GTR-Tyres Industry Preliminary Information Sheet

TOPIC: Bead Unseat (Bead Push-off)

BACKGROUND:

Bead unseat regulations have been established by many regulatory bodies. Most bead unseat requirements are pattered after the USA DOT passenger car tyre regulation FMVSS 109. (Note: US bead unseat regulations have only been established for passenger car tyres. It has not been applied to other classes of tyres such as light truck, truck-bus, motorcycle, etc.) The FMVSS 109 test procedure and minimum performance requirements were originally established in the late 1960s. At that time, the most common passenger car tyres in the US were bias (diagonal) ply tyres with high aspect ratios (and large section height).

The regulation was subsequently modified to include radial ply tyres. The actual performance requirements (i.e. a tyre's ability to withstand 2600 lbs of bead unseating force for a standard load tyre of section width generally greater than 150 mm (6 inches) remained the same for both bias and radial tyres.

The basic test procedure specified in FMVSS 109 has not changed in a material fashion. A bead unseat block of specified dimensions and profile is pressed against the sidewall of a tyre. The regulation specifies the radial distance from the tyre's center of rotation at which point the block should contact the tyre sidewall. This dimension (often defined as the 'A' dimension), is based on the tyre rim diameter, regardless of aspect ratio or section height. Based on the common tyres at the time of introduction of the regulation (80 to 70 aspect ratio tyres) the point of contact was near the midpoint of the tyre section height (mid-sidewall).

The introduction of low aspect ratio tyres (small section height) in addition to large rim diameter tyres has rendered the current US regulation inadequate. Specifically, the specified test block geometry is of such curvature that the block contacts large diameter test rims during the test. The "A" dimension developed for large section height tyres can result in the test block barely contacting the tread shoulder, and subsequently slipping off the tread during the test. This can result in a low test result, but not a bead unseat.

Recent work by ASTM International and some deviations by national regulatory bodies have started to address these procedural issues.

Regardless of the recent proposals to modify test block geometry and application location ('A' dimension), the current test has significant limitations that suggest that this is not appropriate for inclusion in the GTR-Tyres.

Concerns with current type of bead unseat regulatory tests:
The test was designed for bias ply tyres. The structure of the bias ply tyres is radically different from radial ply tyres in the manner in which forces are transferred from the tread region to the sidewall region (normal tyre operations) or from the sidewall region to the tread region (bead unseat test procedure and possible unique accident occurrence).

The basic premise of the test is to apply a lateral force to the tyre sidewall, at a rate of 2 inches per minute, to a non-rotating tyre (static test). This is not representative of the transmission path of lateral forces that act on the tyre tread through the footprint area during typical vehicle application, as mentioned above. Nor is this representative of accident occurrence either. Although one could postulate that a tyre could contact an object at mid-sidewall during an unspecified accident, this would surely not be at a rate of 2 inches per minute. Additionally, if such an incident did occur; a vehicle runs off the road and contacts a large object, how significant is the issue of bead retention once the vehicle has already crashed into another object?

In a similar analysis, the US government research has conducted vehicle rollover tests and determined that after the vehicle tips up on two (or sometimes even just one wheel) a tyre becomes unseated (debeaded in the US government descriptions). Again, once a vehicle has become so unstable so as to have two or more tyres lose contact with the road surface, could the average driver be expected to maintain control of the vehicle? The government research has not substantiated nor even suggested that probability.

Another concern with this test procedure deals with the mechanics of the applied force. As the location of the force applied through the tyre sidewall gets closer to the bead area, which is a direct result of low section height tyres, the test is effectively pushing the bead directly from the rim. This is not indicative of typical vehicle operation or even of foreseeable tyre-rim contact with foreign objects. Therefore, this becomes an artificial test that can indeed unseat a bead, but not in a probable real-world occurrence.

