

**TRADE: ROAD CONSTRUCTION**

**MODULE CODE: RCTSE501**

**Module Name: Sand Equivalent Test**

**TEACHER’S GUIDE**

**RQF LEVEL 5**

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**Acronym**

**ASTM ………………………… American Society for Testing and Materials**

**AASHTO …………………….. American Association of State Highway and**

**Transportation Officials.**

**PPE ……………………… …… Personal protective equipment**

**SE ……………………………… Sand Equivalent**

# Introduction

# The Purpose and the Process.

# The purpose of the sand equivalent test is to indicate, under standard conditions, the relative proportions of clay-like or plastic fines and dusts in granular material and fine aggregates that pass the 4.75 mm sieve.

# A minimum sand equivalent value may be specified to limit the permissible quantity of clay-like fines in an aggregate. The test may also be used for determining changes in the quality of aggregates during production or placement.

# The sand equivalent is expressed as a percentage of sand to clay content.

# Although controlled amounts of fines and dust can improve some characteristics of asphalt or concrete mixes, too much negatively affects the behaviors of the materials. Excessive fines increase the total surface area of solids in concrete and reduce workability while increasing water demand. In asphalt, high fines contribute to a loss of adhesion between asphalt binder and aggregate, and more binder is required.

# In 1953, the sand equivalent test was presented in the Highway Research Board Proceedings, by “Francis N. Hveem”. (pronounced “veem”) a materials and research engineer with the California Division of Highways. As a standard test method it is described in ASTM D2419 and AASHTO T 176.

# Module Code and Title: RCTSE501 Sand Equivalent Test

**Learning Units:**

1. Prepare materials, tools and equipment
2. Determine quantity of clay and silt in sand
3. Make a report

# Learning Unit 1: Prepare materials, tools and equipment

|  |
| --- |
| C:\Users\Teacher\Desktop\4T03.png  **Fugure 1.1: Sand equivalent Test tools and Equipment** (Sand Equivalent Test Set) |

# STRUCTURE OF LEARNING UNIT 1

|  |
| --- |
| **Learning outcomes:**  **1.1.** Correct preparation of tools and equipment in accordance with specifications  **1.2.** Correct preparation of materials in accordance with specifications  **1.3.** Correct preparation of workplace in accordance with specifications |

## Learning outcome 1.1 Prepare tools and equipment

|  |  |  |
| --- | --- | --- |
| **Duration: 50min** | | |
| Learning outcome 1.1 objectives: By the end of the learning outcome, the trainees will be able to:  1.Distinguish clearly tools used in Sand equivalent  2. Distinguish effectively equipment used in sand equivalent  3. Categorise correctly tools and equipment according to their use in the test | | |
| **Resources** | | |
| **Equipment** | **Tools** | **Materials** |
| Oven  Timer  [Sand Equivalent Shakers](https://www.globalgilson.com/sand-equivalent-shakers)  Sample Splitters | Plastic cylinder  Rubber stopper  Measuring tin  Scoop  Siphon assembly  Irrigator Tube  [Weighted Foot Assembly](https://www.globalgilson.com/weighted-foot-assembly-for-sand-equivalent-test)  Measuring Tin | Stock solution made of:  Calcium chloride  Formaldehyde and  Glycerine solution  Mixed with distilled water to get work solution  Fine aggregate |
| **Advance preparation:**   * Having prepared materials, tools equipment and work place. * Having arranged tools, equipment and materials according to the task to be performed. * Having made trainee’s groups in order to facilitate them to work in good conditions. | | |

### 

### Content 1: Identify types of tools

|  |
| --- |
| * **Graduated cylinder**: * The cylinder is constructed of clear acrylic and has 0.1in graduations from the bottom of the cylinder to 15in height.     **Figure 1.2**: **Graduated cylinder** (E.Backus)   * **Rubber stopper:** * A stopper to fit the plastic cylinder. * **Measuring tin**: * A tin measure approximately 57 mm in diameter having a capacity of 85 ± 5 mL. * **Scoop**: * a utensil resembling a spoon, with a short handle and a deep bowl, used for removing dry or semi-solid substances from a container. * **Funne**l: * A wide-mouth funnel suitable for directing the test specimen into the plastic cylinder. / a tube or pipe that is wide at the top and narrow at the bottom, used for guiding liquid or powder into a small opening. * **Irrigator tube**: * brass, stainless steel, or copper; 0.25-in. (6.4-mm) outside diameter; approximately 20 in. (508 mm) long; one end closed to form a wedge-shaped tip; two holes (drill size 60) drilled laterally through the flat side of the wedge. Or is attached to the latex tubing of the siphon assembly and flushes a stream of working solution into the sample during the irrigation procedure to bring the fine particles into the solution. * **Weighted foot assembly**: * consisting of a metal rod connected to a foot with a flat, smooth surface at the lower end and a weight at the upper end to give the total assembly a weight of 1,000 ± 5g. Use one of the assembly models described in Sections 2.4.1 and 2.4.2. * **Siphon assembly**: * A bent pipe or tube through which a liquid can be drawn by air pressure up and over the edge of a container.     **Figure 1.3**: **Siphon Assembly** (E.Backus)   * **Glass bottle,1 gal. (3.8 L**): * Equipped with a siphon assembly consisting of a two-hole rubber stopper and pieces of glass or copper tubing, sits 3 ft. ±1 in. (912 ±25 mm) above the work surface. * **Measuring Tin** * Serves dual purposes for measuring out stock solution concentrate when making up the working solution, and also as a volumetric measure when preparing the test specimen. |

### Theoretical learning Activity

* Trainees in their groups discussing about distinguished tools used in sand equivalent test set
* After that task, as trainer guide trainees to ask questions among them for common understand.

