

Container Wagons – Features and Derailment Proneness

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SYNOPSIS

Issue of derailment proneness of BG Low Platform Container Flat wagons (BLCA/BLCB) has been widely debated on the Indian Railways. These wagons have been reported to derail very frequently while entering a loop through 1 in 8 ½ turnout. This paper examines special features of the wagon having influence on derailment proneness, while the train enters a loop through a sharp curve on the turnout. Recommendations have been made on the action required for arriving at a final conclusion.

1.0 Introduction

BG Low Platform Container Flat wagons (BLCA/BLCB) are used for transportation of ISO containers. These wagons have high pay load (61.0 ton) and a high operating speed (100 kmph). Containers are more suitable for inter-modal transfer and provide better security of goods. Hence, there is a huge potential for growth of container traffic on the Indian Railways. These wagons were introduced about 15 years back on the Indian Railways, and their population has already touched a figure of 12, 735 (as on 31.03.2010).

However, there is a disturbing trend of these wagons, having been found prone to derailment. Many of the Railways have reported several cases of derailment of these wagons. Almost all the cases are that of trains having derailed in a sharp curve, most of them in 1 in 8 ½ turnout, while entering a loop,. Thus, there is evidence that these wagons are not able to safely negotiate sharp curves of the order of 8 degree. In fact, there are some special features

of these wagons which make them vulnerable in sharp curves.

2.0 Special features of the wagon

2.1 General

Under frame of the wagon is of all welded construction and is supported over cast steel bogies suitable for 20.32 ton axle load. Low platform height has been achieved with the specific design of bogie frame, bolster and use of smaller wheel diameter. General arrangement of the wagon is shown in figure 2.1.1. Five cars, one A car at each end and 3 B cars in the central portion, consist a unit. A car is fitted with CBC coupler on the raised end and Slack-less Drawbar on the other end. B car is fitted with Slack-less Drawbars on both the ends. These five cars are to be handled as a unit in rake formation as well as for sending them for ROH/ POH.

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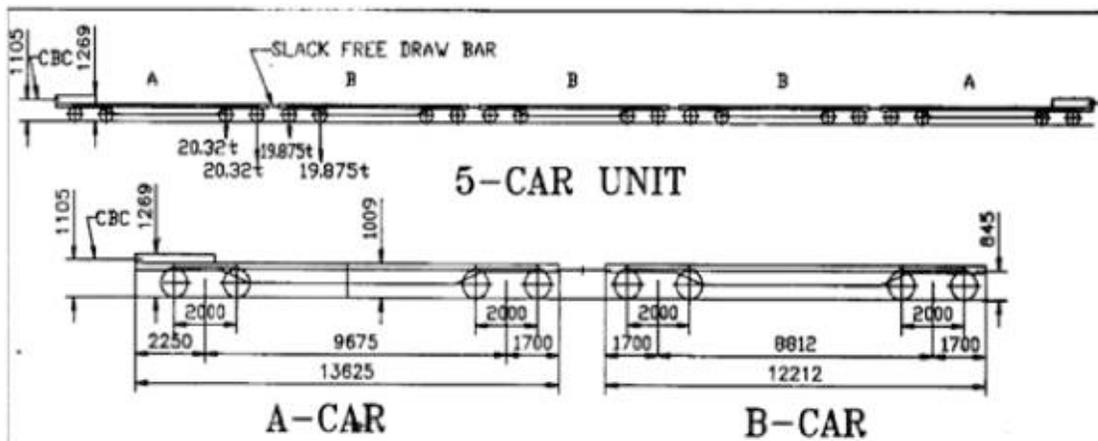


Figure – 2.1.1

2.2 Bogie

Bogie Container Flats are mounted on two cast steel high speed bogies of the type LCCF(C), similar in arrangement to CASNUB bogie (of BOXN /BCN wagon). Each bogie consists of two cast steel side frame, one cast steel bolster, one spring plank, all-coil helical springs, elastomeric pads and adaptors. Flat centre pivot and spring loaded side bearers are provided on the bolster. Load proportional frictional damping has been provided at the secondary suspension stage.

2.2.1 Load distribution system

In a CASNUB bogie, total load is borne by centre pivot. However, this bogie is prone to hunting at higher speeds. Load distribution between centre pivot and side bearers is optimised in LCCF(C) bogie to prevent hunting. Spring loaded side bearers bear 90 % of load under tare condition. 10 % of tare weight and full pay load is borne by centre

pivot. The bottom pivot is integral to bolster while the flat top pivot is bolted to the under frame. Manganese steel liners are provided at the bottom and the verticals.

2.3 Wheel and axle

The wagons are provided with a smaller diameter wheel - 840 mm (new), 780 mm (worn). Axles are fitted with Cartridge Tapered Roller Bearing.

2.4 Draw and Buff gear

A cars are provided with Centre buffer coupler (CBC) on one end and Slack-less draw bar on the other end. B cars are provided with Slack-less draw bars on both ends. Heights of CBC and Slack-less draw bar from rail level are 1105 mm and 845 mm respectively. Thus, A-B and B-B coupling are through Slack-less draw bar and A-A and A- Locomotive coupling are through CBC. Typical arrangement of Slack-less Draw Bar is shown in figure 2.4.1.

