CHAPTER 7

PERMANENT WAY

7.1 CHOICE OF GAUGE

Standard Gauge (1435mm) is generally used for metro railways world over. During the last decade, 20 new metros have been constructed in various cities of the world. All these metros have gone in for Standard Gauge even though the national gauge for mainline railways in some of these countries was different from Standard Gauge. In India the national gauge is Broad Gauge (1676mm). The question whether Bangalore Metro should go in for Broad Gauge or Standard Gauge has, therefore, been examined with following important parameters.

(i) Metro alignments in a city have to pass through heavily built-up areas for optimal passenger utilisation and this imposes severe restrictions on the selection of curves. As in most of the cities in India no 'right of way' has been reserved for metro systems, the alignments have to follow the major arterial roads. These roads may often have sharp curves and right-angle bends. In such a situation adoption of Standard Gauge is advantageous since it permits adoption of sharper curves compared to Broad Gauge to minimise property acquisition along the alignments.

(ii) In Standard Gauge 1 in 7 and 1 in 9 turn-outs, which occupy lesser length, are feasible compared to 1 in 8 ½ and 1 in 12 turn-outs required for Broad Gauge. Length of cross-overs for Standard Gauge is thus lesser than for Broad Gauge. Land requirement for depots where a large number of lines connected together in the shape of ladder is also reduced. Standard Gauge is, therefore, more suited for use in city environment where land availability is scarce.

(iii) For Standard Gauge, optimised state-of-the-art rolling stock designs are available ‘off-the-shelf’. This is not so for Broad Gauge where new designs for rolling stock have to be specially developed which entails extra time and cost.

(iv) Because of the availability of a very large market, constant up-gradation of technology takes place for Standard Gauge coaches. Thus upgraded technology is available on a continued basis in case of Standard Gauge. This is not so in case of Broad Gauge.

(v) For the same capacity gross weight of a metro coach is lower for Standard Gauge than for Broad Gauge. Standard Gauge rolling stock thus results in recurring saving in energy consumption during operation.

(vi) Once technology for Standard Gauge coaches get absorbed and a manufacturing base for them is set up in India, there will be considerable export potential for the coaches, since almost all the countries use Standard Gauge for their metros. This is not so in case of Broad Gauge.

(vii) It is some time argued that adoption of Broad Gauge for metros would enable inter-running of metro trains with Indian Railways since the latter uses Broad Gauge. Inter-running is, however, technically or operationally not feasible as the two systems have different:

- Rolling Stock characteristics,
- Signalling Systems,
- Headways,
- Tariffs,
- Moving dimensions, and
- Loading standards.

(viii) Track gauge is not a technical parameter for any metro rail system. It is a planning parameter. This issue was also examined in January 2000 by the Ministry of Law and Justice who had opined that the choice of gauge is a matter which lies within the jurisdiction of the metro rail organisation entrusted with the responsibility of implementing and operating the metro systems.

Since inter-running is not feasible, choice of Gauge for a metro system should be based solely on technical and economic considerations on which Standard Gauge turns out to be superior.

From the above, it is seen that Standard Gauge will be cost-effective and at the same time enable Bangalore Metro to be at par with world-class metros and enable it to remain technically up-dated in future. Standard Gauge will also enable setting up a manufacturing base for coaches required for metros in other cities of the country as well create an export potential for such coaches. Adoption of Standard Gauge is, therefore, recommended for Bangalore Metro. A wider gauge is not justified as coach width is small and axle loads are as low as 15 ton.

7.2 TRACK STRUCTURE

Track on Metro Systems is subjected to intensive usage with very little time for day-to-day maintenance. Thus it is imperative that the track structure selected for Metro Systems should be long lasting and should require minimum or no maintenance and at the same time, ensure highest level of safety, reliability and comfort, with minimum noise and vibrations. The track structure has been proposed keeping the above philosophy in view.

General

Two types of track structures are proposed for Bangalore Metro. The normal ballasted track is suitable for At-Grade (surface) portion of Main Lines and in Depot (except inside the Workshops, inspection lines and washing plant lines. The ballastless track is recommended on Viaducts and inside tunnels, as the regular cleaning and replacement of ballast at such location will not be possible.

From considerations of maintainability, riding comfort and also to contain vibrations and noise levels, the complete track is proposed to be jointless and for this purpose even the turnouts will have to be incorporated in LWR/CWR.

The track will be laid with 1 in 20 canted rails and the wheel profile of Rolling Stock should be compatible with the rail cant and rail profile.