### Practical learning Activity

* Trainees in their distinguished groups conducting Practical exercises on preparation of tools and equipment**.**
* After that task, with facilitator, Learners will ask questions among them for common understanding

**Points to Remember (Take home message)**

|  |
| --- |
| * Plastic cylinder * Rubber stopper * Measuring tin * Scoop |

## 

### Content 2: Types of equipment

|  |
| --- |
| * **Oven**: A drying oven set to operate at 110 ± 5˚C.  **Its purpose is to heat, dry, harden, sterilize materials and parts**.   Laboratory Drying Oven, Capacity: 0-100 Kg, Rs 25000 Roshan Enterprises |  ID: 18637935888  **Timer Figure 1.4: Oven drying machine** (Richardson & Lusher, 2016)   * : A clock or watch reading in minutes and seconds. Or A timer is a specialized type of clock used for measuring specific time intervals.   Buy Time Timer pocket - Nenko  **Figure 1.5: Timer** (Richardson & Lusher, 2016)   * [**Sand Equivalent Shakers**](https://www.globalgilson.com/sand-equivalent-shakers) add efficiency, accuracy, and repeatability to the testing process. As noted above, manual agitation is acceptable in the standard, but the specified reciprocating action can be difficult and tiring to perform correctly. Economy and manual shakers are easy to set up and use anywhere, and a motorized shaker removes any operator error, optimizes accuracy, and produces the most consistent results.     **Figure 1.6: Shaker machine** (E.Backus)   * **Sample Splitters** provide the most accurate samples when preparing test specimens. The test method tolerates some manual sample dividing methods, but a mechanical splitter has a clear advantage in producing a representative sample.     **Figure 1.7: Sample Splitter** (E.Backus) |

### Theoretical learning Activity

* Trainees in their groups discussing about distinguished equipment used in sand equivalent test
* After that task, the trainees they ask questions among them for understand well.

### Practical learning Activity

* Trainees in their distinguished groups conducting Practical exercises on preparation of equipment used in sand equivalent test**.**
* After that task, Learners ask questions among them for common understanding

**Points to Remember (Take home message)**

|  |
| --- |
| * Oven * Timer * Sample Splitters |

## Learning outcome 1. 1 formative assessment

**Written assessment**

1. Excessive fines increase the total surface area of solids in concrete and reduce workability while increasing water demand **“True”**
2. **Oven**: A drying oven set to operate at 80 ± 3˚C.  **Its purpose is to heat, dry, harden, sterilize materials and parts**. **“False”**
3. **Timer**: A clock or watch reading used to start of finishing testing **“False”**
4. **Weighted Foot Assembly** is immersed into the graduated cylinder to take the sand reading of the test sample **“True”**
5. **Choose the tool which is not used in Sand equivalent test**
6. Plastic cylinder
7. Hammer
8. Measuring tin
9. Scoop
10. The stock solution used in sand equivalent is composed by:
11. Concentrated mixture of calcium chloride, formaldehyde in glycerine solution
12. Acidic methylene blue solution.
13. formaldehyde diluted with distilled water
14. A buffer solution
15. How to prepare working solution or flocculating solution for sand equivalent test

**Answer:**

**It is prepared from the concentrated stock solution by mixing 85ml of the stock solution into 1.0gal (3.8L) of distilled or demineralized water.**

1. What is mechanical splitter?

**Answer:**

**Mechanical Splitter – This accurate and repeatable method is the most widely accepted for reducing aggregate samples to test size.**

* **Assessment tools**

1. As trainer, select tools and equipment used while conducting Sand equivalent test and ask the trainees to assembly and explain them one by one.

* **Observation checklist**

|  |  |  |
| --- | --- | --- |
| CHECK LIST | SCORE | |
| YES (1) | NO (0) |
| Types of Tools |  |  |
| Quantity of tools required are mentioned |  |  |
| Status of tools are indicated according to their use |  |  |
| Types of tools are mentioned and indicated |  |  |
| Types of Equipment |  |  |
| Quantity of equipment required are mentioned |  |  |
| Status of equipment are indicated according to their use |  |  |
| Types of equipment are mentioned and indicated |  |  |

## Learning outcome 1.2. Prepare materials

|  |  |  |
| --- | --- | --- |
| **Duration: 50min** | | |
| Learning outcome 1.2 objectives: By the end of the learning outcome, the trainees will be able to:  1. To prepare working solution or flocculating solution used in Sand equivalent  2. To distinguish difference materials used to prepare flocculating solution  3. Prepare the quantity of solution require for one gallon of distilled or demineralized water according to the standard. | | |
| **Resources** | | |
| **Equipment** | **Tools** | **Materials** |
| Oven  Sample Splitters | Gallon  Measuring tin  Scoop  Measuring Tin | Stock solution made of:  Calcium chloride  Formaldehyde and  Glycerine solution  Mixed with distilled water to get work solution  Fine aggregate |
| **Advance preparation:**   * Having prepared fine aggregate used for testing. * Having prepared working solution used for separating sand from clay during testing. * Having made trainee’s groups in order to facilitate them to work in good conditions. | | |

### 

### Content 1: Materials determination

|  |
| --- |
| * Prepare test specimens from the materials. * Provide the most accurate samples when preparing test specimens by using mechanical splitter. * Prepare a cleaning solvent by diluting sodium hypochlorite solution (household chlorine beach) with an equal quantity of water * Working Solution, or flocculating solution, is prepared from the concentrated stock solution by mixing 85ml of the stock solution into 1.0gal (3.8L) of distilled or demineralized water. * Obtain at least 1500 g of material passing the (4.75 mm) sieve * The test is conducted on soils or graded aggregate passing the 4.75mm (No. 4) sieve. When separating the sample special care should be made to collect all the minus 4.75mm (No. 4) material. Any clumps or dust should be broken apart and included with the material passing the 4.75mm (No. 4) sieve. |

### Theoretical learning Activity

* Trainees in the group will discussing on the ways of preparing fine aggregate materials by using sieve with 4.75mm.
* Trainees in the group will discussing on the ways of preparing working solution (flocculating solution) from stock solution
* After that task, facilitator will help the trainees to share what they did to explain more.

### Practical learning Activity

1. Learners Group practical exercises on preparation of working solution (flocculating solution) from stock solution**.**
2. Learners group practical exercises of preparation of at least 1500g of fine aggregate materials on each group by using sieve with 4.75mm size of opening
3. After that task, the trainees will share what they did to explain more.

