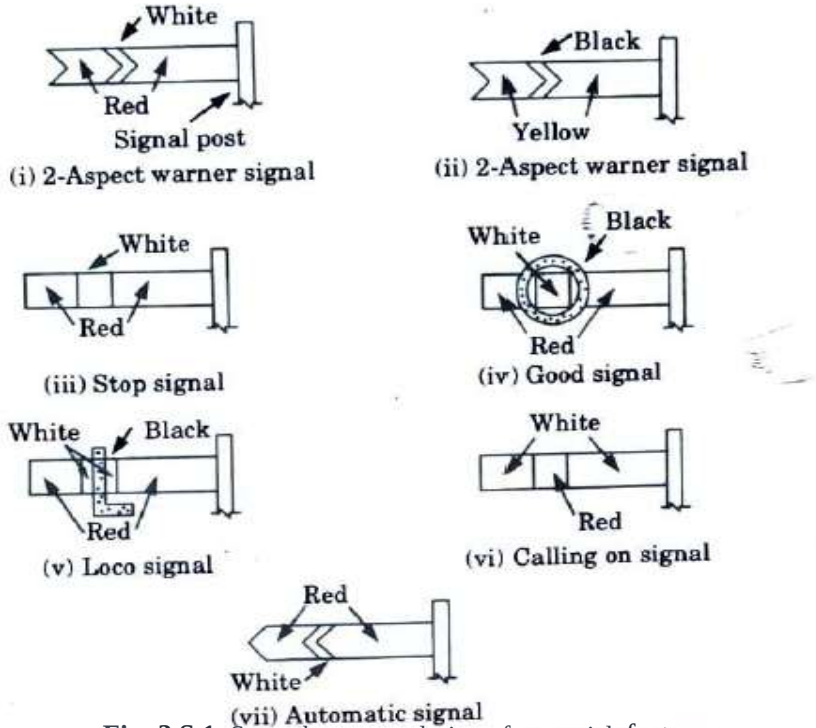


Fig. 3.S.1. Semaphore arm designs for special_features.

2. **Component Parts of Semaphore Signal** :

i. **Movable arm:** This is pivoted on the horizontal pin known as spindle near the top of the post. The arm is 1.2 m to 1.7 m long, 23 cm to 25 cm wide at the inner edge and 25 cm to 35 cm wide at the outer edge. In the normal position, this arm remains horizontal.

ii. **Weight and Lever Arrangement: A** lever capable ofrevolving about horizontal pin is provided. At ohe end, a weight is attached and crank rod is connected to the lever through a cam. To the other end of the lever, a wire is attached which is taken to signal cabin after passing over pulleys.

iii. **Spectacle Frame** : It is provided in the arm and it consists ofred glass at the top and green glass at the bottom with a lighting arrangement for signalling at night.

iv. **Crank or Alternate Mechanism** : This provided to ensure that the signal and crank move together. This crank is fixed in the spindle where the movable arm is fixed.

v. **Crank Rod** : This is used to actuate the crank or other mechanism provided.**Ladder:** The movable arm being higher than man's average height a ladder is provided for physical connection between the movable arm and the ground level.