Several alternative bead unseat tests have been proposed and/or evaluated. These include the “wedge” (Toyota) bead unseat test or a dynamic (rolling tyre) slip angle type test to induce bead unseating. While intellectually stimulating, no test has been proposed that formulated a credible indication of bead unseating resistance that enhances vehicle safety.

CURRENT REGULATIONS:

Some countries require a bead unseating test for both bias and radial tyres. Below is the US procedure. Other countries or regions may have variations on points measured, block geometry, and inflation pressure. A listing of countries and their variation from the basic test is included on the last page.

USA – FMVSS 109

S5.2 Tubeless tyre bead unseating resistance

S5.2.1 Preparation of tyre-wheel assembly.

S5.2.1.1 Wash the tyre, dry it at the beads, and mount it without lubrication or adhesives on a clean, painted test rim.

S5.2.1.2 Inflate it to the applicable pressure specified in Table II at ambient room temperature.

S5.2.1.3 Mount the wheel and tyre in a fixture shown in Figure 1, and force the bead unseating block shown in Figure 2 or Figure 2A against the tyre sidewall as required by the geometry of the fixture. However, in testing a tyre that has an inflation pressure of 60 psi, only use the bead unseating block described in Figure 2A.

S5.2.2 Test procedure

S5.2.2.1 Apply a load through the block to the tyre's outer sidewall at the distance specified in Figure 1 for the applicable wheel size at a rate of 50 mm (2 inches) per minute, with the load arm substantially parallel to the tyre and rim assembly at the time of engagement.

S5.2.2.2 Increase the load until the bead unseats or the applicable value specified in S4.2.2.3 is reached.

S5.2.2.3 Repeat the test at least four places equally spaced around the tyre circumference.

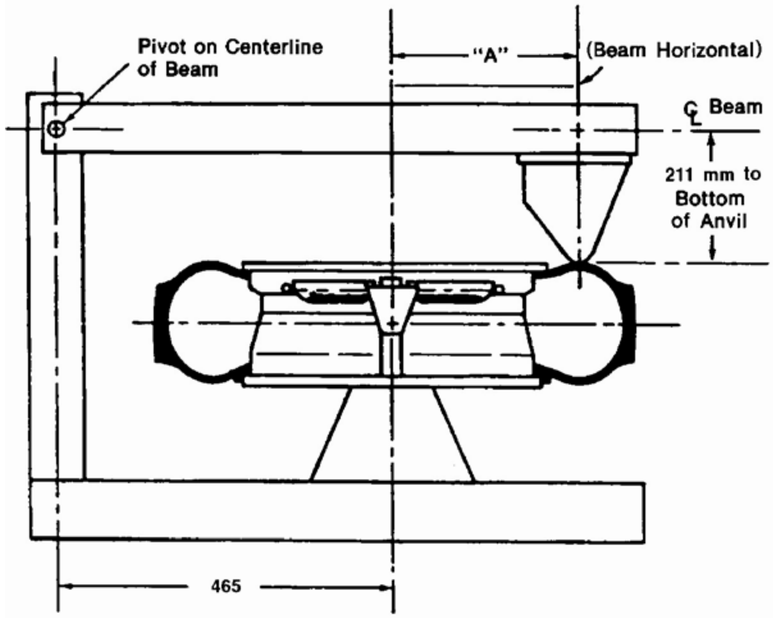


Figure 1.—Bead Unseating Fixture
All Dimensions in Millimeters (mm)

