# Racing Surfaces Testing Laboratory

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## LABORATORY TEST METHOD FOR ABRASION RESISTANCE OF RACING SURFACE SAND MATERIALS USING MICRO-DEVAL APPARATUS (ADAPTED FROM ASTM D7428)

*Note:*
*This procedure applies to dirt only. All material must be completely free from wax and other synthetic materials.*

**This procedure is only for one Micro-Deval jar. Ideally, two jars/tests should be performed for each sample if enough material is available. The samples should be labeled 1 and 2.**

### AGGREGATE CALIBRATION

1) Standard Sutherland Micro-Deval Fine Aggregate is the calibration aggregate that is currently used.

2) If supplies are low, more **Sutherland Sand** can be acquired from the Soils and Aggregates Section, Engineering Materials Office, Ministry of Transportation, 1201 Wilson Avenue, Downsview, Ontario, Canada M3M1J8. Fax: 1-416-235-4101.

3) Place 500g of oven dried calibration material in the 1000 ml beaker.

4) Pour **distilled water** into the beaker until the sample is covered. Stir the material thoroughly.

5) Rinse any material stuck to the spoon back into the beaker with distilled water, and allow the mixture to soak for 24 hours.

6) Get a **#270 sieve** and confirm that it does not have any holes. Place the sieve in the **plastic sink** or over a bucket.

7) Stir the material and water mixture in the 1000 ml beaker then empty it into the #270 sieve. Use a spray bottle of **tap water** to wash any sample stuck to the sides of the beaker into the sieve.

8) Stir the material and water mixture gently with a **silicon utensil**, taking care not to damage the mesh of the sieve. Flush the sieve with tap water from the **tap hose** while stirring. Avoid splashing the water and do not let it spill from the top. Continue until the water clear of clay and silt particles and flows easily out of the bottom of the sieve.

9) Let the sieve sit for about 30 minutes to allow excess water to run out of the sample. If time is an issue, reduce this to about 10 minutes.

10) Weigh a clean foil **sample tin**, and record the weight under “Weight of the sample tin (gram)”.

11) Spoon the material from the #270 sieve into the clean foil sample tin.

12) Decant excess water from the sample tin over the #270 sieve if needed and rinse sieve to make sure none of the remaining sample is resting on the edge of the sieve.

13) Place the tin and sieve in the oven, and allow the sieve enough time to dry. When the sample on the sieve is dry, it will move loosely over the sieve. This will take approximately half an hour.

14) Pour the dry sample from the sieve into the sample tin containing the rest of the material. Allow the sample to dry to constant mass at approximately **110°C**.

15) When the sample is dry, remove it from the oven and allow it to cool before continuing the test.

16) Mix the dried sample in the sample tin with a **spoon**.

17) Weigh a clean **foil tin** with a scale accurate to ±0.1g and record the weight under “Empty Container (g)” in the “BEFORE GRINDING” column.

18) Add the **dry wet-sieved sample** to the empty sample tin and record the mass to ±0.1g under "Container + Sample" in the "BEFORE GRINDING" column.

19) Pour the entire weighed sample into a **Micro-Deval jar** and record the jar's number under "Micro-Deval Jar #".

20) Use a **graduated cylinder** to measure 750±5mL tap water. Pour the water into the Micro-Deval jar and make sure the sample is immersed.

21) Allow the sample and water to sit for at least **60 min**. While the sample is soaking, check that the r**eflective decal** on the jar lid and the **encoder** on the Micro-Deval machine are not damaged or dirty. Do not clean either with anything abrasive.

22) Check the diameter of the **ball bearings** using a set of **calipers**. The balls must be **9.5 ±.5 mm**. If they are outside of this range, a new set will need to be conditioned. Refer to the "Conditioning Jars and Bearings" section of this document.

23) Check the **ball bearings** to make sure that they are not covered with excessive amounts of steel dust. If they are, pour them over a **#4 sieve** with a paper towel placed between the sieve and the countertop. Use a brush or a paper towel to free the bearings from dust.

24) Place a small **stainless steel tin** on a scale. Record the mass to the nearest 0.1g under "Empty Container 2 (g)" in the "BEFORE GRINDING" column.