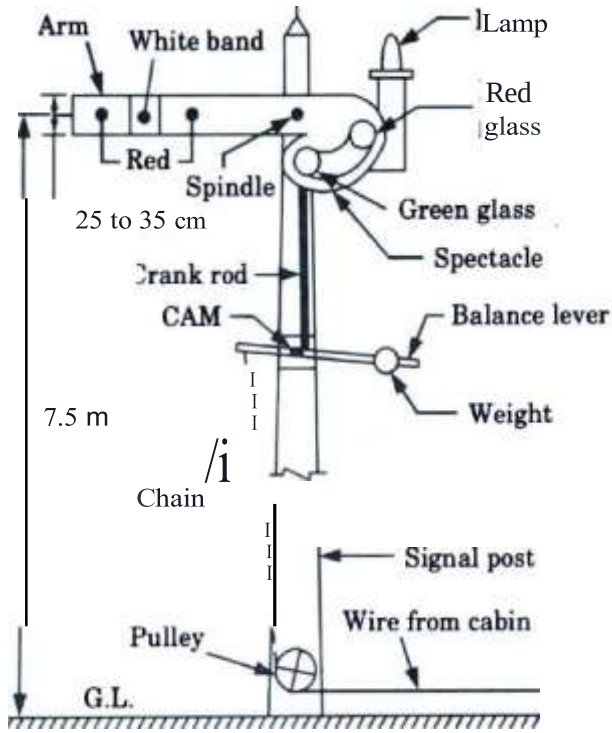


Fig. 3.3.2. Semaphore types or stop signal.

Que 4. What are the different systems of controlling the movement of trains ? Give the advantages of CTC system.
[AKTU 2017-18, 10 Marks]

Answer

System of Controlling: Following are the various system o'fcontrolling the movement of train:

1. One-engine only system.
2. Following train or Time interval system.
3. Pilot guard system.
4. Train staff and Ticket system.
5. Absolute block or Space interval system.
6. Automatic block system also called automatic signalling.
7. Centralized traffic control system (CTC system).
8. Automatic train control system (ATC system).

Advantages: Following are the advantages of CTC system:

1. This system increases the track capacity, so encourages to run additional trains. This is a special benefit in case of single line operation.
2. As the signal cabins are not required, there is great saving in staff.
3. The dispatcher, controlling the panel, can arrange the train movements in advance and is free to do other works of the office.
4. Points and signals can be operated in few seconds by means of thumb- switches.
5. This system is capable of detecting the defects of the track.

Que 5. Briefly describe the absolute block system of controlling the movement of trains for single and double lines. Also gives its merits.

Answer

1. **Absolute Block System or Space Interval System (or Lock and Block System)**:

i. In this system, the entire track is divided into sections called block sections, separated by block stations, *i.e.*,stations provided with block- instruments in pairs at each station.

ii. These instruments are used to show as to whether the section ahead is clear or reserved for a train.

iii. All block-sections are linked in series both telegraphically for operation of block instruments and telephonically for verbal exchange of information.

iv. A block station is under the charge of the station master and a block section under the joint charge of two adjacent block stations.

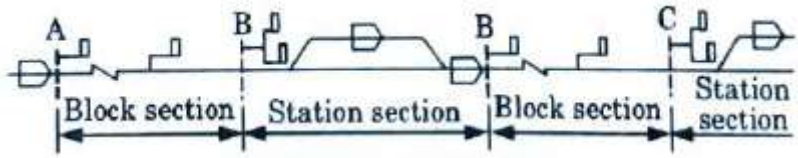


Fig. 3.5.1. Absolute block system.

2. The following are the essentials of the absolute block system :

i. No train should leave a block station unless permission to do has been received from the block station in advance *i.e.*, receiving station. This is essential for dispatching of trains.

ii. No train should be given permission to approach a block station unless:

a. In the case of double line, when the line on which the train being run is clear upto an adequate distance beyond the first stop signal at the station at which the permission is being given.

b. In the case of single line, when the line is free of trains and is clear upto an adequate distance beyond the first stop signal and is free of trains running in the opposite direction or will be free of the trains after the complete arrival of the train going towards the station to which the permission is being given. These are essentials for reception of trains.

iii. When two trains are running on the same line and in the same direction, the permission to approach for the second train should not be given unless:

a. The first train has arrived at its proper position within the home.

b. AJI the signals behind the first train have been pu.t back to ON positions.

c. The line is clear not only upto the first stop signal of the station but also for an adequate distance beyond it.
d. AJI the switches or point have been set, facing point locked and trailing points bolted for the second train. These are the essentials for conditional line clear.

