

**To:** All HQ Directors: Operations, Planning and Major Projects  
All Regional Directors  
All Regional Managers Engineering  
All Regional Traffic Engineers  
All District Managers Transportation

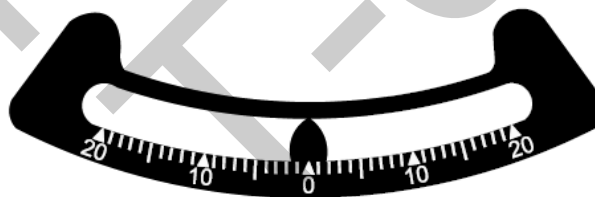
**Subject:** Establishing Curve Advisory Speeds

### 1.0 Purpose

This technical circular outlines the procedure for establishing curve advisory speeds using ball-bank indicator testing and updates the procedures found in the [Manual of Standard Traffic Signs and Pavement Markings](#).

### 2.0 Background

Ball-bank testing is a widely used and practical method for determining the location and type of curve warning signs and advisory speeds for horizontal curves. Mounted in a moving vehicle, the reading from a ball-bank indicator represents the combined effect of vehicle body roll, superelevation, gravity, and lateral acceleration angle. A manual or electronic ball-bank indicator can be used. The ball-bank indicator used for curve testing should be capable of measuring inclination to at least a 1-degree accuracy. A manual ball-bank indicator, as illustrated below, consists of a steel ball in a sealed glass tube where the ball is free to roll except for the dampening force of the liquid in the tube.



An electronic ball-bank indicator usually consists of an electronic accelerometer capable of measuring lateral forces and accelerations experienced by a driver negotiating a horizontal curve.

### 3.0 Policy

Ball-bank testing shall be conducted by qualified personnel using a test vehicle approved by the Senior Traffic Engineer (STE). For the purpose of this document, a qualified person is one who is knowledgeable in the principles behind ball-bank testing and who can demonstrate curve testing experience through previous work experience or training.

The test vehicle should be a typical mid-sized family sedan, station wagon, or minivan with suspension in good condition and all-season tires with average wear. Pick-up trucks, SUVs built on a truck platform, and cargo vans are not acceptable test vehicles.

Ball-bank testing shall only be performed on paved asphalt or concrete roads under dry conditions. Testing shall not be performed if the roadway is wet, has any degree of snow cover, or may be icy. In addition, testing shall not be performed on gravel or unpaved roads. A permanent painted centreline must be in place and lane lines painted for multi-lane roads. Testing with either temporary pavement markings or no pavement markings is not acceptable.

Curve advisory speeds shall be determined based on ball-bank testing with consideration of other factors that may impact the choice of advisory speed, such as sight distance, intersections, collision history of the curve, truck volumes, and lighting. Prior to implementation, curve advisory speeds and warning signage recommended by qualified curve testing personnel shall be approved by the Regional Traffic Engineer (RTE) and a copy of the recommendations and ball-bank test results supplied to the District Engineer. For examples of ball-bank testing data sheets, see the attached sample sheets. Alternative presentation of ball-bank results should be approved by the local RTE.

#### **4.0 Scope and Application**

The following procedures shall be followed when conducting curve testing and determining curve advisory speeds.

#### **4.1 Prior to Conducting Ball-Bank Testing**

To ensure proper operation of the bank indicator and reliable testing results, the following items must be addressed before conducting testing:

1. Inflate all tires to a uniform pressure as recommended by the manufacturer.
2. Calibrate the test vehicle's odometer or distance measuring instrument.
3. Calibrate the test vehicle's speedometer.
4. Calibrate and zero the ball-bank indicator.

See the following guidelines for more detail on each of the above actions.

##### **4.1.1 Tire Pressure:**

Vehicle tire pressure should be checked at the beginning of each day of testing. Prior to checking tire pressure, the vehicle should be driven 5 to 8 km to warm the tires. Tires shall be uniformly inflated to the manufacturer's recommended level.

##### **4.1.2 Vehicle Odometer:**

The vehicle odometer readings may vary depending on tire pressure and should therefore be checked daily and whenever the tire pressure is adjusted. The

distance measured by a vehicle's odometer should be checked for accuracy by comparing its distance measurements against road km markers or a measured distance. The distance that the vehicle odometer is checked against should be at least 3 km. If the distance reading from a vehicle odometer differs from the manually measured distance, then a correlation ratio for distance shall be determined by dividing the actual distance as measured against the odometer distance.