**Points to Remember (Take home message)**

|  |
| --- |
| * Prepare test specimens from the material. * Prepare a cleaning solvent by diluting sodium hypochlorite solution (household chlorine beach) with an equal quantity of water. * Obtain at least 1500 g of material passing the (4.75 mm) sieve. |

## Learning outcome 1. 2 formative assessment

**Written assessment**

**Assessment tools**

1. The flocculating solution forces the clayey materials into suspension above the granular aggregate. **“True”**
2. Working Solution, or flocculating solution, is prepared from the concentrated stock solution by mixing 850ml of the stock solution into 1.0gal (3.8L) of distilled or demineralized water. **“False”**
3. **Choose the minimum materials in gram prepared during Sand equivalent test**
4. 2000g
5. 5000g
6. 1500g
7. 3000g
8. The stock solution used in sand equivalent is composed by:
9. Concentrated mixture of calcium chloride, formaldehyde in glycerine solution
10. Acidic methylene blue solution.
11. formaldehyde diluted with distilled water
12. A buffer solution
13. Which sieve used to prepare aggregate sample used for sand equivalent test

**Answer:**

**4.75 mm sieve.**

* **Assessment tools**

1. As trainer, select material from the quarry and stock solution used while conducting Sand equivalent test and ask the trainees to prepare it in their distinguished groups.

* **Observation checklist**

|  |  |  |
| --- | --- | --- |
| CHECK LIST | SCORE | |
| YES (1) | NO (0) |
| Quality requirement for testing materials |  |  |
| Quality of material are mentioned |  |  |
| Used sieve of 4.5mm is selected |  |  |
| Quantity of material are prepared |  |  |
| Quantity of solution are prepared |  |  |
| Cleanness of material are indicated |  |  |
| Status of material are indicated |  |  |

## Learning outcome 1.3. Prepare workplace

|  |  |  |
| --- | --- | --- |
| **Duration: 20min** | | |
| Learning outcome 1.3 objectives: By the end of the learning outcome, the trainees will be able to:   1. To prepare workplace where Sand equivalent test take place 2. Discarding unused material | | |
| **Resources** | | |
| **Equipment** | **Tools** | **Materials** |
| Oven  Timer  Sample Splitters | Measuring tin  Irrigator tube  Scoop  Measuring Tin  Siphon  Rubber stopper  Funnel  Plastic cylinder | Chalks  Sweeper  Stock solution made of:  Calcium chloride  Formaldehyde and  Glycerine solution  Mixed with distilled water to get work solution  Fine aggregate |
| **Advance preparation:**   * Having prepared work place, materials, tools and equipment to be used. * Having prepared working solution used for separating sand from clay during testing. * Telling the trainees to use personal protective equipment in order to be safe. * Having made trainee’s groups in order to facilitate them to work in good conditions. | | |

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### Content 1: Preparation techniques of workplace

|  |
| --- |
| * prepare a cleaning solvent by diluting sodium hypochlorite solution (household chlorine beach) with an equal quantity of water. * **Use of personal protective equipment**: * Personal protective equipment, commonly referred to as "PPE", is equipment worn to minimize exposure to hazards that cause serious workplace injuries and illnesses. These injuries and illnesses may result from contact with chemical, radiological, physical, electrical, mechanical, or other workplace hazards * Removal of safety hazard or risk * How do you remove a hazard from a safety hazard? Fix the problem * Eliminate the hazard. * Remove it completely from your workplace. * Substitute the hazard. * Replace it with a safer alternative. * Isolate the hazard. * Keep it away from workers as much as possible. * Use engineering controls. * Use administrative controls. * Use personal protective equipment (PPE) * Remove of sand and dust from the workplace |

### Theoretical learning Activity

* Facilitator brainstorming with learners on the ways of organizing materials, tools and equipment while implementing the test.
* Learners’ discussion on the ways of wearing PPE to promote safety measurement
* Facilitate the Learners to discuss on the ways of discard sand and dust from the workplace

### Practical learning Activity

* Trainees in groups will conduct practical exercises on preparation working solution (flocculating solution) from stock solution**.**
* With respect of safety precaution, trainees will be discarding sand and dust from the workplace

**Points to Remember (Take home message)**

|  |
| --- |
| * prepare a cleaning solvent by diluting sodium hypochlorite solution (household chlorine beach) with an equal quantity of water. * use of personal protective equipment. * removal of safety hazard or risk. * remove of sand and dust from the workplace. |

## **Learning outcome 1.3.1 formative assessment** Written assessment

**Assessment tools**

1. The flocculating solution forces the clayey materials into suspension above the granular aggregate. **“True”**
2. Working Solution, or flocculating solution, is prepared from the concentrated stock solution by mixing 850ml of the stock solution into 1.0gal (3.8L) of distilled or demineralized water. **“False”**
3. Remove of sand and dust from the workplace in order
4. To stop the ongoing test
5. To Finish the ongoing test
6. **To discard the un necessary material**
7. All of the above are correct
8. The stock solution used in sand equivalent is composed by:
9. **Concentrated mixture of calcium chloride, formaldehyde in glycerine solution**
10. Acidic methylene blue solution.
11. formaldehyde diluted with distilled water
12. A buffer solution
13. Explain why is important to use PPE while conducting Sand equivalent?

**Answer:**

**PPE, or Personal Protective Equipment, helps prevent staff emergencies on the job due to inhalation, absorption, irritants, or other prolonged contact with a cleaning chemical. This actively reduces accidents, improves the health of your employees, and makes for a safer, secure work environment.**

**Practical assessment**

* **Assessment tools**

1. As trainer, select PPE used while conducting Sand equivalent test and ask the trainees to use it in their distinguished groups while installing the SE tool set.