FIGURES FOR STANDARD 109

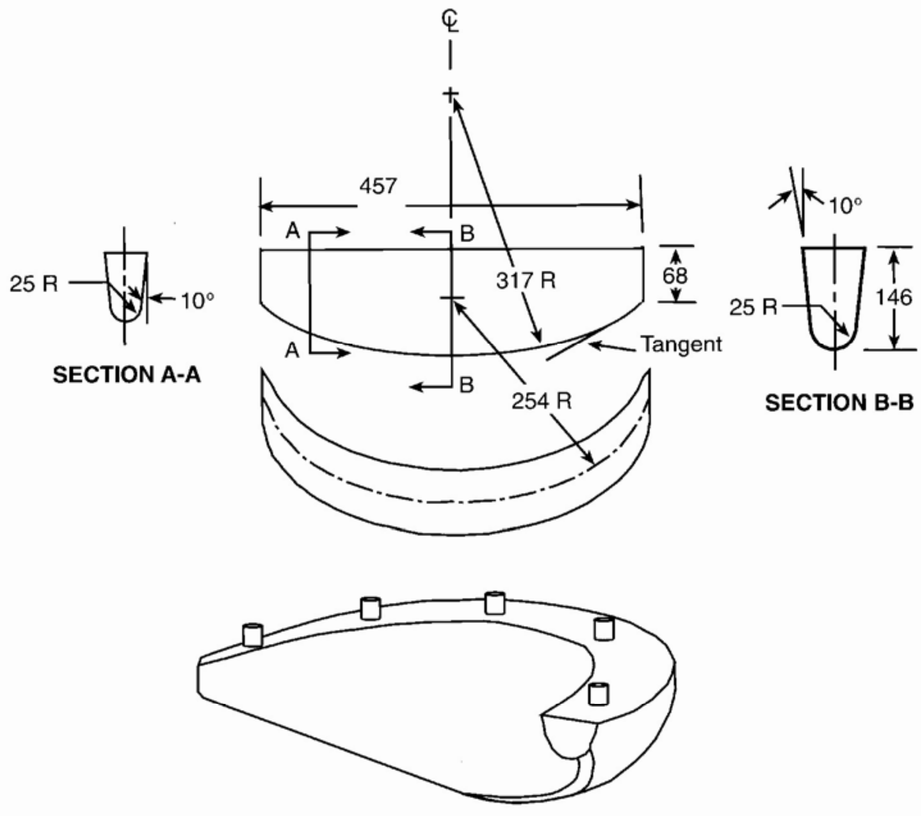
Wheel sizes	Dimension "A" for tires with maximum inflation pressure			
	Other than 60 psi	Other than 420 kPa	60 psi	420 kPa
19	13.00 in	330	12.00 in	305
18	12.50 in	318	11.40 in	290
17	12.00 in	305	10.60 in	269
16	11.50 in	292	9.90 in	251
15	11.00 in	279	9.40 in	239
14	10.50 in	267	8.90 in	226
13	10.00 in	254	8.40 in	213
12	9.50 in	241		
11	9.00 in	229		
10	8.50 in	216		
320	8.50 in	216		
340	9.00 in	229		
345	9.25 in	235		
365	9.75 in	248		
370	10.00 in	254		
390	11.00 in	279		
415	11.50 in	292		
400[1]	10.25 in	260		
425[1]	10.75 in	273		
450[1]	11.25 in	286		

FIGURES FOR STANDARD 109—Continued

Wheel sizes	Dimension "A" for tires with maximum inflation pressure			
	Other than 60 psi	Other than 420 kPa	60 psi	420 kPa
475[1]	11.75 in	298		
500[1]	12.25 in	311		