Rail Section

Keeping in view the proposed axle load and the practices followed abroad, it is proposed to adopt UIC-54 (54 kg. /m) rail section as shown in **Fig. 7.1**. Since on main lines, sharp curves and steep gradients would be present, the grade of rail on main lines should be 1080 Head Hardened as per IRS-T- 12-96. As these rails are not manufactured in India at present, these are to be imported. For the Depot lines, the grade of rails should be 880 which can be easily manufactured indigenously.

Ballastless Track on Main Lines (Viaducts/Tunnels)

On the viaducts, it is proposed to adopt plinth type ballastless track structure with RCC derailment guards integrated with the plinths (shown in **Fig.7.2**). In tunnels, slab type track structure is to be adopted (shown in **Fig.7.3** & **7.4**).
Further, it is proposed to adopt Vossloh-336 Fastenings System (shown in **Fig.7.5**) on both types of ballastless track structures, with a base-plate to base-plate spacing of 65 cm. on viaducts and 70 cm. in tunnels. Most of the components of Vossloh-336 fastening system are now indigenously available. The toe load design for the clips is to be finalised at the detail design stage.

Ballasted Track on Main Lines and on Depot Lines

It is proposed to have a ballast cushion of 300 mm below the PSC sleepers on main lines whereas on Depot lines, the same shall be 250 mm. The proposed sleeper density is 1540 Nos. per km. (sleeper spacing being 65 cm) both on main lines and Depot lines. The fastenings system on ballasted track may be same as prevalent on Indian Railways; i.e. ERC Mark III clips with GR Sole plates and GFN liners. The Standard Gauge PSC sleeper for ballasted track would need to be designed on the same lines as done on Indian Railways or an appropriate ready design from abroad adopted.

Transition between Ballasted and Ballastless Track

Transition slab of 6 to 8 m length should be provided at the junction of Viaduct and earth formation. The transition from Ballastless track to Ballasted track should be made smooth over this length.

Ballastless Track in Depot

The ballastless track in Depot may be of the following types:

- Discretely supported on concrete/steel pedestal for inspection lines.
- Embedded rail type inside the Workshop.
- Plinth type for Washing Plant line.

7.2.7 Turnouts

- From considerations of maintainability and riding comfort, it is proposed to lay the turnouts also with 1 in 20 cant. Further, it is proposed to adopt the following two types of turnouts:
- On main lines, 1 in 9 type turnout with a lead radius of 300 metres and permissible speed on divergent track as 40 km/h (shown in **Fig.7.6**).
- On Depot lines, 1 in 7 type turnout with a lead radius of 140 metres and permissible speed on divergent track as 25 km/h (shown in **Fig.7.7**).
- The Scissors cross-overs on Main Lines (1 in 9 type) will be with a minimum track centre of 4.5 m (shown in **Fig.7.8**).
- The proposed specifications for turnouts are given below: -
- The turnouts should have fan-shaped layout throughout the turnout so as to have same sleepers/base-plates and slide chairs for both LH and RH turnouts.
- The switches and crossings should be interchangeable between ballasted and ballastless turnouts.
- The switch rail should be with thick web sections, having forged end near heel of switch for easy connection with lead rails, behind the heel of switch. The switches should have anti creep device at heel of switch for minimising the additional LWR forces transmitted from tongue rail to stock rail.
- The crossings should be made of cast manganese steel and with welded leg extensions. These crossings should be explosive hardened type for main lines and without surface hardening for Depot lines.
- The check rails should be with UIC-33 rail section without being directly connected to the running rails.

BUFFER STOPS

On main lines and Depot lines, friction buffer stops with mechanical impact absorption (non-hydraulic type) need to be provided. On elevated section the spans on which friction buffer stops are to be installed are to be designed for an additional longitudinal force of 85 T, which is likely to be transmitted in case of Rolling Stock impacting the friction Buffer Stops.

RAIL STRUCTURE INTERACTION

For continuing the LWR/CWR on Viaducts, the elevated structures are to be adequately designed for the additional longitudinal forces likely to be transmitted as a result of Rail-Structure interaction. Rail structure interaction study will determine the need and locations of Rail Expansion Joints (REJ) also. REJ in ballasted track will be for a maximum gap of 120 mm, whereas on ballastless track for a maximum gap of 180 mm.

WELDING

Flash Butt Welding Technique is to be used for welding of rails. Alumino-Thermic Welding is to be done only for those joints which cannot be welded by Flash Butt Welding Technique, such as joints at destressing locations and approach welds of switches & crossings. For minimising the population of

Thermit welds, mobile (rail-cum-road or portable) Flash Butt Welding Plant will have to be deployed.

7.5 COST

Total cost of track work on East-West Corridor = Rs.112 crores
(including track in Baiyappanahalli Depot).
Total cost of track work on North-South Corridor = Rs.95 crores.
(including track in Yeshwantapur Depot)

*****