* **Observation checklist**

|  |  |  |
| --- | --- | --- |
| CHECK LIST | SCORE | |
| YES (1) | NO (0) |
| Preparation of workplace |  |  |
| Cleanness of workplace are indicated |  |  |
| PPE are respected |  |  |
| Safety measurement are respected |  |  |
| Sign posts for safety are mentioned |  |  |

# References

Blvd, 5. F. (2017). *METHOD OF TEST FOR SAND EQUIVALENT.* CALIFORNIA: Sacramento, California 95819-4612.

NIKOLAIDES\*, A., & M. SARAFIDOU, E. (2007). *SAND EQUIVALENT AND METHYLENE BLUE VALUE OF.* Thessaloniki: Aristotle University of Thessaloniki.

*Soil and Aggregate Sample Preparation.* (2011). California: BUSINESS, TRANSPORTATION AND HOUSING AGENCY.

# 

# Learning Unit 2: Determine quantity of clay and silt in sand

|  |
| --- |
| **Picture/s reflecting the Learning unit 2**  Sample in Graduated Cylinder  **Picture 2.1: Representing the quantity of clay and silt in sand** (Richardson & Lusher, 2016) |

# STRUCTURE OF LEARNING UNIT 2

|  |
| --- |
| **Learning outcomes:**  **2.1. Deposit sample in the measuring cylinder**  **2.2. Check the materials in the measuring cylinder**  **2.3. Place the measuring cylinder in 20 minutes for settling and check the level of sand** |

## Learning outcome 2.1 Deposit sample in the measuring cylinder

|  |  |  |
| --- | --- | --- |
| **Duration: 10hrs** | | |
| Learning outcome 2.1 Objectives: By the end of the learning outcome, the trainees will be able to:  1. To split the sample used in Sand equivalent test and depositing it in measuring cylinder  2. To dampen the material to avoid segregation of loss of fines during sand equivalent  3. To identify materials used to conduct the test | | |
| **Resources** | | |
| **Equipment** | **Tools** | **Materials** |
| Oven  Timer  [Sand Equivalent Shakers](https://www.globalgilson.com/sand-equivalent-shakers)  Sample Splitters | Plastic cylinder  Rubber stopper  Measuring tin  Scoop  Siphon assembly  Irrigator Tube  [Weighted Foot Assembly](https://www.globalgilson.com/weighted-foot-assembly-for-sand-equivalent-test)  Measuring Tin | Stock solution made of:  Calcium chloride  Formaldehyde and  Glycerine solution  Mixed with distilled water to get work solution  Fine aggregate |
| **Advance preparation:**   * Having prepared materials used to conduct test. * Having arranged tools, equipment and materials according to the task to be performed. * Having made trainee’s groups in order to facilitate them to work in good conditions. | | |

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### Content 1 Guideline for deposing sample into measuring Cylinder:

|  |
| --- |
| * Split enough material to fill four tin measures to the brim or slightly: provide the most accurate samples when preparing test specimens. The test method tolerates some manual sample dividing methods, but a mechanical splitter has a clear advantage in producing a representative sample. * dampen the material to avoid segregation of loss of fines during the splitting or quartering operations. * Use care in adding moisture to the sample to retain a free flowing condition of the material |

### Theoretical learning Activity

* Learners group will discuss on the best ways of depositing sample into measuring cylinder
* After that task, each group will share what they did to explain more.

### Practical learning Activity

* Trainees in groups will conduct practical exercises on pouring sample into measuring cylinder by using open funnel**.**
* After that task, each group will represent what they did to explain more

Points to Remember (Take home message)

|  |
| --- |
| * Split enough material to fill four tin measures to the brim or slightly. * dampen the material to avoid segregation of loss of fines during the splitting. * Use care in adding moisture to the sample to retain a free flowing condition of the material. |

## 

## **Learning outcome 2.1.1 formative assessment**

**Written assessment**

**Assessment tools**

1. While pouring the prepared test specimen from the measuring tin into the plastic cylinder**, we Use the open funnel** to avoid spillage **“True”**
2. Release air bubbles and promote thorough wetting by bumping the base of the plastic cylinder against a firm object while the test specimen is being poured into the plastic cylinder or by tapping the plastic cylinder sharply on the heel of the hand several times after the test specimen has been poured in. **“True”**
3. Allow the wetted material to stand undisturbed for 20 min ± 3 min **“False”**
4. **Choose the correct statement**
5. Allow the wetted material to stand undisturbed for 15 min ± 3 min
6. Allow the wetted material to stand undisturbed for 30 min ± 5 min
7. **Allow the wetted material to stand undisturbed for 10 min ± 1 min**
8. Allow the wetted material to stand undisturbed for 20 min ± 4 min
9. How Pour the prepared test specimen from the measuring tin into the plastic cylinder

**Answer:**

**By Using the open funnel**

* **Assessment tools**

1. As trainer, select tools and equipment used while conducting Sand equivalent test and ask the trainees to assembly and explain them one by one.

* **Observation checklist**

|  |  |  |
| --- | --- | --- |
| CHECK LIST | SCORE | |
| YES (1) | NO (0) |
| Deposition of sample |  |  |
| Segregation of material are respected |  |  |
| Quality of the sand are indicated |  |  |
| Quantity of the sand are mentioned |  |  |
| Quantity of solution are respected |  |  |

## Learning outcome 2.2. Shake the materials in the measuring cylinder

|  |  |  |
| --- | --- | --- |
| **Duration: 10Hrs** | | |
| Learning outcome 2.2 objectives: By the end of the learning outcome, the trainees will be able to:  1. To place the stoppered cylinder in the mechanical sand equivalent shaker,  2. To set the time, and allow the machine to shake the cylinder and the contents for 45 ± 1 second.  3. To Secure the stoppered cylinder in the three spring clamps on the carriage of the hand operated sand equivalent shaker and reset the stroke counter to zero. | | |
| **Resources** | | |
| **Equipment** | **Tools** | **Materials** |
| Oven  Sample Splitters | Gallon  Measuring tin  Scoop  Measuring Tin | Stock solution made of:  Calcium chloride  Formaldehyde and  Glycerine solution  Mixed with distilled water to get work solution  Fine aggregate |
| **Advance preparation:**   * Having prepared fine aggregate used for testing. * Having prepared working solution used for separating sand from clay during testing. * Having made trainee’s groups in order to facilitate them to work in good conditions. | | |

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### Content 1: Mechanical Shaking Method

|  |
| --- |
| * place the stoppered cylinder in the mechanical sand equivalent shaker, set the time, and allow the machine to shake the cylinder and the contents for 45 ± 1 second * continue the shaking action for 100 strokes |

### Theoretical learning Activity

* Learners will discuss on how to connect stoppered cylinder within shaker machine
* After that task, the student will share what they did to explain more.

