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Comparison and Application of Railway Station Design Principle between Bangladesh and China

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Abstract: *The railway facilities in Bangladesh are old, and the coverage of the railway network is limited, mainly concentrated between major cities and regions in Bangladesh. The passenger and freight transportation share is relatively low, making the railway construction market huge. With Chinese enterprises going global, there are diverse design principles in the construction of new railway projects, which differ from Chinese design principles to some extent. In order to promote and develop projects better, it is essential to understand the railway design standards and principles in Bangladesh. Based on completed and ongoing projects, this paper provides a comparative analysis of the main differences of station yard design principles between Bangladesh Railway and China mixed passenger-freight railway, aiming to provide reference for future research on BG and DG railway designs in Bangladesh or the South Asian region.*

Keywords: *South Asian region railway, Design principles, South Asian railways, DG track; BG track; Standard gauge track*

1. Introduction

Bangladesh has a large population and a fast-growing economy, resulting in a rapid increase in passenger and freight transportation demand. In contrast, the railways have low transportation efficiency, with railway capacity and service quality not matching the rapidly growing transportation demand.

Bangladesh Railway, managed by the Bangladesh Railway Corporation, is responsible for passenger and freight services. The railway network in Bangladesh is divided into eastern and western parts by the Jamuna River. The main railway lines are located in the eastern and western regions of the country. The western region has a BG (1676mm), while the eastern region has a MG (1000mm). The eastern and western railways are connected at the existing Jamuna Bridge in Dhaka for gauge change. The total length of the railway network is approximately 3,600 kilometers. The railway network in Bangladesh also has eight junctions that connect with the Indian Railways, forming the South Asian subcontinent railway system along with the railways of India, Pakistan, Nepal, and Afghanistan.

For a long time, the railway construction in Bangladesh has been slow, and the railway design standards have not been updated. There is a mixture of national standards, Indian standards, American standards, European standards, and Chinese standards [1~3], which often leads to disputes in practical operations. To better develop and promote projects, seize market opportunities, it is crucial to understand the differences between Bangladesh and China's design principle.

2. The main principles of railway station yard design in Bangladesh and China

The clearance specifications in Bangladesh have been following the Indian standards without updates. The Bangladesh Railway Schedule of Dimensions 5 ft. 6 in. Gauge was last published in 1980. BR has confirmed that the latest version of the Indian Broad Gauge Railway Clearance Specifications [4] (Technical Aid to Indian Railways Schedule of Dimensions 1676 Gauge (BG), 2004) is applicable to the ongoing railway projects.

2.1 Distance between centers of tracks

The spacing of tracks between new or altering existing track is 5.300m. In cases where it is difficult to renovate existing stations, the minimum spacing of track can adopt 4.265m with approved special instructions. Extra clearances required on curves, as shown in Fig1.

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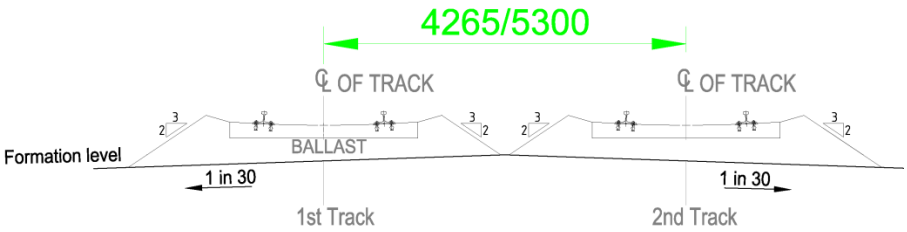

Fig.1 Spacing of BG Track of Bangladesh

2.2 Gradient in Station Yards

Bangladesh experiences heavy and intense rainfall during the monsoon season, so stations are generally designed with longitudinal gradient. For newly constructed railway lines, a recommended gradient is 1 in 1200 (0.083%), with a maximum limit of 0.25% (if the maximum slope is used, shall be recorded by Zonal railway). No station yard shall be constructed nor shall any siding join a passenger line on a grade steeper than 1 in 260 (0.38%), except where it is unavoidable and then also only with the previous sanction of railway board, obtained through the commissioner of railway safety, when slip siding or safety arrangement is made sufficient to prevent accident.