3. Merits : Following are the merits of absolute block system :

i. Human error is eliminated.
ii. Greater safety and efficiency.
iii. Less personal required.
iv. Less operating cost and capital cost.
v. Increase the traffic density.

Que 6. Explain the centralized traffic system of train. Also give it advantages.

Answer

A. Centralized Traffic Control Systems (CTC):

1. Centralized traffic control means the centralization of operation of all the points and signals at the various stations on a section of the railways at one single location and concentrating the control over all the points and signal indications into the hands of a single official.
2. This official thus has the control over all the traffic movements on the section.
3. This is progressive technique in control of points and signals from the non-interlocked to the multiple cabin, from the multiple cabin to the single cabin, then to remote control of points and finally to centralized control of points and signals over an entire section.
4. This is the latest system developed to control the movement of trains in which the points and signals are operated from a central control room and no signal cabins are required.
5. In this system, the centralized traffic control panel is used which consists of illuminated track diagram, showing the relative position of signals, points and track circuits together with their reference numbers.
6. There are number of thumb switches below the illuminated track diagram for the control of points.
7. In addition immediately below the point-thumb switches, the signal thumb-switches are mounted to operate the signals in different positions.
8. There is also a switch to determine the direction of movement of train. The ignal in the opposing direction remain in danger position.
9. The person controlling the panel is known as a dispatcher. The Dispatcher makes all the arrangements for crossings, points and signals.
10. The duty of drivers is merely to respect the different indications given by the signals.
11. The arrangements are also made in this system to display stop signals automatically in advance and bring the trains automatically to a rest to avoid a collision, in case the driver does not obey signal indications.

Que7. Explain the automatic block system. Answer

Automatic Block System (or Automatic Signaling):

1. This system is an improvement on absolute block system and avoids the possibility of accidents due to negligence on the part of human beings.
2. In this ystem, the signals are actuated by the trains themselves and, therefore the trains can follow each other between the two stations.
3. The section between the two stations is divided into a number of blocks (one block is of about 5 km to 7 km length).
4. An electric current is conveyed through the electric circuited

track. When a train enters a particular block, the electric current puts the signal at danger position (red light at night) for the particular block until the train has gone nearly two blocks ahead, *i.e.*, for adequate distance.

5. In America, further advancement in automatic signalling in which they use electric fittings with wheels brakes of the locomotives.
6. This further helps to take caution in danger position of signal even if the driver has failed to act according to the signal indication, then these brakes are automatically applied.

Advantages: Following are the advantages of automatic block system :

1. Reduce the requirements of number oflocomotive and carriages.
2. No block instruments are required.
3. Modernization in traction.
4. Greater safety and efficiency.
5. Less number of personnel for operating signal is required.

Que 8. Explain any four methods adopted to control movements of train and compare their merits. [AKTU 2016-17, 10 Marks]

Answer

Following methods are used for controlling train movement :

1. One-Engine-Only System :

i. This system permits only one train to remain in a section at one time.

ii. The movement of train is controlled with the help of a wooden staff or a token with suitable identification marks, which are in the possession of the driver (loco pilot) of the train.

iii. As the same object cannot be at two places at the same time, the safety of train is fully ensured.

iv. This system is possible only on short branch lines that have limited traffic.

v. Normally there is only one train, which works to and fro on the same section.

vi. The system fails if it becomes necessary to dispatch more than one train in the same direction. This system does not require a line clear directive.

Merits: It is safe and more reliable system.

Que 9. Write short note on the following:

1. **Following Train System.**
2. **Pilot Guard System.**
3. **Train Staff and Ticket System.**

Answer

1. Following Train System:

i. In this system, trains follow each other after a time interval that is generally less than 15 minutes.

ii. Trains scheduled after the first train can run at a maximum speed of 25 km/hr.

iii. *As* an adequate time interval is kept between two successive trains safety is ensured to a limited extent.

iv. The system is used under the following circumstances:

a. In the case of emergencies, such as the failure of block instruments and the telephone system.
b. In short double line stretches.