### Practical learning Activity

1. Groups Practical exercises on shaking of material in measuring cylinder by using mechanical shaker machine**.**
2. After that task, each group will discuss what they did to explain more.

**Points to Remember (Take home message)**

|  |
| --- |
| * Place the stoppered cylinder in the mechanical sand equivalent shaker, set the time, and allow the machine to shake the cylinder and the contents for 45 ± 1 second. * Continue the shaking action for 100 strokes |

### Topic 2: Manual Shaking Method

|  |
| --- |
| * Secure the stoppered cylinder in the three spring clamps on the carriage of the hand operated sand equivalent shaker and reset the stroke counter to zero. * Tighten the screw to hold the cylinder * Apply enough force to the right-hand spring steel strap during the thrust portion of each stroke to move the pointer to the stroke limit marker by pushing against the strap with the ends of the fingers to maintain a smooth oscillating motion. * Hold the cylinder in a horizontal position and shake it vigorously (forcefully) in a horizontal linear motion from end to end. * Shake the cylinder 90 cycles in approximately 30 seconds using a throw of   9 ± 1 in. (229 ± 25 mm). A cycle is defined as a complete back and forth motion.  To shake the cylinder at this speed properly, it will be necessary for the operator  to shake with the forearms only, relaxing the body and shoulders. |

### Theoretical learning Activity

* Discussion on the ways of connecting stoppered cylinder within manual shaker machine
* Trainees brainstorming on how to use manual shaker machine.
* After that task, the trainees will share what they did to explain more.

### Practical learning Activity

1. Groups work of shaking material in measuring cylinder by using manual shaker machine**.**
2. After that task, each group will share what they did to explain more.

Points to Remember (Take home message)

|  |
| --- |
| * Secure the stoppered cylinder in the three spring clamps on the carriage of the hand operated sand equivalent shaker and reset the stroke counter to zero. * Apply enough force to the right hand spring steel strap during the thrust portion of each stroke to move the pointer to the stroke limit marker by pushing against the strap with the ends of the fingers to maintain a smooth oscillating motion. |

## Learning outcome 2. 2 formative assessment

**Written assessment**

**Assessment tools**

1. The flow used while shaking the cylinder in the mechanical shaker machine is around 9 ± 1 in. (229 ± 25 mm). **“True”**
2. The purpose of shaking the plastic cylinder with sample is to separate sample from flocculating solution. **“False”**
3. **Choose the shaking cycle and time taken to shake sample in graduated cylinder by using manual shaker machine**
4. Shake the cylinder 60 cycles in approximately 50 seconds
5. Shake the cylinder 80 cycles in approximately 40 seconds
6. **Shake the cylinder 90 cycles in approximately 30 seconds**
7. Shake the cylinder 40 cycles in approximately 30 seconds
8. The graduated cylinder with solution and sample is hold in the shaker machine in which manner
9. Hold the cylinder in a vertical position and shake it vigorously (forcefully) in a horizontal linear motion from end to end.
10. **Hold the cylinder in a horizontal position and shake it vigorously (forcefully) in a horizontal linear motion from end to end.**
11. Hold the cylinder in an oblique position and shake it vigorously (forcefully) in a horizontal linear motion from end to end.
12. Explain why is better to use mechanical shaker than using manual shaker

**Answer:**

**Economy and manual shakers are easy to set up and use anywhere, and a motorized shaker removes any operator error, optimizes accuracy, and produces the most consistent results.**

* **Assessment tools**

1. As trainer, guide the trainees to select the machine used to shake material and allow them to shake the prepared sample by using that machine.

* **Observation checklist**

|  |  |  |
| --- | --- | --- |
| CHECK LIST | SCORE | |
| YES (1) | NO (0) |
| Shook material by using shaker |  |  |
| The shaker machine is selected |  |  |
| Homogeneity of material are achieved |  |  |
| Time to shake material are respected |  |  |
| Position of measuring cylinder are respected |  |  |

## Learning outcome 2.3. Place the measuring cylinder for settling after checking and check the level of sand

|  |  |  |
| --- | --- | --- |
| **Duration: 5hrs** | | |
| Learning outcome 2.3 objectives: At the end of this content the learn should be able to By the end of the learning outcome, the trainees will be able to:   1. Set efficiently the cylinder to stand undisturbed for 20 min ± 15 s from the time the irrigation is completed 2. Determine correctly the clay reading comparing to the sand reading 3. Record properly the result of reading on testing sheet | | |
| **Resources** | | |
| **Equipment** | **Tools** | **Materials** |
| Oven  Timer  Sample Splitters | Measuring tin  Irrigator tube  Scoop  Measuring Tin  Siphon  Rubber stopper  Funnel  Plastic cylinder | Stock solution made of:  Calcium chloride  Formaldehyde and  Glycerine solution  Mixed with distilled water to get work solution  Fine aggregate |
| **Advance preparation:**   * Having prepared workbench or table free of vibration. * allow the plastic cylinder and contents to stand undisturbed. * Having made trainee’s groups in order to facilitate them to work in good conditions. | | |