2.3 Loop Line

The Clear Standing length (CSL) of a loop line refers to the length of track on a railway line that is used for the arrival and departure of trains and for parking. It typically starts from the end of the platform and extends to a sufficient distance to accommodate the parking and departure operations of arriving trains. The length of a siding depends on the requirements of the platform and operational plans to ensure smooth docking, waiting, and departure of trains. The CSL of loop line for passenger trains is mainly determined based on the type of passenger train coach, the number of coaches, the length of locomotives, and the additional braking distance. For freight trains, the CSL is primarily determined based on factors such as conveying capacity, traction weight, and capacity of adjacent railways.

In Bangladesh, the CSL of loop line is generally 750 meters. In extreme and special case, due to station yard limitations, the minimum value can be determined based on total length of the longest train plus 35 meters. For the renovation of existing stations, CSL is generally based on available land and house demolition conditions, allowing for a shorter length, but it should not be less than 450 meters. In China, the mainline railway network has formed a series of effective lengths of 650 meters, 850 meters, and 1050 meters. Heavy-duty railways can even have lengths of up to 1700 meters and 2800 meters, effectively improving railway transportation efficiency.

2.4 Turnout

In Bangladesh, newly constructed railway lines are mostly designed for a speed of 120 km/h. 1 in 12 turnouts are used on the mainline, and for higher speed requirements, 1 in 16 turnouts can be used. For maintenance workshops and freight yard within stations, 1 in 8.5 turnouts can be adopted [5]. Due to some constraints, curved turnout and symmetry turnout can be adopted, but curved turnouts should not be placed on transition curves. In Bangladesh, single-point control is commonly used for turnouts. If multiple control points are considered, it is important to clarify this during the contract negotiation process.

Bangladesh's railway specifications and operational departments do not have specific regulations regarding the length of short tracks inserted between turnouts. Generally, they can be arranged according to Chinese station yard standard. When site conditions are limited, the length can be appropriately shortened. However, attention should be given to the existence of throat areas with multiple crossovers and the interference issues of turnout sleepers, ensuring sufficient installation space for the turnout sleepers. For example, in the Fig 2, when the track spacing is small and it is difficult to arrange according to the standard tracks, if an 8-meter short track is inserted, there may be interference between the sleepers of turnout No. 2 and No. 3. In such cases, it is necessary to contact the turnout design unit to verify whether there is any conflict in the layout of the sleepers. If there is a conflict, the turnout position or the overall turnout design should be adjusted promptly.

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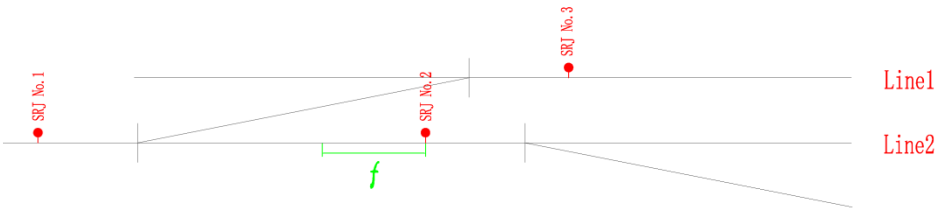

Fig. 2 Turnout Interference Case

2.5 Safety separation equipment

According to the current Railway Signaling Guidelines in Bangladesh, it is necessary to install trap switch or overrun track line as safety separation equipment between the loop line and main line, as well as between the siding line and the loop line. From the perspective of meeting operational safety requirements, both trap switch and safety lines are feasible options for the ends of the loop line. Their function is to prevent trains parked on the loop line from entering the main line and ensure safe operation.