2. Pilot Guard System:

i. In such a system, one person, known as the pilot guard, accompanies the train by_riding on the foot plate of the engine (or gives a ticket personally to the guard of the train, which is authority to proceed) and returns to the same station with another train.

ii. The pilot guard is normally identified by his or her prescribed uniform, which is red in colour, or the badge that he or she wears and is an authority for the train to proceed.

iii. Even in this system trains can follow each other after a fixed time interval of not less than 15 minutes.

iv. The system is applicable in short single-line sections or in the case of failure of communication between two stations.

3. Train Staff and Ticket System :

i. This system is similar to the pilot guard system. The authority to proceed in this case is either a wooden staff or a ticket.

ii. There is only one wooden staff for a section and the same is kept at one of the two stations on that section. Each station has a ticket box, which contains printed tickets and is kept locked.

iii. The wooden staff is interlocked with the box in a way that it cannot be taken out so long as the box is locked.

iv. A train can only be dispatched from the station that has the staff. In case only one train is to leave the station, then the staff is handed over to the driver of the train. If more than one train is to be dispatched from the same station, the preceding trains are dispatched on the authority of the ticket while the last one is dispatched along with the staff.

v. The time gap between two successive trains is not less than 15 minutes and the speed of the train is restricted to 25 km per hour. A similar system is followed for dispatching trains from the other station.

vi. In this system, the safety of the trains is ensured on account of the fact that only one ticket can be issued at one time and the driver insists on seeing the staff before accepting the ticket as his authority to proceed.

Que 10. What are the essentials of interlocking? Distinguish between direct and indirect interlocking. What purposes does the lock bar serve? [AKTU 2022-23, 2017-18, 10 Marks]

Answer

A. Interlocking: It is defined as the mechanical relationships established between various levers operating the signals and the points through mechanical or electrical agencies such that contrary effects are not at all possible in the working of the signal mechanism.

B. Essentials of Interlocking: The essentials of interlocking are as follows:

1. It should not be possible to turn a signal off unless points for the line on which the train is to be received are correctly set, all the facing points are locked and all interlocked level crossings are closed and inaccessible to road traffic.
2. The line should be fully isolated before the signal is turned off, *i.e.*, no loose wagons should be able to enter this line.
3. After the signal has been taken off, it should not be possible to make adjustments in the points or locks on the route, including those in the isolated line. Also, no interlocked gates should be released until the signal is replaced to the 'ON' position.
4. It should not be possible to turn any two signals off at the same time, which can lead to conflicting movements of the trains.
5. Wherever feasible, the points should be so interlocked as to avoid any conflicting movement.

C. Difference between Direct and Indirect Interlocking:

Indirect Interlocking	Direct Interlocking
Indirect interlocking means that the points are set and locked from one place and the signals are operated from another place and another lever frame; the interlocking is effected by means of keys carried from one place to the other.	Direct interlocking means that all levers, viz. the point, the point locks and the signal levers are concentrated in one lever frame and worked therefrom; the interlocking is effected by means of rigid

	connections between levers without the use of keys.

D. Purpose of Lock Bar: This is provided for the purpose that the point may not be operated while the train is on it.

Que 11. Explain various functions of interlocking. [AKTU 2018-19, 10 Marks]

OR

Explain the principle and functions of interlocking.

Answer

A. Principle of Interlocking : Following are the various principles of interlocking :

1. It shall not be possible to take OFF conflicting signals at one and the same time.
2. It shall not be possible to take OFF signal for the running line until :
   a. All points on the running line are correctly set and facing points locked.
   b. All points, giving access to the running line from the sidings and goods lines, are set against the running line.
   c. Level crossing gates if included or controlled by interlocking are locked across the roadway.
   d. A signal lever operated when drawn must lock or back lock as necessary the levers operating the points and gate locks referred to above.
3. When all signals are in the ON position, all points which would be locked by taking OFF such signals must be free for shunting purposes.
4. It must be impossible to take OFF a warner signal, until all the relative stop signals in advance have first been taken OFF and when OFF it must back lock all such signals.