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### Content 1: Process of sand level Determination

|  |
| --- |
| PERFORMING THE SAND EQUIVALENT TEST:   1. Set up the workstation so that the glass bottle containing the working calcium chloride solution sits 3 ft. ± 1 in. (912 ± 25 mm) above the work surface. 2. Siphon 2 ± 0.1 in. (101.6 ± 2.5 mm) of the working calcium chloride solution into the plastic cylinder. Check the agitator tube to be certain that the solution flows freely. 3. Transfer the sample from the measuring can into the plastic cylinder using the small funnel. 4. Stopper the cylinder. 5. Tap the bottom of the cylinder on the heel of the hand several times to remove air bubbles and promote thorough wetting of the sample. 6. Remove stopper. 7. Wash particles clinging to wall of cylinder into the mixture, using a minimum amount of solution. 8. Allow the cylinder with contents to stand undisturbed, free of any vibration, for 10 ± 1 minutes. 9. Replace stopper in the end of cylinder. 10. Partially invert cylinder and shake to dislodge material from the bottom. 11. Place stoppered cylinder in the mechanical sand equivalent shaker and set the timer. 12. Allow machine to shake the cylinder and contents for 25 ± 1 seconds. 13. Following the mixing operation, place the cylinder on the worktable. 14. Remove stopper. 15. Wash down the cylinder wall with the agitator tube. 16. Force the agitator through the material to the bottom of the cylinder by gently twisting and shoving while the solution flows from the tip of the tube. 17. Continue smoothly jabbing the agitator tube up and down with a gentle twisting motion while slowly rotating the cylinder in a vertical position to flush the fine clay-like material into suspension above the coarse sand particles. Continue the operation until the cylinder is filled to the 15 in. (381 mm) mark. 18. Slowly remove the agitator tube without shutting off the flow, so the level of the liquid is maintained at 15 in. (381 mm). 19. Regulate the flow of the solution and adjust the level of solution to 15 in. (381 mm) when the agitator tube is entirely withdrawn. 20. Allow the cylinder and contents to stand undisturbed for 20 minutes ± 15 seconds. Start the timing immediately after the removal of the agitator tube. 21. After the 20-minute sedimentation period, read the level of the top of the clay suspension and record as the clay reading. 22. If there is no clear line of demarcation or clay meniscus at the end of the 20-minute   sedimentation period, allow the material to stand undisturbed until the division is clear.   1. Read and record the level of the clay meniscus and the total sedimentation time.   Note 6—If the total sedimentation time exceeds 30 minutes, rerun the test using three more samples of the same material. Use the clay reading obtained from sample with the shortest sedimentation time.   1. When using the weighted foot assembly with sand reading indicator, gently lower the foot assembly into the cylinder until it comes to rest on the sand. Very gently tilt the assembly until the indicator touches the graduation marks on the cylinder. Tilt assembly back to vertical before taking reading. Read the level indicated by the top edge of the indicator and subtract 10 in. (252 mm) Record this reading as the sand reading. 2. When using the weighted foot assembly with no sand reading indicator, gently lower the weighted foot assembly in the cylinder until it comes to rest on top of the sand. Keep one of the centering screws in contact with the cylinder wall near the graduation marks while lowering the foot assembly so that the centering screw remains visible. Read the middle of the centering screw, and record this reading as the sand reading.   If the clay or sand readings fall between two divisions on the graduated cylinder, round up to the nearest marked interval (e.g., 8.68 = 8.7 in., 6.21 = 6.3 in.)  Calculation  1. Calculate the sand equivalent to the nearest 0.1 % as follows:  SE= (sand reading/clay reading) X 100  where:  SE = sand equivalent   * If the calculated sand equivalent is not a whole number, report it as the next higher   whole number. For example, if the sand equivalent were calculated from the example in 12 above, the calculated sand equivalent would be: (3.3/8.0) X 100 = 41.2  Since this calculated sand equivalent is not a whole number it would be reported as  the next higher whole number which is 42.   * If it is desired to average a series of sand equivalent values, average the whole   number value determined as described above. If the average of these values is not  a whole number, raise it to the next higher whole number as shown in the following  example:  • Calculate SE values: 41.2, 43.8, 40.9.  • After raising each to the next higher whole number they become 42, 44, 41.  • Determine the average of these values as follows: (42 + 44 + 41)/3 = 42.3  • Since the average value is not a whole number, it is raised to the next higher whole number, and the sand equivalent value is reported as 43.  **Common Testing Errors**     * Calcium Chloride Solution not mixed properly, used outside of the temperature range or not checked for organic growth. * Vibrations or jarring while sample is settling out in the solution. * Improper sample preparations (splitting & test sample preparations.) * Solution exposed to direct sunlight. * Sample not irrigated correctly. * Sample not shaker properly in graduated cylinder. |

### Theoretical learning Activity

* Group discussion about the process of conducting sand equivalent test with respect the procedures.
* Learners group will discuss on how to calculate the result of SE.
* After that task, facilitator will help the trainees to share what they did in the group.

### Practical learning Activity

* Learners group work of conducting sand equivalent test and calculation of result.
* After that task, each group will interpret the result.

Points to Remember (Take home message)

|  |
| --- |
| * Secure the stoppered cylinder in the three spring clamps on the carriage of the hand operated sand equivalent shaker and reset the stroke counter to zero. * Following the shaking operation * Remove the stopper. * Allow the cylinder and contents to stand undisturbed for 20 min ± 15 seconds. * Start the timing immediately after withdrawing the irrigator tube. * Level of sand determination. * Use tape measure. |

## **Learning outcome 2.3. 1 formative assessment**

**Written assessment**

**Assessment tools**

1. The flocculating solution forces the clayey materials into suspension above the granular aggregate. **“True”**
2. Working Solution, or flocculating solution, is prepared from the concentrated stock solution by mixing 850ml of the stock solution into 1.0gal (3.8L) of distilled or demineralized water. **“False”**
3. Choose the minimum materials in gram prepared during Sand equivalent test
4. 2000g
5. 5000g
6. **1500g**
7. 3000g
8. The stock solution used in sand equivalent is composed by:
9. **Concentrated mixture of calcium chloride, formaldehyde in glycerine solution**
10. Acidic methylene blue solution.
11. formaldehyde diluted with distilled water
12. A buffer solution
13. Explain why is important to use flocculating solution during implementation of sand equivalent test?