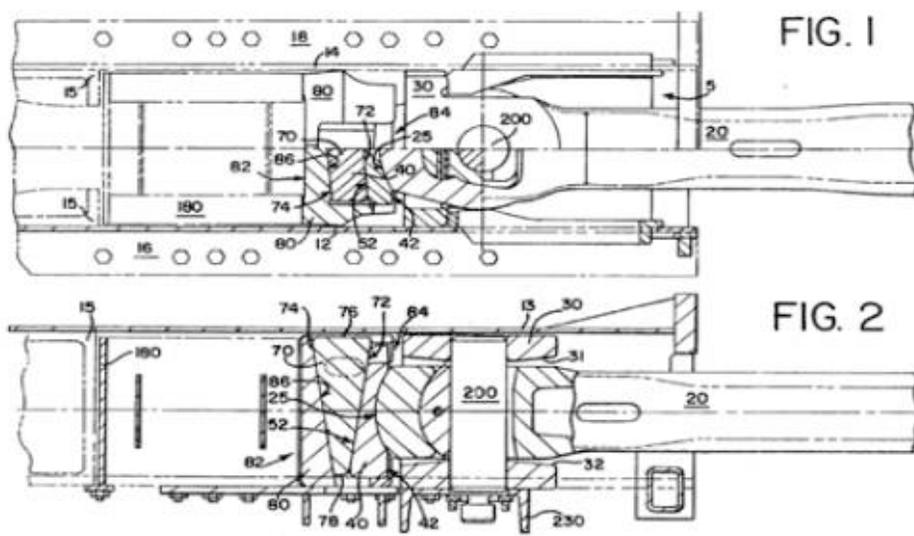


Figure – 2.4.1

3.0 Special features and effect on safety

3.1 Slack-less coupling arrangement

Presence of slack in coupling results in smaller coupler forces during braking and acceleration. When properly managed, the slack in a goods train can accommodate gradient changes (and consequent speed changes), time lag in transmission of brake force application from front to rear of the train and gradual redistribution of tractive forces between distributed locomotives with smaller coupler forces. However, the total amount of coupler slack in a long train can be substantial, and inappropriate or injudicious train handling may cause jerks due to run-in or run-out. In order to overcome this problem, slack-less couplers have been developed and, generally, used in Heavy Haul operations, where train length is large.

High buff/ draft force are very critical in sharp curves as they generate an unbalanced lateral force on the wagon, adversely affecting lateral/ vertical force ratio and, hence, derailment proneness.

The slack-less drawbar needs to rotate freely in both lateral and vertical directions in order to avoid large lateral force and off-loading, for maintaining safety. Typically, in a slack-less system, the mating faces of the follower block and gravity wedge, as well as the follower block and coupler are curved to permit the coupler to pivot slightly both vertically and laterally. Since slack-free connections are usually under some longitudinal loading from the action of the gravity wedge under draft or buff loading, the frictional resistance present during vertical and lateral angling should be reduced. Studies have found that under high longitudinal buff loading, the frictional forces at the follower block/coupler interface might create lateral force components high enough to cause wheel climb. This would virtually make the Draw Bar connection more rigid. This condition is especially pronounced when wagons are forced to undergo extreme curving and cornering conditions, such as while negotiating a turnout at low speed.

3.2 Eccentricity of buffing force

Cars are provided with Centre buffer coupler (CBC) on one end and Slack-less draw bar on the other end. As heights of CBC and Slack-less draw bar from rail level are different, 1105 mm and 845 mm respectively, there is an enhanced vertical eccentricity in the buffing/ draft forces acting on this car. This vertical eccentricity of buffing/ draft forces would generate a pitching moment, resulting into off-loading of wheels. Magnitude of this off-loading would be directly proportional to the magnitude of buff/ draft force

and the vertical eccentricity, and inversely proportional to the distance between the bogie centers.

3.3 Angular movement of wheels

Leading outer wheel of a bogie has a tendency to move angular to track in a sharp curve. The reason being that the conicity of the wheel tread is not sufficient to generate the required rolling radius difference between outer and inner wheels for negotiating the curve without longitudinal slip of wheels. This results in angular movement and flanging of the outer wheel.

Maximum angle of attack that a wheel set can assume on a track depends on (is proportional to) the lateral clearance between track and wheel set and (is inversally proportional to) the distance between the point of flange contact at the front of the axle (on the outer wheel) and that behind the axle (on the inner wheel). This distance between the points of contact depends on radius of the wheel, being larger for a larger wheel. Hence, angle of attack in case of a BLC wagon negotiating a sharp curve would be larger compared to a BOXN wagon, as the wheel diameter is smaller.