B. Functions of Interlocking : Following are the functions of interlocking :

1. It must be impossible to take OFF a signal for approaching train unle the route (including the over-lap)to which the train is taking, is properly set, locked and held. This means that the points must be set and each facing point is locked so that it finds the passage of the train to withstand the stresses created by the train at the junction of divergence. At the same time, it is necessary that it must be impossible to operate the oints *(i.e.,* to unlock or reverse the points) while the train in moving on it; as otherwise, there is danger of the train taking conflicting routes.
2. It must be impossible to take OFF position at one and the same time for two fixed signals at the same time which would lead to conflicting movements *(i.e.,* movements which cross each other's path). So the points and signals should be interlocked against such movements.
3. It must be impossible for loose wagons to interfere with the route for which the points are set and signal has been taken to OFF position. For this purpose, it is necessary that levers operating points and signals should be interconnected in such a way that they can be pulled only in a particular sequence or order, and also can be put back in a particular sequence *(i.e.,* reverse sequence or order).
4. The route, for which the points are set and signal taken to OFF position, should be clear of any obstructions.

Que 12. Explain the various methods of interlocking.

Answer

Methods of Interlocking: Following are the method of interlocking :

A. Key Interlocking:

1. Key interlocking is the simplest method of interlocking and still exists on branch lines of smaU stations on Indian Railways.
2. This method involves the manipulation of keys in one form or the other.
3. This type of interlocking is normally provided with standard interlocking

with a speed limit below 50 k.rnph.

4. The simplest arrangement of key interlocking is accomplished in the following manner :

i. Take the example of a station with a main line and a loop line, the point can be set either for the main line or branch line.

ii. The point ha two keys, the first is key *A*, which can be taken out when the point is set and locked for the main line. Similarly, key *B* can be taken out when the point is set and locked for the loop line. At any given time either key *A* or key *B* can be taken out, depending upon whether the route is set for the main line or the loop line.

iii. The lever frame operating the signals is provided with two levers. The lever concerning the main line signal can be operated only by key *A* and similarly the loop line signal lever can be operated only by key *B.*

iv. If the train is to be received on the main line, the points are set and locked for the main line and key *A* is released. This key is used for interlocking the main line signal lever, thus lowering the signal for the main line. Since key *A* cannot be used for interlocking and lowering the loop line signal, only the appropriate signal can be taken off. This type of interlocking is called indirect locking.

5. In case more than one point is to be operated, the key released at the first point is used to W1lock and operate the second point and so on.
6. The key released at the last point can then be used for unlocking the lever operating the appropriate signal. This type of interlocking is also known as succession locking and is also used for checking conflicting movements in shunting operations.
7. There are other methods of interlocking with the help of keys, but all of them involve considerably lengthy trips from the point to the signal levers and from point to point, thereby leading to delays.
8. Such arrangements are, therefore, satisfactory only for stations that handle very light traffic.

B. Mechanical System of Interlocking :

1. A1most 70 percent of railway stations in the country work with the mechanical system of signalling.

2. The interlocking arrangements for mechanical signalling system have to be mechanically oriented.

3. There are two systems of mechanically designed signals :

i. Single wire system.

ii. The double wire system.

4. A mechanically structured signal has :

i. Spectacle with an arm.

ii. Signal post, which may be tubular or lattice. Longer posts are chosen to be lattice.

iii. A counterweight to help pull the wire back to allow the signal to go back to its on/normal position.

5. Such mechanical structures of signals are :

i. Two aspect semaphore signal.

ii. Multiple aspect semaphore signal.

6. Mechanical interlocking or interlocking oil lever frames is an improved form of interlocking compared to key locking. It provides greater safety and requires less manpower for its operation.

