

CHAPTER XXVII

LINE CAPACITY

27001. Definition.- The capacity of a line is expressed in the number of trains in both directions that can be run on a given section of the line. Line capacity of a section represents the maximum number of trains can be passed over the section from 00 hrs to 24 hrs. without reducing the speed considerably.

27002. Calculation of line capacity by Scotts' formula.- (a) Line capacity is theoretically calculated by the Scott's formula which expresses the line capacity in terms of trains per day in both directions. The formula is as follows :-

$$\frac{1440 \text{ (minutes per day)} \times 70}{T + t} \times \frac{100}{100}$$

(b) In this formula.-

- (i) T - running time in the minutes of a ruling train on the ruling section of the line.
- (ii) t - time in minutes normally required between the arrival and departure of two/opposite trains in a station which for token working is 5 minutes.
- (iii) The "Ruling Section" or the Governing Section is the section between those two stations of the line with the longest running time of the "ruling trains". The "ruling trains" normally are the slowest moving goods trains.
- (iv) The 70% factor is an efficency factor, which accounts for the impossibility of regular distribution of trains over the day, as it is not possible to run trains strictly one after the other, which is assumed while arriving at the theoretical line capacity.

(c) To calculate the line capacity of a single line section the figure derived by the above formula should be divided by 2.

27003. Limitations of the Scotts' formula.- The Scotts' formula has the following limitations :-

- (a) It assumes as a rule that trains are running by turns up and down on the ruling section. It is, however, impossible to arrange such a succession of trains on sections with mixed, passenger and goods traffic.
- (b) It does not take into account the total length of the line for which the capacity has to be worked out. Experience shows that the longer the line, the lesser usually is its capacity, other conditions remaining the same.
- (c) The number and location of the long sections is another factor which is not taken into consideration. The more the number of long sections on a line, the less is its capacity.
- (d) There is no mention in the formula of the importance of the number of crossing loops at stations or number of lines or sidings at junctions both of which affect the line capacity considerably.

(e) It does not take into account effect of various signalling arrangements over line capacity. Operating time between two successive trains in Automatic section equipped with automatic block and on a non-interlocked section cannot be the same.

(f) It is also silent about the influence of different patterns of traffic on the line capacity over various sections.

27004. Master charts.- The above formulae provide only a rough estimate of line capacity. It is, however, best to realistically determine the line capacity of a section by actually plotting the paths of trains on a master chart. Passenger train paths should be plotted first and then goods train paths should be interpolated so as to make the maximum use of the line. While doing so, the terminal facilities should be taken into account.

27005. Various methods of increasing line capacity.- (a) To increase the capacity of a line, efforts should be made to reduce the value of the denominator in the formulae given above and increase, as much as is possible, the efficiency factor. The efficiency factor depends on the peculiarities of each railway and it is not possible to evaluate it mathematically. However, its influence on line capacity is very important. It is a measure of the deviation of the actual performance from what is planned. The first requirement to improve this efficiency factor is an intelligent forecast, which will give an accurate and true picture of the whole transportation business. Then again, all reasonable precautions should be taken to keep the effect of inevitable irregularities and interference as small as possible.

(b) The following are some of the methods of improving the capacity of a section :-

(i) Instilling in staff a sense of the importance of time.

(ii) Having close and constant supervision.

(iii) Reduction of stopping time of trains at stations by curtailing of time in loading and unloading, shunting and marshalling of trains etc.

(iv) Arranging of as few crossing at stations as possible and arranging one of the trains crossing at a station to run through as far as is possible, thereby increasing average speed.

(v) Keeping a watch on temporary engineering restrictions which should be imposed for the absolute minimum period.

(vi) Using more block trains.

(vii) Subject to the length of loops on the section, running of double rakes.

(viii) Keeping under constant review operating rules or practices which after careful consideration, are deemed to be unnecessarily conservative under present conditions.

(ix) Improvement of facilities at wayside stations, such as those for :-

(1) attaching and detaching of wagons;

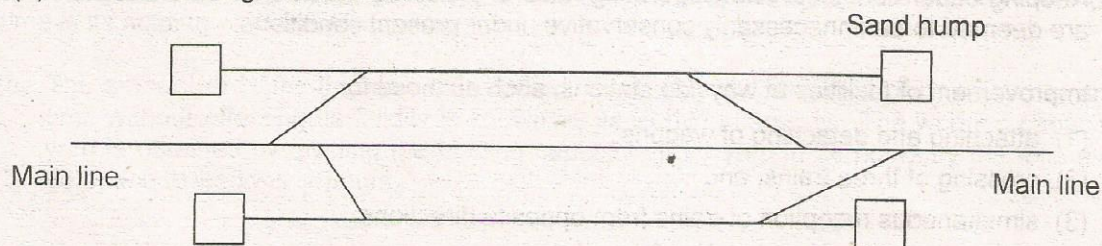
(2) crossing of three trains; and

(3) simultaneous reception of trains from opposite directions.