Another distinguishing feature of BLC wagon bogie (from CASNUB bogie) is the flat centre pivot and spring loaded side bearer assembly. As the side bearers support 90 % of the tare weight (compared to no load in CASNUB) there would be frictional resistance on this account to bogie rotation. The flat pivot is also likely to give more frictional resistance to bogie rotation. Although the higher frictional resistance to bogie rotation is a design feature of BLC wagon bogie (in order to prevent hunting at higher speed), it would result in increased angular run of bogie in curves.

4.0 Present situation on Indian Railways

There have been a disproportionately large number of derailments of BLC wagons on the Indian Railways. Almost all the cases are that of trains having derailed in a sharp curve, most of them while entering a loop, in the turn out portion, particularly on 1 in 8 ½ turnout. Many of the Railways have raised the issue of derailment of these wagons in various forum (PCE / CTE Conference), emphasizing the inability of these wagons in negotiating 1 in 8 ½ turnout, requesting for a review of the wagon design. On some of the Railways, local operating instructions have been issued, restricting movement of these wagons on loops provided with 1 in 8 ½ turnout.

In response to a reference from the Railway Board on the issue, Wagon Directorate/ RDSO vide its letter No MW/ Container/ ISO/ BG - Flats dt. 08.09.2010 has stated the following

- (i) As per the Oscillation Trial Report MT-94 of 1997, BLC wagons exhibit stable running at 110 kmph on straight and 100 kmph on curve. They also exhibit satisfactory movement on station yards.
- (ii) The permissible coupler movement in lateral direction is 11 degree (in both directions from centre line of wagon), with some clearance still available. Physical examination of these wagons was carried out by an RDSO team at TKD yard and it was found that there were no abnormal wear/mark on the various faces of striker casting/ Slack-less draw Bar.
- (iii) Regarding less slack, the same has been taken into consideration in design of wagon and ,also, the system is preferred for container wagons world over.

5.0 Issues yet to be addressed

Derailment history of BLC wagons indicates their inability to negotiate entering into a loop through 1 in 8 ½ turnout. This movement involves negotiating a very sharp curve of 8 degree, most likely in combination with a high buffing force resulting from control of train while entering into the loop.

The Oscillation Trial, referred to by RDSO in para 4.0 above, does not include trial under these operating conditions. "Satisfactory movement over station yard" refers to movement through station yard at normal speed. Trial on curve has been carried out on a curved track of 2 degree. A comparison of the data of Oscillation Trial Reports of BLC and BOXN wagons (M-403 of 1984) indicates a greater extent of off-loading in case of BLC wagons. In fact, at the maximum speed, the extent of off-loading is found to be more than 100%, but the cases have been interpreted to be of isolated nature and having no tendency of sustained build up.

Considering the design parameters and observations made by the RDSO team, suspected lateral rigidity of the wagons in an 8 degree curve on account of obstruction to lateral rotation of Slack-less Draw Bar due to lack of lateral clearance between striker casting and Slack-less Draw Bar is ruled out.

Under the extreme curving condition (on an 8 degree curve), the high longitudinal buff load would generate an unbalanced lateral force on the wagon, adversely affecting lateral/ vertical force ratio. Further, under these conditions, as discussed in para 3.1 above, the frictional force at the follower block/coupler interface is likely to generate a large lateral force component. Studies on the foreign Railways have found this force to be large enough to cause wheel climb derailments. On these Railways, developments in

design are being done to reduce this frictional force. Extent of this frictional force and lateral/ vertical wheel loads need to be measured by conducting trials under the subject operating conditions.

Derailment proneness of the wagons is likely to increase further due to the adverse effect of increased wheel angularity (para 3.3) and vertical eccentricity of buffing force (para 3.2) on the lateral/ vertical force ratio.

Although RDSO have pointed out that Slack-less Draw Bar system is preferred for container wagons world over, it needs to be ascertained whether these trains are made to negotiate the extreme curving as in 1 in 8 ½ turnout, and their safety performance under such conditions.

6.0 Conclusion

Field data have established that BLC wagons are extremely prone to derailment while entering a loop through 1 in 8 ½ turnout. A large buff force is likely to be present while the train enters a loop on account of Slack-less Draw Bar system. Under a large buff force, the Slack-less Draw Bar is likely to have increased lateral rigidity, on account of frictional forces in the coupling system. This increased lateral rigidity in combination with a large angular run would increase derailment proneness of the wagon in the sharp curve.

7.0 Recommendation

Detailed study should be carried out by RDSO to ascertain lateral rigidity and angular run of BLC wagons while negotiating a sharp curve (of the order of 8 degree) under buff action and to assess their influence on wheel climb derailment.

8.0 Reference

1. Maintenance Manual of BLCA & BLCB, April, 2002, by RITES Ltd.
2. Oscillation Trial Report No. MT – 94 (for BLC wagon) of Aug, 1997 by RDSO
3. Selected heavy haul insights: Some South African perspectives by Dr. Dave van der Meulen, Railway Corporate Strategy CC, South Africa
4. NSW, Transport Rail Corporation RSU 100 series – Minimum Operating Standards for Rolling Stock

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