In Chinese standards, when the other line is connected to the loop line without any isolation, or based on the braking distance and gradient requirements, overrun track line is set up. For the loop line which turnouts already incorporated into interlocking systems, there is no need to install overrun lines or trap switch for separation. The design of safety lines and trap switch has a significant impact on the yard track layout plan, resulting in significant differences in project quantity and investment compared to Chinese standards. This principle differs significantly from Chinese station specification. To avoid contractual disputes during the implementation phase, it is important to clearly specify the type of safety isolation equipment before signing the contract.

2.6 Fouling mark

The fouling mark is provided between two converging tracks at the point beyond which the center-to-center distance of the track is less than the stipulated minimum distance, to indicate the stopping position of locomotives and vehicles, preventing side collisions. In Bangladesh's broad-gauge railway, the track spacing at the location of the fouling mark is generally 4.725m (shown in Fig 3), with a minimum track spacing of 4.265m, while in meter-gauge railway, it is 3.66m.

In Chinese standards, the fouling mark is set at a distance of 2 meters from the center of the adjacent track. For tracks equipped with track circuits, the position of fouling mark is determined in conjunction with short rail arrangements and signal machine placement.

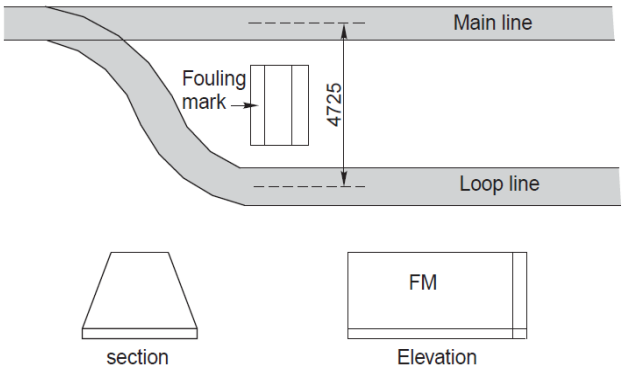

Fig. 3 Layout Plan of Fouling Mark of BG

2.7 Width of embankment

According to the Indian BG code [6~7], the maximum width for embankments for single line is 6.85m, while the maximum width for cuttings (excluding side drains) for single line is 6.25m. For double track sections, the maximum width for embankments is 12.15m, and for cuttings (excluding side drains), it is 11.55m, as shown in Fig4.

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Based on the implementation of projects by Bangladesh Railway, the typical width of the railway subgrade for single line is generally taken as 7.5m. This width is slightly larger than the requirements of the Indian clearance specifications. However, it is slightly smaller than the requirement of 7.85m specified in the Indian subgrade design specifications for a 25t railway, as shown in Fig5.

