

# How Do We Find D60 And D10 From The Grain Size Distribution Curve In Excel?

## How Do We Find D60 And D10 From The Grain Size Distribution Curve In Excel?

Understanding the grain size distribution of soils is fundamental in geotechnical engineering, sedimentology, and material science. It provides crucial insights into soil stability, permeability, compaction, and suitability for construction projects. Among the various parameters derived from grain size analysis, D10 and D60 are particularly important. They represent the particle diameters at which 10% and 60% of the soil sample's particles are finer, respectively. These parameters help classify soil types, evaluate filtration potential, and assess soil behavior under load.

In practical applications, especially when working with lab data or field samples, researchers and engineers often rely on Excel to analyze grain size distribution curves. This article provides a comprehensive, step-by-step guide on how to find D10 and D60 directly from a grain size distribution curve in Excel, ensuring accuracy and efficiency in your analysis.

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## Understanding Grain Size Distribution and Its Significance

Before diving into the Excel procedures, it's essential to grasp what grain size distribution entails and why D10 and D60 are critical.

### What Is Grain Size Distribution?

Grain size distribution describes the proportions of different particle sizes within a soil or sediment sample. It is typically expressed as a percentage finer than a specific particle size (fines percentage), resulting in a curve that plots particle size against cumulative percentage finer.

### Why Are D10 and D60 Important?

- D10: The particle diameter at which 10% of the particles are finer. It indicates the smaller particle size threshold and influences permeability and filtration properties.
- D60: The particle diameter at which 60% of the particles are finer. It reflects the coarser end of the distribution and helps classify soil types (e.g., gravel, sand, silt, clay).

These parameters are used to compute coefficients like the coefficient of uniformity ( $C_u$ ) and coefficient of curvature ( $C_c$ ), which are vital for soil classification and engineering design.

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# Preparing Data for Analysis in Excel

To find D10 and D60 from the grain size distribution curve, you must have the following data:

1. Particle Size (D): The particle diameter in millimeters or micrometers.
2. Percent Finer (F%): The cumulative percentage of particles finer than each size.

Typically, this data is obtained from laboratory sieve analysis or hydrometer tests and organized in two columns.

## Sample Data Format

| Particle Size (D) | Percent Finer (F%) |
|-------------------|--------------------|
| 4.75 mm           | 100                |
| 2 mm              | 90                 |
| 1 mm              | 80                 |
| 0.5 mm            | 70                 |
| 0.25 mm           | 50                 |
| 0.125 mm          | 30                 |
| 0.075 mm          | 10                 |
| 0.045 mm          | 5                  |

Ensure your data is complete and accurately reflects the grain size analysis.

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## Plotting the Grain Size Distribution Curve in Excel

Visualization helps in understanding the distribution, but for precise D10 and D60 values, interpolation is necessary.

## Steps to Plot the Distribution Curve

1. Input Data: Enter particle sizes in one column and corresponding percent finer in the adjacent column.
2. Create a Scatter Plot:
  - Select your data.
  - Insert a scatter plot (without lines).
3. Add Trendline:
  - Right-click on data points.
  - Choose "Add Trendline."
  - Select a suitable fit (usually logarithmic or polynomial).
4. Display Equation & R-squared:

- Check options to display the trendline equation and R-squared value.

The trendline provides a mathematical model of the distribution curve, enabling interpolation of D10 and D60.

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## Finding D10 and D60 Using Interpolation in Excel

Since the grain size distribution curve is typically nonlinear, simple reading from the graph is insufficient for accuracy. Instead, interpolation based on the trendline equation is used.

### Method 1: Using the Trendline Equation

Suppose the trendline equation is:

$$\log(D) = a (F\%) + b$$

or in some cases, a polynomial:

$$\log(D) = c (F\%)^2 + d (F\%) + e$$

1. Identify the Equation: After plotting, note the equation displayed on the chart.
2. Solve for D at F% = 10 and 60:
  - Rearrange the equation to solve for D:

$$D = 10^{\{(a F\% + b)\}} \text{ (if linear in log scale)}$$

3. Calculate D10 and D60:
  - Substitute F% = 10 and F% = 60 into the equation.
  - Use Excel formulas to compute these values.

Example:

If the trendline equation is:

$$\log(D) = -0.5 F\% + 1$$

- For F% = 10:
  - $\log(D) = -0.5 \cdot 10 + 1 = -5 + 1 = -4$
  - $D = 10^{-4} = 0.0001 \text{ mm}$
- For F% = 60:
  - $\log(D) = -0.5 \cdot 60 + 1 = -30 + 1 = -29$
  - $D = 10^{-29} \text{ mm}$  (which is physically unreasonable, indicating the need for a better fit or a different model)

Note: Usually, a logarithmic or polynomial trendline better models the data. The key is to use the equation and solve for D at desired F%.