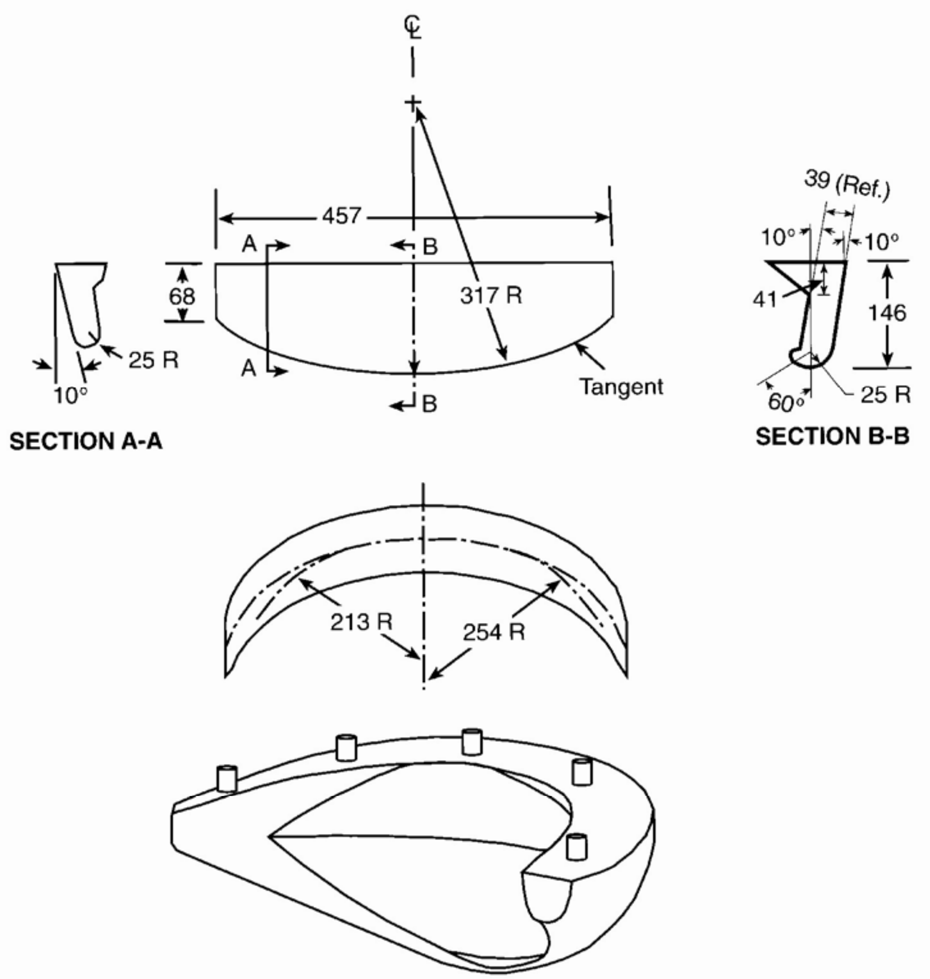
[1] For CT Tires only.

Wheel size	Dimension "A" for tires with maximum inflation pressure			
	Other than 60 psi (in)	Other than 420 kPa	60 psi (in)	420 kPa
20	13.50	345	....	....
19	13.00	330	12.00	305
18	12.50	318	11.40	290
17	12.00	305	10.60	269
16	11.50	292	9.90	251
15	11.00	279	9.40	239
14	10.50	267	8.90	226
13	10.00	254	8.40	213
12	9.50	241	....	....
11	9.00	229	....	....
10	8.50	216	....	



MATERIAL: Cast Aluminum 355
T-6 Condition
Finish-1.3 Micrometer (um)

Figure 2. DIAGRAM OF BEAD UNSEATING BLOCK
All dimensions in millimeters (mm)



MATERIAL: Cast Aluminum 355
T-6 Condition
Finish-1.3 Micrometer (um)