7. This method of interlocking is done using plungers and tie bars. The plungers are made of case hardened steel sections measuring 30 cm x 1.6 cm and have notches in them.

8. The tappets tie bars are placed at right angles to the plungers and are provided with suitably shaped pieces of cast iron or steel that fit exactly in the notches of the tappets.

9. The entire arrangement of plungers and tappets is provided in a locking trough. Each lever is attached to the plunger, which has suitably shaped notches to accommodate the locking tappets.

10. When a lever is pulled, it moves the plunger to which it is connected.

Due to wedge action, the tappet accommodated in the notch of the plunger is pushed out at right angles to the movement of the plunger.

11. The motion is transmitted to all other tappets that are connected to this tappet through a tie bar.
12. *As* result of I.his motion, the other tappets either get pushed into or ut of th respective notches of the other plunger depending upon the mterlocking provided.
13. In case the other tappet is free but slips inside the notch of the other plunger, it locks the lever connected to this plunger.
14. In consequence, the other lever gets locked in that position, and cannot be operated.
15. However, if the tappet was earlier positioned in the notch of the plunger, thereby locking the lever, and is now out of the notch the other lever becomes free to be operated.
16. This arrangement thus sets the predetermined sequence for pulling the levers and hence actuates the interlocking.

C. Electrical System of Interlocking:

1. As the signal displays fixed light illuminated by incandescent lamp or a light emitting diode (LED)signal, the operation of such system may be through mechanically operated levers or by push buttons provided on the yard layout depicted on the top panel box to be termed as the control cum indication panel.
2. Under the electrical signalling system the colour light signals are used in any case operated by lever, points (i) Operated by wrought iron solid 33 mm rod· (ii) Operated by electric point machines, or operated by control-cum-indication panel operating points by an electric point machine with signals being coloured light.
3. The system of operation of electrically operated signals by levers is hybrid and is invariable an interim measure to suit 25 **kV AC** traction, to be subsequently converted to operation by control-cum-indication panel.

D. Electronic System of Interlocking:

1. In case of electrical interlocking the relays used are wired using a cable of copper conductors to translate the interlocking relations given in the selection table, into logic circuits.
2. In case of electronic interlocking, these logic circuits are converted into Boolean equations and finally converted into a program loaded on the processor of the computer.
3. The yard layout may be loaded on the computer and the train operation may be carried out using a mouse and the VDU or the control-cum- indication panel or either of the two with both options being available, transferring the control by a switch provided on the control-cum- indication panel.
4. Ultimately relays are energized by the system having evaluated the interlocking relations, to transmit commands to point and the signal.

Que 13.Write short notes on the track requirements for high speed trains.

Answer

Track Requirements for High Speed Routes :

1. **Rails:**

i. For high speed routes, 60 kg rails are adopted by the railways world over.

ii. Continuous welded rail (CWR) is used to improve the ride quality and to reduce noise and vibrations.

2. **Sleepers**:

i. Prestressed concrete sleepers have been a better choice.

ii. Sleeper density of 1660 is being used on Indian Railways.

3. **Fastenings**:

i. Double elastic rail fastenings are necessary for the concrete

sleeper track.

ii. Rubber pads are used as cushioning material between the rail and sleepers fastened by leaf spring/wire spring fittings for distribution of vertical load and for dampening the vibrations.

4. Curve for High Speed Trains :

i. Flat curves are generally adopted on a high speed track.

ii. The minimum radius of curvature for high speed lines generally varies from 4000 m to 7000 m for a standard gauge.

5. Level Crossing/Grade Separation : Level crossing is not suitable in unavoidable circumstances, level crossings may be required. Then it must be interlocked with the signals.

6. Fencing:

i. On high speed lines, trespassing is very risky. Therefore, the entire high speed track is to be provided with fencing.

ii. Track ballast stones sometimes fly off and hit the surroundings. To avoid such incidences also track fencing is required.

Que 14. What are the important limitations in attaining high speeds? Discuss.