#### **4.1.3 Vehicle Speedometer:**

If using a manual ball-bank indicator, the accuracy of the vehicle speedometer should be checked at the beginning of each section of roadway being tested or every 1 to 3 days at a minimum. The accuracy of a vehicle's speedometer can be verified using a radar or laser speed meter, or similar device, or by timing the vehicle as it travels a measured distance at a constant speed.

#### **4.1.4 Ball-Bank Indicator Leveling:**

The ball-bank indicator shall be calibrated to zero prior to each day of curve testing, or if the ball-bank indicator results become suspect during the testing process.

A manual ball-bank indicator shall be calibrated by adjusting the indicator to read zero degrees while the vehicle is on a flat level surface and all testing personnel are in the same position in the vehicle as they would be during testing.

Some electronic ball-bank units have an auto leveling or relative zero feature that allows the device to be calibrated to zero when not on a flat level surface. Follow the manufacturer's instructions for calibration of electronic ball-bank indicators with an auto-leveling or relative zero feature.

#### **4.1.5 Ball-Bank Testing Procedure**

Ball-bank testing shall be conducted for each direction and each lane on a curve. Test results may differ based on travel direction and lane position.

Tests may be conducted with a driver only, or both a driver and an observer to record the ball bank readings. If conducting testing with a driver only and a manual ball-bank indicator, the driver should use a voice and/or video recorder to document readings and observations while driving.

### **4.2 Ball-Bank Testing**

The following testing procedure should be followed when conducting ball-bank testing.

#### **4.2.1 Testing Preparation**

1. Ensure the test vehicle and ball-bank indicator equipment have been calibrated and vehicle tire pressure has been checked, and adjusted if necessary, as per the above guidelines including manufacturer's recommendations.
2. For each direction, choose a landmark as the starting position that is well in advance of the curve being examined.
3. Drive the curve in each direction, noting the distance from the selected starting position to any signs, intersecting roads, or other landmarks relevant to sign placement. Ensure the locations of the start and end of curve are noted.

#### 4.2.2 Testing

1. Begin testing at the selected landmark in advance of the curve.
2. Centre the test vehicle in the travel lane driving parallel to the roadway centreline. If no shoulder line is painted, offset the vehicle 0.5 to 1.0 m from the centreline.
3. Begin first trial run at a speed below the expected maximum advisory speed or existing advisory speed.
4. Maintain a constant speed throughout the curve.
5. At the end of each pass through the curve review the test results. Assess the maximum inclination recorded based on the speed driven and the table below. If the maximum inclination is lower than the angle given in the speed range table, increase speed by 10 km/h and repeat test run. If the maximum inclination is higher than expected based on the table below and speed driven, decrease speed by 10 km/h and repeat test run.
6. Once an appropriate speed for the curve has been determined, continue testing until at least two matching ball-bank readings are achieved for each direction of travel.
7. Including testing preparation and testing, each curve should be driven a minimum of 3 times for each lane, in each direction.

#### 4.3 Establishing an Advisory Speed

The following table correlates the ball-bank reading with a corresponding range of advisory speeds. This table replaces Table 3.1b in the [Manual of Standard Traffic Signs and Pavement Markings](#).

**Table 1** – Speed and Ball-Bank Inclination

Maximum Inclination	Posted Speed Range (km/h)
8°	110+
10°	70 to 100
12°	50 to 60
14°	0 to 40

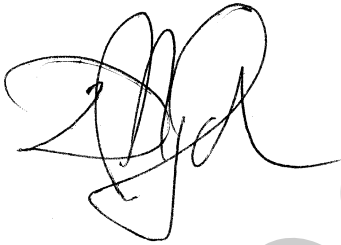
Advisory speeds shall be set at a multiple of 10 km/h.

Where there are a series of curves, the advisory speed posted shall be based on the curve with the lowest advisory speed in the series. However, if the difference in advisory speed between curves is greater than 10 km/h, separate warning signs and advisory speeds should be posted for each curve in the series.

Advisory speed signs, and curve and alignment warning signs shall be selected and placed in accordance with the [Manual of Standard Traffic Signs and Pavement Markings](#).