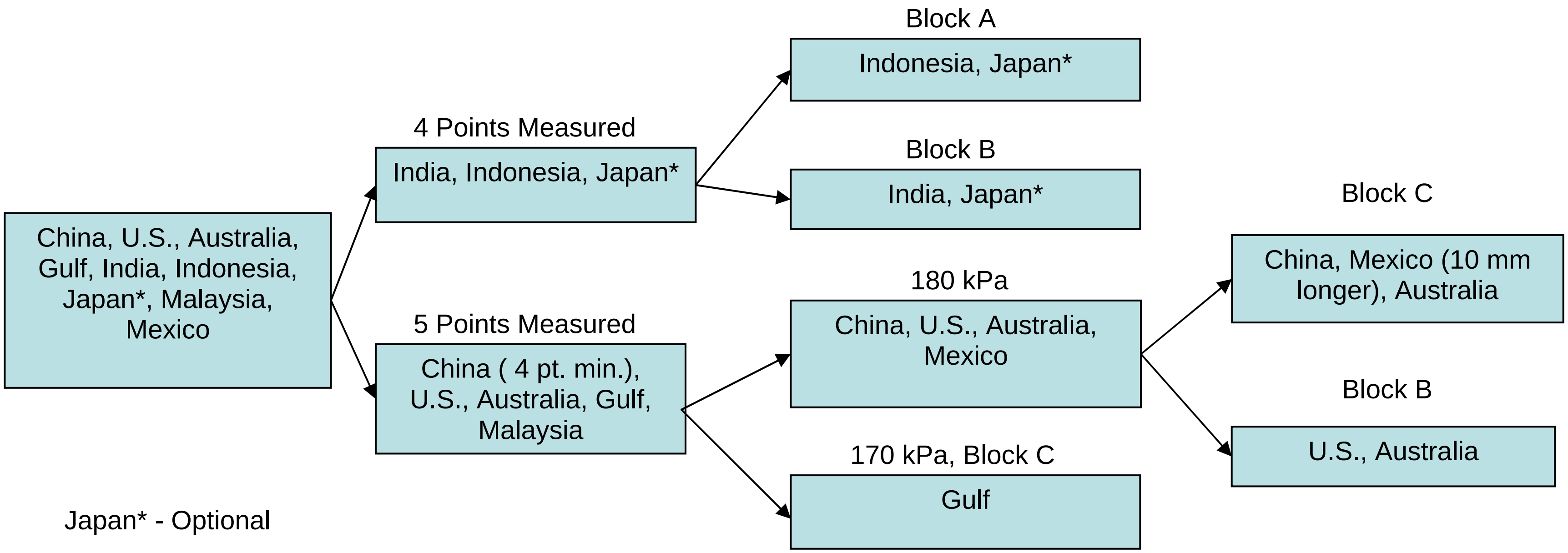
Figure 2A. DIAGRAM OF BEAD UNSEATING BLOCK
All dimensions in millimeters (mm)

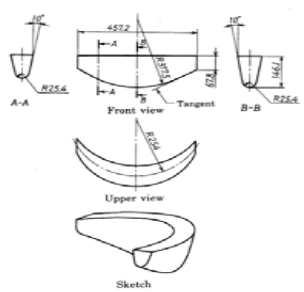
TABLE II—TEST INFLATION PRESSURES

[Maximum permissible inflation pressure to be used for the following test]

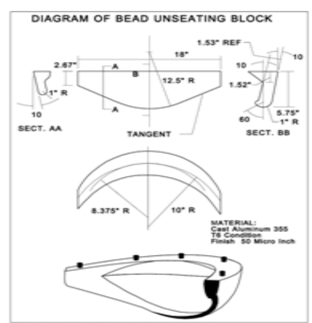
Test type	Tires other than CT tires									CT tires			
	psi				kPa					kPa			
	32	36	40	60	240	280	300	340	350	290	300	350	390
Physical dimensions, bead unseating, tire strength, and tire endurance	24	28	32	52	180	220	180	220	180	230	270	230	270
High speed performance	30	34	38	58	220	260	220	260	220	270	310	270	310

Bead Unseating Procedure Grouping for mandatory and optional testing, with notable variations in points measured, block types, and inflation pressures.

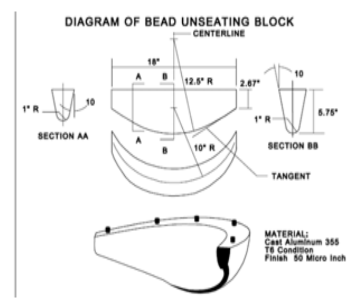




Block A



Block B



Block C