**Answer:**

**Because, it helps in the separation of clay from sand**

* **Assessment tools**

1. As trainer, select material, tools and equipment used while conducting Sand equivalent test and ask the trainees to use it in their distinguished groups.

* **Observation checklist**

|  |  |  |
| --- | --- | --- |
| CHECK LIST | SCORE | |
| YES (1) | NO (0) |
| Placed measuring cylinder after shaking |  |  |
| Material and solution used are selected |  |  |
| Tools and equipment used are selected |  |  |
| Separation of sand silt are observed |  |  |
| Level of sand are recorded |  |  |
| Level of silt are recorded |  |  |

# References

Blvd, 5. F. (2017). *METHOD OF TEST FOR SAND EQUIVALENT.* CALIFORNIA: Sacramento, California 95819-4612.

NIKOLAIDES\*, A., & M. SARAFIDOU, E. (2007). *SAND EQUIVALENT AND METHYLENE BLUE VALUE OF.* Thessaloniki: Aristotle University of Thessaloniki.

*Soil and Aggregate Sample Preparation.* (2011). California: BUSINESS, TRANSPORTATION AND HOUSING AGENCY.

# Learning Unit 3: Make a report

|  |
| --- |
| [Pouring a sample into the graduated cylinder](http://www.pavementinteractive.org/wp-content/uploads/2011/04/Pouring.jpg)  **Figure3.1: Sample pouring in graduated cylinder** (E.Backus) |

# STRUCTURE OF LEARNING UNIT

|  |
| --- |
| **Learning outcomes:**   * 1. **Fill working sheet**   2. **Identify sand equivalent test report elements**   3. **Describe the final result** |

**Learning outcome 3.1. Fill working sheet**

|  |  |  |
| --- | --- | --- |
| **Duration: 1hrs** | | |
| Learning outcome 3.1 objectives: By the end of the learning outcome, the trainees will be able to:  1. Identify correctly Sand Equivalent Test working sheet contents.  2. Fill out effectively Sand Equivalent working sheet as required. | | |
| **Resources** | | |
| **Equipment** | **Tools** | **Materials** |
| calculator | Working sheet | Pencil  Paper  Pens |
| **Advance preparation:**  . prepare working sheet to be used  . Having a calculator  . Having pen to be used in recording | | |

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### Content 1.: Identification of Sand equivalent test working sheets’ contents

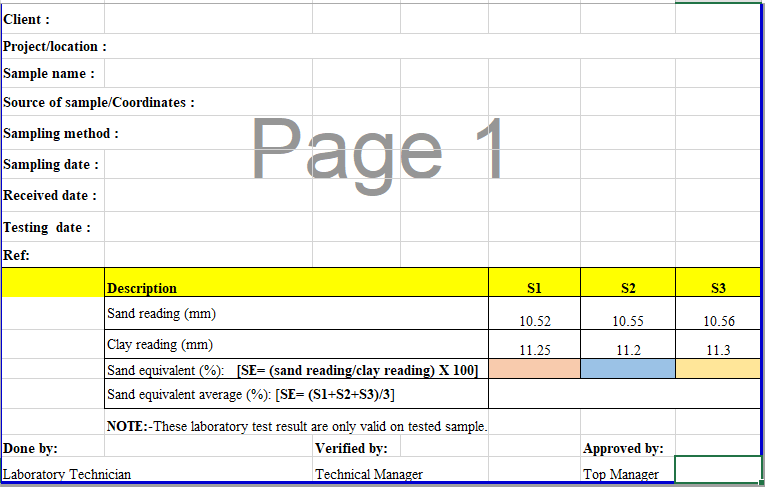
|  |
| --- |
| * Contents of Sand equivalent test working sheets: * Title * Project * Lab no * date * location * Client * Company name * Responsible technician * Approver * Checker * Test method * Depth * Target sand equivalent * Present sand equivalent Values   **Sand Equivalent Sheet** |
|  |
|  |

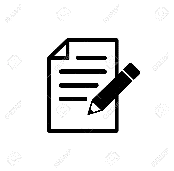
### Theoretical learning Activity

* **Within the pair groups:**
* Ask trainees to discuss about working sheet elements

### Practical learning Activity

* After performing sand equivalent test, Trainees in pair groups fill the working sheet below by calculating SE for each point and their average.



**Points to Remember (Take home message)**

|  |
| --- |
| * Contents of Sand equivalent test working sheet * Title * Project * Lab no * date * location * Client * Company name * Responsible technician * Approver * Checker * Test method * Depth * Target sand equivalent * Present sand equivalent Values |

**Learning outcome 3.2. Identify sand equivalent test report elements**

|  |  |  |
| --- | --- | --- |
| **Duration:1 hrs** | | |
| Learning outcome 3.2 objectives: By the end of the learning outcome, the trainees will be able to:  1. Enumerate four(4) report elements of Sand Equivalent test  2. Interpret correctly Sand Equivalent Test element by reading | | |
| **Resources** | | |
| **Equipment** | **Tools** | **Materials** |
| **calculator** | **Working sheet** | **Pencil**  **Paper**  **Pens** |
| **Advance preparation:**  . Prepare working sheet to be used  . Having a calculator  . Having pen to be used in recording | | |

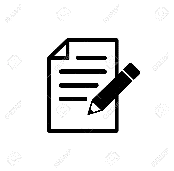
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## Content 1: Identification of types of sand equivalent test report elements

|  |
| --- |
| * Types of sand equivalent test elements * Sand level * Silt level * Types of material and sample identification * Reference of this procedure * Percentage value of sand equivalent * **MEASUREMENTS**   Leave each graduated cylinder to settle, without disturbance and free from vibration, for (20,00 ± 0,25) min. At the end of this period, using the rule, measure the height h1 of the upper level of the flocculate relative to the base of the graduated cylinder (see Figure 2). Carefully lower the plunger assembly into the cylinder, until the end piece rests on the sediment. Locate the collar on top of the cylinder and then lock it onto the plunger rod. Determine the height of sediment h2 by measuring the distance between the lower face of the plunger head and the upper face of the collar using the graduated rule inserted into the slot in the collar (see Figure 2). Record the heights h1 and h2 to the nearest millimeter. Measure and record heights h1 and h2 in the same manner with the second cylinder.   * **CALCULATION AND EXPRESSION OF RESULTS**   Calculate the ratio (h2/h1) \* 100 for each cylinder to one decimal place. If the two values differ by more than 4 the test procedure shall be repeated. Calculate the sand equivalent value (SE) as the average of the ratios (h2/h1) \*100 obtained on each cylinder and record to the nearest whole number.      **Figure 3.2 : Sand and Clay Reading** (E.Backus) |