25) Add **1250±5g** stainless steel balls to the tin and record the mass to the nearest 0.1g under "Container 2 + Balls Before Grinding (g)" in the "BEFORE GRINDING" column.

26) After the sample and water have soaked for at least 60 min, add the 1250±5g stainless steel balls to the **jar**.

27) Install and tighten the jar lid. Make sure the **lid** and **O-ring** are centered and that the reflective decal is clearly visible.

28) Invert the jar and check the lid for **leaks**. If leaks are found, remove the jar lid, clean the O-ring, and then secure the lid again.

29) Place the jar in the **Micro-Deval machine**, and plug the machine in.

30) Run the machine for **1500±10** revolutions by pressing "B", which will select revolution mode. Check to make sure that the machine is set to 1500 revolutions, if it is not it can be reset by pressing "OK", which will enable changes with the plus and minus buttons. When the machine is set to run for 1500 revolutions, press the green **"Start"** button. The machine will run for approximately 15 minutes.

31) Place a large, plastic **Tupperware** container in the **sink** and put a **#4 sieve** in it.

32) After the machine has stopped, carefully transport the jar to the kitchen and remove the lid.

33) Hold the lid over the plastic container and rinse it off using the **tap hose**. Check around the rubber O-ring, as sand tends to stick on and under it.

34) Using the hose, rinse water that may be on the rim of the jar back into it. Also rinse off the inner edge on one side of the jar. This will create a clean place to hold the jar during the rest of the emptying process.

35) Use the **magnetic pick and release stick** to gather the balls from the jar. Insert the stick with the shaft completely down to attract the balls. Lift the stick out, rinse the balls over the Tupperware, and release them onto the #4 sieve. Repeat this step until all of the ball bearings are removed from the jar.

36) Completely rinse the **sieve** with all the ball bearings in it. Make sure to rinse the sides of the sieve to free any material that may have settled on it in the Tupperware. Any **black residue** on the ball bearings that is particularly difficult to remove is fines ground from the ball bearings and can be dried with the ball bearings and brushed off once they are dry.

37) Get a clean **stainless steel sample tin** and record its weight under "Empty Container 2 (g)" in the "AFTER GRINDING" column.

38) Move the **ball bearings** into that sample tin, making sure to **label** which set they are. Place them in the oven to dry.

39) Grabbing the **jar** by the clean edge, tilt it and begin pouring material into the **Tupperware**. Hold the jar so it is



tilted toward the sieve, and use a stainless steel spoon to help work the material over the lip of the jar. When necessary, use the **hose** to rinse material to the edge of the jar.

40) When almost all of the material is rinsed from the jar, it will be useful to completely invert the jar over the Tupperware container. Use the **tap hose** to spray all contents down to the edge, tilting the jar just slightly to concentrate the material at one side. Then, still holding the hose, use your fingers to pull the material over the lip of the jar.

41) When you believe the jar is clean, feel around the inside to check if it is truly free of particles. If it is, set the jar aside.

42) Get a **#270 sieve**, record its number on the data sheet, and place it over the **plastic sink**.

43) Pour the material and water from the **Tupperware** container over the sieve. Make sure to rinse all material into the **sieve**.

44) Continue to sieve the material as usual, flushing the sample with water and moving it gently with a **silicon spoon** until the water runs freely and clearly from the sieve. Expect this to take longer than it did before the sample was ground.

45) Allow the sample to drip dry on the sieve for about 30 minutes. If time is limited, this can be reduced to as little as 10 minutes.

46) Weigh a clean **foil tin** to the nearest 0.1g and record the mass under "Empty Container (g)" in the "AFTER GRINDING" column.

47) Spoon the material from the #270 sieve into that clean foil **sample tin**.

48) Decant excess water from the sample tin over the #270 sieve if needed, and rinse of the sieve to make sure none of the remaining sample is resting there.

49) Place the tin and sieve in the **oven**, and allow the sieve enough time to dry. When the sample on the sieve is dry, it will move loosely over the sieve. This will take approximately half an hour.

50) Pour the dry sample from the sieve into the **sample tin** containing the rest of the material. Allow the sample to dry to constant mass at 110°C.

51) Record the weight of the **tin and dry material** under "Container + Sample (g)" in the "AFTER GRINDING" column.