- (x) Improving the facilities at terminal yards, e.g. the number of reception and departure lines, simultaneous reception and despatch of trains from and to different directions, adequate length of shunting neck and stabling accommodation etc.
- (xi) Resorting to the use of heavier trains requiring more powerful locomotive.
- (xii) Using not only heavier trains and locomotive, but also wagons of greater capacity. This will reduce the number of wagons to be marshalled and coupled as and such, speed up operations.
- (xiii) Lengthening of loop lines at stations to cater the increased loads of trains. A limit to such lengthening is, however, set by the ruling gradient on the sections and the hauling power of the permitted locomotives.
- (xiv) Reducing the length of block sections by providing additional crossing stations on single line and 'C' class stations on double lines.
- (xv) Improving the existing standard of permanent way, bridges and gradients to permit of higher speeds and heavier loads of trains. This also includes improvements to the existing turnouts to permit higher speeds.
- (xvi) Improvement in the methods of signalling and inter-locking, such as:-
 1. Provision of warners where considered necessary and placing of signals in such a way that they are always in good view of the Drivers.
 2. Grouping and interlocking of points at stations, and centralising of control as far as possible.
 3. Providing for multiple aspect upper quadrant semaphore or colour light signals to suit the different conditions of traffic.
 4. Wherever possible, housing of block instruments in cabins. This, in the case of single line shall permit of tokens being dropped and picked up opposite the corresponding cabin and thus the time required for block working shall start as soon as the engine passes the cabin. This will also save some time in observing the tail lamp and starting block working before the train stops.
 5. Introduction of working by tokenless block instruments on single line section.
 6. Remote control of outlying points and junctions between running lines adjacent to important stations.
 7. Use of automatic block signalling system on busy double line sections when justified by traffic density.
 8. Introduction of centralized traffic control to relieve serious bottlenecks on the single line where alternative methods short of doubling cannot meet the situation.

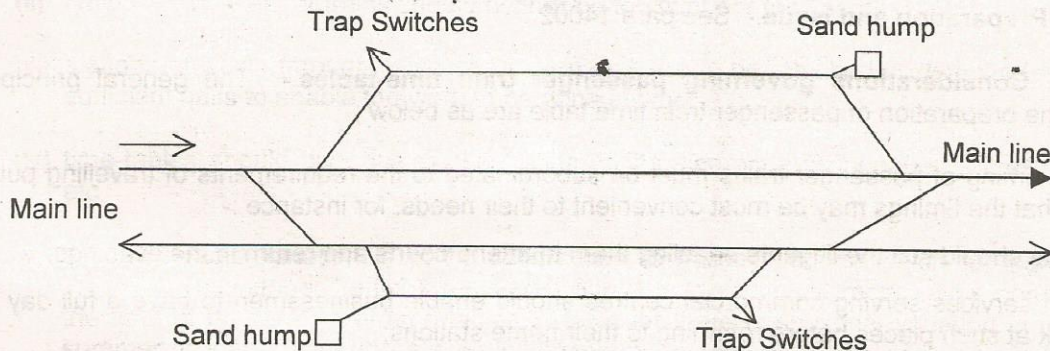
27006. Lay outs of stations:-

1. Board have decided that in order to enhance safety and to provide desired level of flexibility in train operation the layout of road side stations on single line and double line sections will be as follows:-
 - (a) Stations on single line sections



There will be a minimum of two loops one on each side of the main line with sand humps on either side of each of the loop lines.

(b) Stations on Double line sections:-



There will be one loop in each direction. The loops will have sand humps in the facing direction and trap switches in the trailing direction. There will be emergency cross overs at both the ends.

2. The provisions stipulated in (1) above are minimum requirements. More facilities will be provided depending on traffic requirements.
3. These directives will apply to all future proposals for new stations on existing lines, stations on routes on which Gauge Conversion or Doubling work is in progress and stations proposed on new lines under construction.
4. These directives supersede all previous instructions of the Board regarding station layouts, including those contained in Board's letters of even number dated 31.03.1999, 06.12.1996 and 05.04.1991.

27007. Sectional congestion.- (a) It means that the normal flow of traffic over the section is retarded and the usual running of trains is affected. It may be a permanent feature due to insufficiency of running facilities resulting in the section being saturated with the work load or the line capacity may have been temporarily reduced due to certain causes.

- (b) It is essential that the cause or causes of sectional congestion be carefully found out and necessary remedial measures applied quickly to prevent set back to operation.