**Contact:**

Ed Miska, P.Eng., PTOE  
Chief Traffic, Electrical, Highway Safety and Geometric Engineer  
Engineering Branch  
Tel: (250) 387-7676  
Ed.Miska@gov.bc.ca



---

Dirk Nyland, P.Eng.  
Chief Engineer

Attachments

**Ball-Bank Testing Data Sheet (Highway Section)**

Date: June 1, 2008	Analyst(s): Chuck Norris
Route: Hwy XX	Segment: 0000
From: Town Limit	To: Somewhere Road
District: Rocky Mountain	Section Length Tested: 3.0 km
Travel Direction: Southbound	# Lanes: 2

Date: June 1, 2008	Analyst(s): Chuck Norris
Route: Hwy XX	Segment: 0000
From: Somewhere Road	To: Town Limit
District: Rocky Mountain	Section Length Tested: 3.0 km
Travel Direction: Northbound	# Lanes: 2

km	Existing Conditions						Ball Bank Reading Results by Speed										Recommendations	
	Existing Sign Names & Locations	Other Landmarks	Regulatory Speed	Advisory Speed	Curve Deflection (Left, Right)	Curve Limits (Start, End)	20	30	40	50	60	70	80	90	100	Speed	Signs	
0.0		Entrance Ave	60															
0.1	W-130																	
0.2																		
0.3																		
0.4																		
0.5	G-10																	
0.6																		
0.7	W-1L																	
0.8																		
0.9				None	Left	Start			3	6	10				60	no change		
1.0					Left	End												
1.1																		
1.2																		
1.3	W-7R																	
1.4																		
1.5		Hidden Ave																
1.6																		
1.7	W-1R																	
1.8																W-1R		
1.9																		
2.0				None	Right	Start			4	7	9				60	sign relocation		
2.1																		
2.2					Right	End												
2.3																		
2.4	W-1L, W-22 (50)															W-2L, W-22 (40)	change signs	
2.5				50	Left	Start			12	14					40			
2.6					Left	End												
2.7																		
2.8	R-4 (60)																	
2.9																		
3.0		Terminal Rd																

km	Existing Conditions						Ball Bank Reading Results by Speed										Recommendations	
	Existing Sign Names & Locations	Other Landmarks	Regulatory Speed	Advisory Speed	Curve Deflection (Left, Right)	Curve Limits (Start, End)	20	30	40	50	60	70	80	90	100	Speed	Signs	
3.0		Entrance Ave																
2.9	W-130																	
2.8																		
2.7																		
2.6																		
2.5	G-10																	
2.4																		
2.3																		
2.2																		
2.1																		
2.0																		
1.9																		
1.8	W-1L																	
1.7																		
1.6																		
1.5																		
1.4		Park Place																
1.3																		
1.2																		
1.1																		
1.0																		
0.9																		
0.8																		
0.7	W-1L			None	Left	Start			5	8	11				60	no change		
0.6																		
0.5																		
0.4																		
0.3	W-1R, W-22 (50)																	
0.2																		
0.1	R-4 (60)																	
0.0		Terminal Rd	60															

Comments:

Comments:

Approving Engineer: Reginald Bald  
 Signature: \_\_\_\_\_ Date: June 5, 2008

Approving Engineer: Reginald Bald  
 Signature: \_\_\_\_\_ Date: June 5, 2008

## Ball-Bank Testing Data Sheet (Single Curve)

<b>Date:</b> June 1, 2008	<b>Analyst(s):</b> Chuck Norris
<b>Route:</b> Hwy XX	<b>Segment:</b> 0000
<b>From:</b> km 22.5	<b>To:</b> km 22.6
<b>District:</b> Rocky Mountain	<b>No. of Lanes:</b> 2

Northbound	<b>Existing Signs:</b> W-1L located 200 m in advance of curve					
	<b>Other Landmarks:</b> no intersecting roads					
	<b>Curve Deflection (Left/Right):</b> Left					
	<b>Posted Speed:</b> 90 km/h					
	<b>Advisory Speed:</b> no advisory speed					
	Trial No.	Lane (inside, outside)	Field Measurements		Recommendations	
			Speed on Curve	Deflection	Speed	Signs
	1	N/A	70	3	90	no change
	2	N/A	80	7		
	3	N/A	90	9		
4	N/A	90	9			
5						
6						
7						
8						

**Comments:**  
 Highway section has been recently reconstructed with new pavement.  
 Speed limit was raised from 80 km/h to 90km/h.

Southbound	<b>Existing Signs:</b> W-1R located 200 m in advance of curve					
	<b>Other Landmarks:</b> no intersecting roads					
	<b>Curve Deflection (Left/Right):</b> Right					
	<b>Posted Speed:</b> 90 km/h					
	<b>Advisory Speed:</b> no advisory speed					
	Trial No.	Lane (inside, outside)	Field Measurements		Recommendations	
			Speed on Curve	Deflection	Speed	Signs
	1	N/A	70	4	90	no change
	2	N/A	80	8		
	3	N/A	90	10		
4	N/A	90	10			
5						
6						
7						
8						

**Comments:**  
 Same as above.

**Approving Engineer:** Reginald Bald

**Signature:** \_\_\_\_\_ **Date:** June 5, 2008