52) When dry, take the tin of **stainless steel balls** out of the oven and allow them to cool.

53) Once they are cool, record the mass to the nearest 0.1g under "Container 2 + Balls After Grinding (g)" in the "AFTER GRINDING" column.

54) Results from the **Sutherland Sand** tests should fall between 13% and 17% loss.

55) If testing has not taken place for several months, ten samples of the calibration aggregate must be tested before testing can continue.

56) The **calibration aggregate** should be tested again every ten samples, or every week in which a sample is tested if fewer than 10 samples are tested in a week. If the test results are outside the limits, the ball bearings and jars should be **reconditioned** and the calibration aggregate should be tested again. See the "Conditioning Jars and Bearings" section of this document for instruction. If after conditioning the bearings and jars the results still fall beyond the limits, there is another cause for the anomalous values, and the cause should be found and resolved before testing continues.

57) After 20 samples of calibration material have been tested with no anomalies, the frequency of calibration tests can be reduced to once per month.

## CONDITIONING JARS AND BEARINGS

1) Conditioning should be performed if the **calibration aggregate** test results are outside the acceptable limits. In addition, new **bearings** and **jars** should always be conditioned before being used.

2) Place 1250±5g of **stainless steel ball bearings**, 500g of the **calibration aggregate**, and 750 mL of **tap water** in a Micro-Deval jar. It is not necessary to soak the sand.

3) Plug in the **Micro-Deval** machine.

4) Press the **A** button on the Micro-Deval machine to put it in time mode.

5) Set the time test to **240 minutes** by pressing the **OK** button, then using the +/- buttons.

6) Place the Micro-Deval jar in the machine and run for **4 hours**.

7) Remove the sand and bearings from the jar. Wash the bearings and dry in the oven.

**MICROSCOPY AND SIEVE**

1) It is necessary to collect data on the original material. If a sieve and microscopy have not been performed on the material to be ground, then they must be performed as prerequisite to abrasion resistance. Record these data in standard sieve and microscopy files.

**ABRASION RESISTANCE**

1) Place approximately **800g** sample in oven to remove moisture. Refer to the Moisture Removal & Determination Procedure for details.

2) Using a **scale accurate to ± 0.1g** weigh an empty **1000-ml beaker** and record the mass under "Weight of empty beaker (gram)."

3) Place **600g** of oven dried material in the **1000 ml beaker**. If it is suspected that the material is more than 20% fines, use more material to compensate for the loss. Record the mass of the material and beaker under "Initial weight of beaker & dry material (gram)."

4) Pour **distilled water** into the beaker until the sample is covered. Stir the material thoroughly.

5) Rinse any material stuck to the spoon back into the beaker with distilled water, and allow the mixture to soak for 24 hours.

6) Get a **#270 sieve** and confirm that it does not have any holes. Place the sieve in the **plastic sink** or over a bucket.

7) Stir the material and water mixture in the 1000 ml beaker then empty it into the #270 sieve. Use a spray bottle of **tap water** to wash any sample stuck to the sides of the beaker into the sieve.

8) Stir the material and water mixture gently with a **silicon utensil**, taking care not to damage the mesh of the sieve. Flush the sieve with tap water from the **tap hose** while stirring. Avoid splashing the water and do not let it spill from the top. Continue until the water clear of clay and silt particles and flows easily out of the bottom of the sieve.

9) Let the sieve sit for about 30 minutes to allow excess water to run out of the sample. If time is an issue, reduce this to about 10 minutes.

10) Weigh a clean **foil sample tin**, and record the weight under "Weight of # 270 sieve (g)."

11) Spoon the material from the #270 sieve into that clean foil sample tin.

12) Decant excess water from the sample tin over the **#270 sieve** if needed and rinse sieve to make sure none of the remaining sample is resting on the edge of the sieve.

13) Place the tin and sieve in the **oven**, and allow the sieve enough time to dry. When the sample on the sieve is dry, it will move loosely over the sieve.

14) Pour the dry sample from the sieve into the **sample tin** containing the rest of the material. Allow the sample to dry to constant mass at 110°C.

15) Check the **calibration date** for the Micro-Deval. If more than one week has passed, it may need to be recalibrated. See "Aggregate Calibration" at the beginning of this document for more details on calibration.