### Theoretical learning Activity

* **Trainees brainstorm about types of sand equivalent test report elements**

Points to Remember (Take home message)

|  |
| --- |
| * Types of sand equivalent test elements * Sand level * Silt level * Types of material and sample identification * Reference of this procedure * Percentage value of sand equivalent |

**Learning outcome 3.3. Describe the final result**

|  |  |  |
| --- | --- | --- |
| **Duration: 1 hr** | | |
| Learning outcome 3.3 objectives: By the end of the learning outcome, the trainees will be able to:  1. Describe correctly types of decision to be taken in Sand Equivalent Test  2. Enumerate two side effects of low Sand Equivalent Test. | | |
| **Resources** | | |
| **Equipment** | **Tools** | **Materials** |
| **calculator** | **Working sheet** | **Pencil**  **Paper**  **Pens** |
| **Advance preparation:**  . prepare working sheet to be used  .Having a calculator  .Having pen to be used in recording | | |

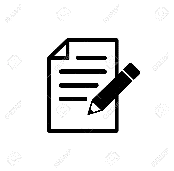
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### Content 1: Description of decision’s types for Sand equivalent test results

|  |
| --- |
| * Types of decisions * Rejected materials; According to the results and standard referred to the material can be rejected when it is not matching with required conditions. * Acceptable materials: According to the results and standard referred to the material can be accepted when it is matching with required conditions.   **Effect of low sand equivalent**  • Clay like material are small particles in the size of clay particles that are deleterious to asphalt concrete.  • The presence of clay in fine aggregate can have detrimental effect on water sensitivity of asphalt concrete mix.  • Clay like materials have the tendency to form layers around the aggregate such that the asphalt binder sticks to this layer instead of the aggregate.  • These materials can coat aggregate particles and prevent proper asphalt binder-aggregate bonding.  • Problems Caused by clay-like material:   * Rutting.is **a permanent, longitudinal surface depression that occurs in the wheel paths of a flexible pavement due to the passage of traffic**. * Moisture damage. * Stripping in the pavement. is **the weakening or eventual loss of the adhesive bond between the aggregate surface and asphalt binder in the asphalt mix due to the presence of moisture**? |

### Theoretical learning Activity

* Trainees in pair group brainstorm about decision to be taken after performing Sand Equivalent Test
* Trainees in pair discuss about the effects of low Sand Equivalent Test

Points to Remember (Take home message)

|  |
| --- |
| * Types of decisions * Rejected materials; * Acceptable materials |

## **Learning Unit 3 formative assessment**

**Written assessment**

1. Multiple choice (Choose the correct answer):

The following list contains element of Sand Equivalent Test working sheet except:

1. Company name
2. Responsible technician
3. Approver
4. **Dipth**
5. None of them
6. True False question: Answer with true for the correct answer and False for the wrong answer.

The following list contains Sand Equivalent Test report elements:

1. Types of sand equivalent test elements **True**
2. Types of material and sample identification **True**
3. Reference of this procedure **True**
4. Percentage value of sand equivalent True
5. Open ended questions
6. Discuss on side effects of low Sand Equivalent Test
7. Explain two types of decision taken after Performing sand Equivalent Test

**Practical assessment**

1. Kigali city want to construct road in residential areas whereby the Aible construction Ltd Company won a tender to construct it. As laboratory technician you are requested to perform Sand Equivalent Test on three (3) different points randomly and make a report by completing working sheet.

* **Observation checklist**

|  |  |  |  |
| --- | --- | --- | --- |
| CHECK LIST | | SCORE | |
| YES (1) | NO (0) |
| Laboratory name is mentioned | |  |  |
| Test name is indicated | |  |  |
| Test method is indicated | |  |  |
| Client name is mentioned | |  |  |
| Source of sample/Coordinates is indicated | |  |  |
| Sampling method is indicated | |  |  |
| Sampling date is indicated | |  |  |
| Received date is indicated | |  |  |
| Testing date is indicated | |  |  |
| Reference is indicated | |  |  |
| Sand reading (mm) is mentioned | |  |  |
| Clay reading (mm) is mentioned | |  |  |
| Sand equivalent (%) is calculated | |  |  |
| Sand equivalent average (%) is calculated | |  |  |
| Marks | | ……/14 | |
| Observation | | | |
| Competent | Not Yet Competent | | |

# References:

**Saskathewan, & Transportation, H. (1993). *Standard Test Procedure Manual for Sand Equivalent Test.* Saskathewan; Highway and Transportation.**

**WSDOT. (2020). *WSDOT Errata to FOP for AASHTO T 176.* WSDOT Materials Manual.**

Blvd, 5. F. (2017). *METHOD OF TEST FOR SAND EQUIVALENT.* CALIFORNIA: Sacramento, California 95819-4612.

E.Backus, B. (n.d.). Sand equivalent test method. In *2011.* California: Gilson Company.

NIKOLAIDES\*, A., & M. SARAFIDOU, E. (2007). *SAND EQUIVALENT AND METHYLENE BLUE VALUE OF.* Thessaloniki: Aristotle University of Thessaloniki.

Richardson, & Lusher. (2016). *HMA AGGREGATE TESTS.* HMA AGGREGATE CONSENSUS.

Sand Equivalent Test Set. (n.d.). www.controls-group.com.

*Soil and Aggregate Sample Preparation.* (2011). California: BUSINESS, TRANSPORTATION AND HOUSING AGENCY.