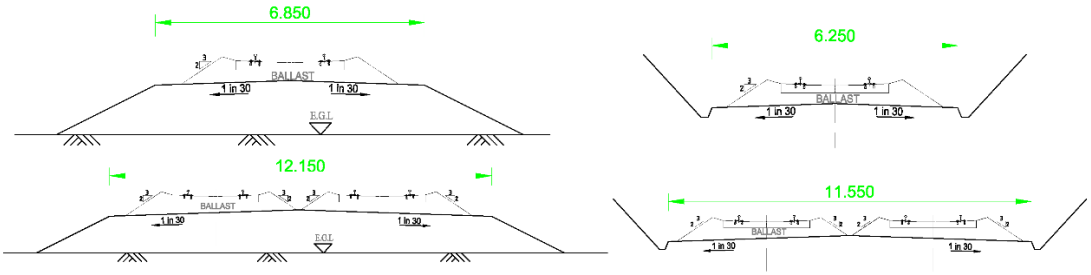

Fig. 4 Width of Single/Double Line Subgrade in Indian Clearance Specifications

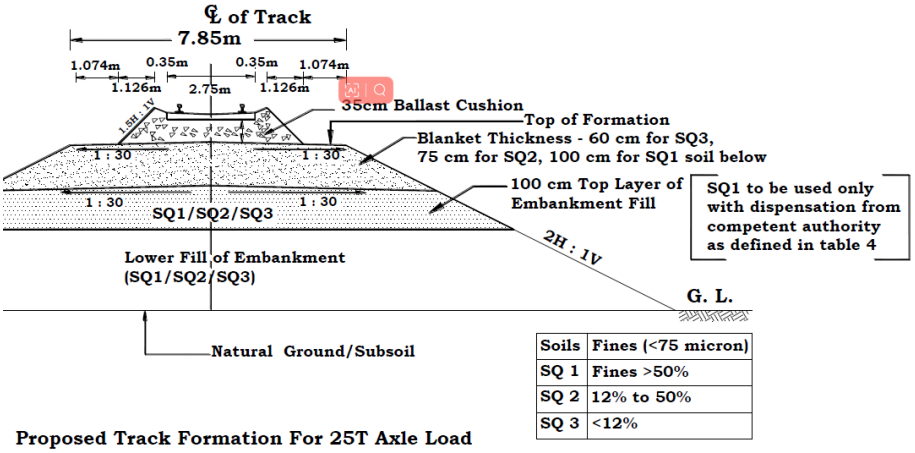

Fig. 5 Width of single-line subgrade surface in Indian Subgrade Specification

3. Main differences of station yard design principle in Bangladesh and China

By conducting a comparative analysis of the main design principle for station yard design, shown in Tab 1, it becomes easier to identify the differences and apply them more effectively in the design practice of Bangladesh railways.

Table 1 Comparison Analysis Table of Main Technical Standards for Station Design in Bangladesh and China.

S.L	Major technical standards	Bangladesh	China
1	Minimum track spacing in station	Existing railway lines with a spacing of 4.265 m, while newly constructed or upgraded lines with a spacing of 5.3 m.	The track spacing , between main lines is more than 4.6m, between other secondary track is 4.6m, tracks with signaling machine is more than 5m
2	Longitudinal slope of station	Existing 2.5‰, newly constructed or upgraded lines 0.83‰	General 1‰, passing station / Over-taking station 6‰
3	CSL of a loop line	Slope less than1% is 750m, other is the maximum length of track +35m	650m, 750m, 850m, 1050m
4	Turnouts	16#, 12#, workshop 8.5#	Not less than 12#, workshop 9#
5	Overrun track line	When the gradient within the station exceeds 2.5‰ (1/400), it is necessary to install safety devices or implement special management measures.	The introduction of third-direction railway lines should be set up as needed. The requirements for station braking distance and gradient should be established. The through freight lines within the station should be separated from the main lines by setting separate access routes.
6	Trap switch	Trap switch should be installed at both ends of the loop line. Overrun track lines can be used as an alternative.	/

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7	Fouling mark	The track spacing at the location of the fouling mark is generally 4.725 meters, with a minimum track spacing of 4.265 meters, while in meter-gauge railway, it is 3.66 meters.	The track spacing at the location of the fouling mark is 4 meters
8	Distance between loop line with platform	Maximum 1.68m, minimum 1.67m	The general height is 1.75 m, while the freight high platform height is 1.85 m.
9	Passenger platform height above rail level	Maximum 1.067m, minimum 0.457m	1.25m

4. Conclusion

By conducting a comparative analysis of the main principles for station layout design in Bangladesh and China's railway, it is evident that there are significant differences in the design principle and concepts between the BG railway design in South Asia and the standard-gauge railway design in China. Summarizing and refining these differences is of crucial guiding significance for future project implantation in Bangladesh.

It is foreseeable that Bangladesh will experience a wave of railway construction. In order for Chinese contractors to construct more high standard railways at south Asian region, it is essential to continuously learn and adapt to foreign standards and regulations, and to better leverage their role as design leaders. This includes clearly understanding the employer's requirements during contract negotiations to avoid potential dispute during project implementation. Moreover, during the project execution phase, having a good understanding of the country regulations will enable the development of satisfactory solutions based on site-specific conditions, accelerate the approval process of drawings, and provide favorable conditions for the smooth progress of the project.

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