CV0425-Metro Systems and Engineering

Unit-3: Mechanical Engineering Aspects

ROLLING STOCK

The required transport demand forecast is the governing factor for the choice of the Rolling Stock. The forecasted Peak Hour Peak Direction Traffic calls for a Medium Rail Transit System (MRTS).

Optimization of Coach Size

The following optimum size of the coach has been chosen for this corridor as mentioned Below:

Size of the coach

Length* Width Height

Driving Motor Car (DMC) 21.64 m 2.9 m 3.9 m

Trailer car (TC) 21.34 m 2.9 m 3.9 m

**Maximum length of coach over couplers/buffers = 22.6 m*

Passenger Carrying Capacity

In order to maximize the passenger carrying capacity, longitudinal seating arrangement shall be adopted. The whole train shall be vestibuled to distribute the passenger evenly in all the coaches. Criteria for the calculation of standing passengers are 3 persons per square meter of standing floor area in normal state and 6 persons in crush state of peak hour.

Therefore, for the Medium Rail Vehicles (MRV) with 2.9 m maximum width and longitudinal seat arrangement, conceptually the crush capacity of 43 seated, 204 standing thus a total of 247 passengers for a Driving motor car, and 50 seated, 220 standing thus a total of 270 for a trailer/motor car is envisaged.

3-car Train: DMC+TC+DMC

Below is the carrying capacity of Medium Rail Vehicles.

Carrying Capacity of Medium Rail Vehicles

Particulars Driving Motor car Trailer car 3 Car Train

	Normal	**Crush**
Seated	43	43
Standing	102	204
Total	145	247

NORMAL-3 Person/sqm of standee area

CRUSH -6 Person/sqm of standee area

Weight

The weights of driving motor car, trailer car and motor car have been estimated as in Table 0.11, referring to the experiences in Delhi Metro. The average passenger weight has been taken as 65 kg.

Table 0.11

Weight of Light Rail Vehicles (TONNES)

DMC TC 3 Car Train

TARE (maximum) 40 40 120

Passenger

(Normal) 9.425 10.4 29.25

(Crush @6p/sqm) 16.055 17.55 49.66

(Crush @8p/sqm) 20.475 22.295 63.245

Gross

(Normal) 49.425 50.4 149.25

(Crush @6p/sqm) 56.055 57.55 169.66

(Crush @8p/sqm) 60.475 62.295 183.23

Axle Load @6

person/sqm

14.014 14.388

Axle Load @8

person/sqm

15.119

15.577

The axle load @ 6persons/sqm of standing area works out in the range of 14.014T to 14.388T. Heavy rush of passenger, having 8 standees per sq. meter can be experienced occasionally. It will be advisable to design the coach with sufficient strength so that even with this overload, the design will not result in over stresses in the coach. Coach and bogie should, therefore, be designed for **16 T axle** load.

Performance Parameters

The recommended performance parameters are:

Maximum Design Speed: 90 kmph

Maximum Operating Speed: 80 kmph

Max. Acceleration: 1.0 m/s2 (with AW3 load)

Max. Deceleration 1.1 m/s2 (Normal brake)

More than 1.3 m/s2 (Emergency brake)

Coach Design and Basic Parameters

The important criteria for selection of rolling stock are as under:

(i) Proven equipment with high reliability

(ii) Passenger safety feature

(iii) Energy efficiency

(iv) Light weight equipment and coach body

(v) Optimized scheduled speed

(vi) Aesthetically pleasing Interior and Exterior

(vii) Low Life cycle cost

(viii) Flexibility to meet increase in traffic demand

(ix) Anti-telescopic

The controlling criteria are reliability, low energy consumption, lightweight and high efficiency leading to lower annualized cost of service. The coach should have high rate of acceleration and deceleration.

VENTILATION AND AIR-CONDITIONING SYSTEM

Need for Ventilation and Air Conditioning

The underground stations are built in a confined space. A large number of passengers occupy concourse halls and the platforms, especially at the peak hours. The platform and concourse areas have a limited access from outside and do not have natural ventilation. It is therefore, essential to provide forced ventilation in the stations and inside the tunnel for the purpose of:

- Supplying fresh air for the physiological needs of passengers and the staff;
- Removing body heat, obnoxious odours and harmful gases like carbon dioxide exhaled during breathing;
- Preventing concentration of moisture generated by body sweat and seepage of water in the sub-way;
- Removing large quantity of heat dissipated by the train equipment like traction motors, braking units, compressors mounted below the under-frame, lights and fans inside the coaches, A/c units etc.;
- Removing vapour and fumes from the battery and heat emitted by light fittings, water coolers, Escalators, Fare Gates etc. working in the stations;
- Removing heat from air conditioning plant and sub-station and other equipment, if provided inside the underground station.

This large quantity of heat generated in M.R.T. underground stations cannot be extracted by simple ventilation. It is, therefore, essential to provide mechanical cooling in order to remove the heat to the maximum possible extent. As the passengers stay in the stations only for short periods, a fair degree of comfort conditions, just short of discomfort are considered appropriate. In winter months it may not be necessary to cool the ventilating air as the heat generated within the station premises would be sufficient to maintain the comfort requirement.

DESIGN PARAMETERS FOR VAC SYSTEM

With hot and humid ambient conditions of Ahmedabad during the summer and monsoon months, it is essential to maintain appropriate conditions in the underground stations in order to provide a 'comfort-like' and pollution-free environment. The plant capacity and design of VAC system needs to be optimized for the "Designed inside Conditions".

The Indian Standards & Codes, which pertain to office-buildings, commercial centers and other public utility buildings. The standards used for buildings are not directly applicable for the underground spaces, as the heat load gets added periodically with the arrival of the train. The patrons will stay for much shorter durations in these underground stations, the comfort of a person depends on rapidity of dissipation of his body heat, which in turn depends on temperature, humidity and motion of air in contact with the body. Body heat gets dissipated is

given out by the process of evaporation, convection and conduction. Evaporation prevails at high temperature. Greater proportion of heat is dissipated by evaporation from the skin, which gets promoted by low humidity of air. The movement of air determines the rate of dissipation of body heat in the form of
sensible and latent heat. There are different comfort indices recognized for this purpose. The 'Effective Temperature' criterion was used in selecting the comfort condition in earlier metros, in this criteria comfort is defined as the function of temperature and the air velocity experienced by a person. A new index named RWI (Relative Warmth Index) has been adopted for metro designs worldwide. This index depends upon the transient condition of the metabolic rate and is evaluated based on the changes to the surrounding ambient of a person in a short period of about 6 to 8 minutes. It is assumed that during this period human body adjusts its metabolic activities. Therefore in a subway system where the train headway is expected to be six minutes or less, then RWI is the preferred criterion.