16) When the sample is dry, remove it from the oven and allow it to cool before continuing the test.

17) Mix the **dried sample** in the sample tin with a spoon.

18) Weigh a **clean foil tin** with a scale accurate to ±0.1g and record the weight under "Empty Container (g)" in the "BEFORE GRINDING" column.

19) Add the dried **wet-sieved sample** to the empty sample tin and record the mass to ±0.1g under "Container + Sample" in the "BEFORE GRINDING" column.

20) Pour the entire weighed sample into a **Micro-Deval jar** and record the jar's number under "Micro-Deval Jar #".

21) Use a **graduated cylinder** to measure 750±5mL tap water. Pour the water into the Micro-Deval jar and make sure the sample is immersed.

22) Allow the sample and water to sit for at least **60 min**. While the sample is soaking, check that the **reflective decal** on the jar lid and the **encoder** on the Micro-Deval machine are not damaged or dirty. Do not clean either with anything abrasive.

23) Check the **ball bearings** to make sure that they are not covered with excessive amounts of steel dust. If they are, pour them over a **#4 sieve** with a paper towel placed between the sieve and the countertop. Use a **brush** or a **paper towel** to free the bearings from dust.

24) Place a small **stainless steel tin** on a scale. Record the mass to the nearest 0.1g under "Empty Container 2 (g)" in the "BEFORE GRINDING" column.

25) Add 1250±5g **stainless steel balls** to the tin and record the mass to the nearest 0.1g under "Container 2 + Balls Before Grinding (g)" in the "BEFORE GRINDING" column.

26) After the **sample** and **water** have soaked for at least 60 min, add the 1250±5g stainless steel balls to the jar.

27) Install and tighten the **jar lid**. Make sure the lid and O-ring are centered and that the reflective decal is clearly visible.

28) Invert the jar and check the lid for **leaks**. If leaks are found, remove the jar lid, clean the O-ring, and then secure the lid again.

29) Place the jar in the **Micro-Deval machine,** and plug the machine in.

30) Run the machine for **1500±10 revolutions** by pressing "B", which will select revolution mode. Check to make sure that the machine is set to 1500 revolutions, if it is not it can be reset by pressing "OK", which will enable changes with the plus and minus buttons. When the machine is set to run for 1500 revolutions, press the green "Start" button. The machine will run for approximately 15 minutes.

31) Place a large, plastic **Tupperware** container in the sink and put a **#4 sieve** in it.

32) After the machine has stopped, carefully transport the jar to the kitchen and remove the lid.

33) Hold the lid over the plastic container and rinse it off using the **tap hose**. Check around the rubber **O-ring**, as sand tends to stick on and under it.

34) Using the **hose**, rinse water that may be on the rim of the jar back into it. Also rinse off the inner edge on one side of the jar. This will create a clean place to hold the jar during the rest of the emptying process.

35) Use the **magnetic pick and release stick** to gather the balls from the jar. Insert the stick with the shaft completely down to attract the balls. Lift the stick out, rinse the balls over the **Tupperware**, and release them onto the **#4 sieve**. Repeat this step until all of the ball bearings are removed from the jar.

36) Completely rinse the **sieve** with all the ball bearings in it. Make sure to rinse the sides of the sieve to free any material that may have settled on it in the Tupperware. Any **black residue** on the ball bearings that is particularly difficult to remove is fines ground from the ball bearings and can be dried with the ball bearings and brushed off once they are dry.

37) Get a clean **stainless steel sample tin** and record its weight under "Empty Container 2 (g)" in the "AFTER GRINDING" column.

38) Move the **ball bearings** into that sample tin, making sure to **label** which set they are. Place them in the oven to dry.

39) Grabbing the jar by the clean edge, tilt it and begin pouring material into the Tupperware. Hold the jar so it is tilted toward the sieve, and use a stainless steel spoon to help work the material over the lip of the jar. When necessary, use the hose to rinse material to the edge of the jar.

40) When almost all of the material is rinsed from the jar, it will be useful to completely invert the jar over the Tupperware container. Use the **tap hose** to spray all contents down to the edge, tilting the jar just slightly to concentrate the material at one side. Then, still holding the **hose**, use your fingers to pull the material over the lip of the jar.