Answer

Limitations : Following are the important limitations to con idering for high speed :

1. Wave Formation:

i. The prop:3.gation velocity of wave in a medium sets the speed limit of a body moving in that medium.

ii. The rail deflects under a wheel and the wave in the rail moves with the vehicle.

iii. The wheel will be accompanied by large amplitude stationary waves, which will eventually destroy the rail. The propagation velocity of deflected wave of the rail sets a speed limit to the train running on it.

iv. A similar phenomenon exists between the pantograph. The pantograph causes deflection of the wire at the contact point leading to a wave formation.

v. If the speed of the pantograph exceeds the propagation velocity of the transverse wave in the wire, the rapid growth of amplitude may destroy the overhead wire system.

2. Adhesion between Wheel and Rails :

i. In the existing system wheels are driven by the power supplied from some source and tractive force is given as the reaction of the rail due to adhesion between rail and wheel.

ii. Adhesion force tends to decrease with the increase of speed of the vehicle.

iii. On the other hand, the train resistances increase approximately with the square vf the speed.

3. Vibrational Limitations :

i. The vibrations ofrolling stock grow with speed. Speed will have to be limited by the consideration of safety of train and riding comfort of passengers.

ii. Besides this, a railway vehicle cannot be free from unstable self excited vibrations, no matter how geometrically straight the rail is. This is a phenomenon inherent in the railway vehicle and is called hwiting.

iii. An elevation of the speed limit due to vibration to about 350 km/hour is theoretically possible. A drastic solution to this question is to make the train float a little over the track rather than the train running on the rails.

4. Special Problems on Curved Track :

i. Unequal wheel loads on the inner and outer rails influence the safety of the vehicle. It is a general practice to give an elevation to the outer rail of the curved track for compensating the centrifugal force.

ii. The curve radius of 2500 m and elevation of 180 mm will provide a balancing speed of 200 kmph.

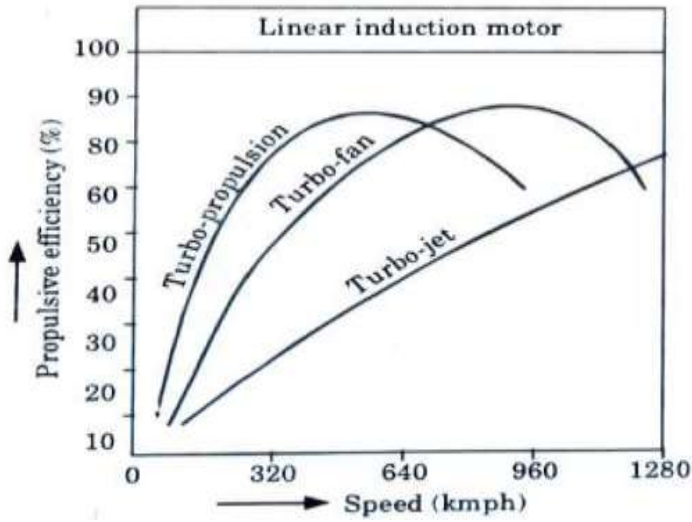
iii. The trouble on the curve can be solved by increasing the radius.
iv. In constructing future high speed tracks, it may be essential toeliminate curves as much as possible.

Que 3.15. / What are the technologies required for high speed track on?

Answer

Following are the technologies required for high speed tracks:

1. **Linear Motor and Wheel** :
   i. The linear induction motor offers almost unlimited scope for attainment of very l)igh speeds.
   ii. It can be considered to be derived from the rotary induction motor by a process of cutting and unrolling both the primary and secondary members and then fY greatly increasing the length of one of the unrolled members.
   iii. The thrust is produced without physical contact and therefore, the motor is suitable for use with all types of guidance and suspension systems including air cushion.
   iv. Fig. 3.15.1shows a graph of the propulsive efficiency for various speeds of linear motor and turbo engines. A traction system such as linear motor, which is free from adhesion, on a very wide track gauge, may enable to attain a speed of 350 kmph.
2. **Linear M tor and Air Cushion Vehicles:** In conventional railway operation, the power requirement increases approximately in proportion with the



quare of speed and, therefore, the combined system of the linear motor and air cushion may, perhaps, offer the best prospects of super high speed operation up to 500 kmph.