41) When you believe the jar is clean, feel around the inside to check if it is truly free of particles. If it is, set the jar aside.

42) Get a **#270 sieve**, record its number on the data sheet, and place it over the **plastic sink**.

43) Pour the material and water from the **Tupperware** container over the **sieve**. Make sure to rinse all material into the sieve.

44) Continue to sieve the material as normal, flushing the sample with water and moving it gently with a **silicon spoon** until the water runs freely and clearly from the sieve. Expect this to take longer than it did before the sample was ground.

45) Allow the sample to drip dry on the sieve for about 30 minutes. If time is limited, this can be reduced to as little as 10 minutes.

46) Weigh a clean **foil tin** to the nearest 0.1g and record the mass under "Empty Container (g)" in the "AFTER GRINDING" column.

47) Spoon the material from the #270 sieve into that clean foil sample tin.

48) Decant excess water from the sample tin over the #270 sieve if needed, and rinse of the sieve to make sure none of the remaining sample is resting there.

49) Place the tin and sieve in the **oven**, and allow the sieve enough time to dry. When the sample on the sieve is dry, it will move loosely over the sieve. This will take approximately half an hour.

50) Pour the **dry sample** from the sieve into the sample tin containing the rest of the material. Allow the sample to dry to constant mass at 110°C.

51) Record the weight of the tin and dry material under "Container + Sample (g)" in the "AFTER GRINDING" column.

52) Take the tin of **stainless steel balls** out of the oven and allow them to cool.

53) Once they are cool, record the mass to the nearest 0.1g under "Container 2 + Balls After Grinding (g)" in the "AFTER GRINDING" column.

54) Keep the ground material in **oven** until you are ready to dry sieve the sample. Before beginning a dry sieve, combine **samples one and two** of the ground material if two tests were run on the material. All data recorded from this dry sieve should be on a POST abrasion sieve sheet in the abrasion resistance workbook.

55) Record the number of the **sieve stack** being used under "Stack Number" on the POST abrasion sieve data sheet. Record the mass of each of the empty **sieves** from the stack using a scale accurate to ±0.1g. Sort sieves from coarsest mesh on top to finest mesh on bottom (10, 14, 18, 35, 40, 60, 100, 140, 200, 270, Pan). The higher the sieve number, the finer the mesh.

56) Pour the dried material into the top sieve (No. 10). Care should be used when pouring to prevent the loss of very fine particles to the air. Place the **sieve cap** onto the top sieve.

57) Place the stack of sieves into the **sieve shaker**, and set the hammer on top of the sieve cap. Check the shaker for loose bolts. Close the clasp and start the shaker by pressing the **red button**. The machine will run for 5 minutes and stop automatically. Wear hearing protection while the machine is running or leave the room.

58) Remove the **sieve stack** from the shaker. Separate the No. 10 sieve from the sieve stack and record the weight of the sieve + material. Continue to record the weight of each sieve all the way down to the pan.

59) Save a small amount of material from the sieve with the highest percentage retained for **microscopy** for sand shape. Put this small amount into a small sample bag labeled with the project ID, sample ID, sieve #, date, and "After Abrasion, For Microscopy".

60) After recording the masses of all of the sieves, pour the contents of each sieve into the pan or another container. Put this material in a **plastic bag** labeled with the sample identifier, the sample description, "After Abrasion, #270 wet sieve" the date, ending weight, and the initials of the person bagging the sample.

61) Be sure to take a **microscopy** image during the post grinding sieve. Name the image MICsieve#_GROUNDprojectID_sampleID_SAND_magnification#X.

| Revision No. | Date | Revision By | Description |
|---|---|---|---|
| 1.1 | 22-May-2012 | M. Segee | put procedure in dropbox, clarified and altered some steps. |
| 1.2 | 6-Aug-2013 | M. Segee | Clarified steps, use plastic container instead of Teflon coated metal pan, added data sheet labels. |
| 2.0 | 23-Mar-2015 | T. Thomson | Changed protocol |
| 2.1 | 22-Apr-2015 | T. Thomson | Clarified steps, removed microwave drying |
| 2.2 | 26-Feb-19 | H. Adams | Update Address and Phone number |
| 2.3 | 19-Mar-2025 | M. Rockefeller | Update Address |