Fig. 3.15.1. Propulsive efficiency of linear motor and turbo engines.

3. **Gas Turbine and Air Cushion (Tracked Air Cushion Vehicle):**
   i. Britain developed a vehicle in 1969 carrying 80 passe gers at s eeds of upto 300 km per hour which was propelled by a 2.3 m diameter air screw powered by two 1200 HP gas turbine.
4. Support was from 8 air cushions, on ea h side and the _vehicle was

guided by6 more air cushions bearing against central vehicle member of the concrete guide way.

5. Magnetic Levitation Vehicles:

i. Experimental vehicles, based on principle of magnetiJ support and guidance, exhibit two distinct concepts :
   a. One using electromagnets pulling upwards and outwards for support and guidance of the vehicle.
   b. The other in which vehicle is supported by magnetic attraction.

ii. Like an aeroplane, the MAGLEV vehicle or train needs wheels for low speed travel, until it reaches lift off at about 80 kmph. The cross sectional details of inverted T-shape and U-shape guideways aloi;igwith

iii. MAGLEV vehicle.MAGLEV have following advantages over the TACV system:
   a. Energy consumption is less.
   b. There is not aero dynamic drag.

iv. There is plenty of scope for development of both these systems. The design of locomotive and coaches would have to be radically modified. Like an aeroplane, the coach may bank inwards on curves as opposed to the outward motion experienced in present trains.

Que 16. Discuss briefly the various types of transport that can be provided in a metropolitan town.

Answer

A. **Types:** Following are the types of urban transport used in metropolitan town:

1. Buses:

i. These run mostly on diesel oil and their e aust emissions have an adverse effect on the environment.

ii. Moreover, bu es, though very convenient for transporting passengers, have very limited seating capacity.

2. Trolley Buses:

i. Trolley buses derive tt)eir energy through overhead electric transmission.

ii. These are superior to buses as they do not pollute the environment.

iii. On the other hand huge expenses are incurred in providing overhead traction for supplying power to trolley buses.

3. Tramways:

i. Tramways equire a track on which the trams can run and as such req _e ! e infrastructure of a proper railway track. Their 1rut1al cost is quite high.They_cause m mal air pollution; however, they contribute significantly to noise pollution.

ii. Tramways are almost obsolete now and are used only in some parts of the country such as in Kolkata.

4. Surface Railways :

i. In sucha system, the track is laid on a ground that hasa suitable embankment or cutting, depending upon the topography of the area.

ii. Metropolitan railway use electric traction because of the following advantages:
   a. Electric traction does not pollute the environment.
   b. The acceleration and deceleration of trains is faster.
   c. Electric traction ensures the availability of power for improved and modern signalling.
   d. An electric locomotive can haul a train with the same efficiency in both the directions and there is no need for reversing the direction of the locomotive.
   e. This system uses special type of coaches called electric multiple *units* (EMUs), which can carry more traffic than conventional coaches.

5. Underground Railways:

i. In underground railways, the railway line is constructed below the ground level.

ii. An underground railway system normally uses electric t:caction, as steam and diesel tractions produce smoke and lead to the pollution of the environment.

iii. Proper arrangements are also made for the drainage of underground railways.

iv. Such underground railways have been constructed in Kolkata and Delhi and in other countries around the world.

6. Elevated Railways :

i. Elevated railways are provided at an elevation above the ground level. The platforms and even the station building are provided at an elevation for the convenience of passengers.

ii. The main advantage of elevated railways is that it does not require any separate land. There is no interference with road traffic as roads can be provided between the columns.