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## Method 2: Direct Interpolation from Data Points

If you prefer not to rely on trendline equations, you can interpolate directly from your data:

1. Identify the two data points between which the F% crosses 10% and 60%.
2. Locate the data points:
  - For F% just below 10% and just above 10%, note their corresponding D.
  - For F% just below 60% and just above 60%, note their corresponding D.
3. Use Linear Interpolation Formula:

$$D_{\text{target}} = D_{\text{lower}} + \left( \frac{F_{\text{target}} - F_{\text{lower}}}{F_{\text{upper}} - F_{\text{lower}}} \right) \times (D_{\text{upper}} - D_{\text{lower}})$$

Where:

- $F_{\text{target}}$  is 10 or 60.
- $D_{\text{lower}}$  and  $D_{\text{upper}}$  are the particle sizes corresponding to F% just below and above the target percentage.

Example:

Suppose for F% = 5% and 30%:

- D at 5% = 0.045 mm
- D at 30% = 0.125 mm

To find D10:

- F% crosses 10% between 5% and 30%
- Apply the interpolation:

$$D_{10} = 0.045 + \left( \frac{10 - 5}{30 - 5} \right) \times (0.125 - 0.045) = 0.045 + \left( \frac{5}{25} \right) \times 0.08 = 0.045 + 0.016 = 0.061 \text{ mm}$$

Similarly, interpolate for D60.

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# Automating the Calculation in Excel

To streamline the process, you can set up formulas for interpolation:

1. Identify the bounding data points for F% just below and above 10% and 60%.
2. Use the `FORECAST.LINEAR` Function:

```
```excel
=FORECAST.LINEAR(Target_F%, F_Percentages, D_Particle_Sizes)
```
```

For example, to find D10:

```
```excel
=FORECAST.LINEAR(10, F_Column, D_Column)
```
```

This function interpolates the D value corresponding to F% = 10%, based on your data.

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## Calculating Coefficient of Uniformity (Cu) and Coefficient of Curvature (Cc)

Once D10 and D60 are determined, they can be used to classify soil:

- Coefficient of Uniformity (Cu):

$$Cu = \frac{D_{60}}{D_{10}}$$

- Coefficient of Curvature (Cc):

$$Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$$

Where D30 is the particle size at 30% finer, found similarly through interpolation.

These parameters help categorize soil types using the Unified Soil Classification System (USCS).

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# Conclusion

Finding D10 and D60 from the grain size distribution curve in Excel involves understanding your data, plotting the distribution, and applying interpolation techniques either through trendline equations or direct data point analysis. By following these steps, engineers and geoscientists can accurately derive critical soil parameters essential for classification and engineering design.

Whether you prefer a graphical approach with trendlines or a data-driven method with interpolation formulas, Excel offers versatile tools to perform these calculations efficiently. Proper application of

## Frequently Asked Questions

### **What is D10 and D60 in the context of grain size distribution curves?**

D10 and D60 are grain size diameters at which 10% and 60% of the soil sample's particles are finer, respectively. They are key parameters used to describe the particle size distribution and are essential for soil classification and engineering applications.

### **How can I identify D10 and D60 from a grain size distribution curve in Excel?**

You can identify D10 and D60 by locating the points on the cumulative percentage curve where the values are 10% and 60%. Draw horizontal lines at these percentages, then find where they intersect the curve. The corresponding grain sizes at these intersections are D10 and D60.

### **What steps should I follow in Excel to calculate D10 and D60 from the grain size distribution data?**

First, organize your data with grain sizes and cumulative percentages. Use interpolation to find the grain sizes corresponding to 10% and 60% cumulative percentages. You can do this by applying the INTERPOLATE function or manually interpolating between data points near these percentages.

### **Can I use Excel functions like VLOOKUP or TREND to find D10 and D60?**

While VLOOKUP may not directly work for interpolated values, you can use TREND or LINEST to create a trend line for your data and then solve for the grain sizes corresponding to 10% and 60%. Alternatively, manual interpolation provides more accurate results.

### **Why is interpolation necessary when finding D10 and D60 from the distribution curve?**

Interpolation is necessary because the cumulative percentage values may not exactly match 10% or

60% in your data points. Interpolating allows you to estimate the precise grain size at these specific percentages by analyzing the data between known points.

## **Are there any Excel templates or tools available to automate the calculation of D10 and D60?**

Yes, many geotechnical and soil analysis templates are available online that include automated calculations for D10 and D60. These templates often incorporate interpolation formulas and plotting tools to streamline the process. Alternatively, custom Excel macros can be created for automation.

## **Additional Resources**

How Do We Find D60 And D10 From The Grain Size Distribution Curve In Excel?

Understanding the grain size distribution of soils is fundamental in geotechnical engineering, sedimentology, and material science. Among the critical parameters derived from grain size distribution curves are D10 and D60, which represent the grain diameters corresponding to 10% and 60% finer particles, respectively. These values are essential for characterizing soil behavior, permeability, compaction, and stability. The process of extracting D10 and D60 from a grain size distribution curve in Excel involves several steps, from data preparation to graphical analysis and calculation. This article provides a comprehensive guide on how to accurately determine these parameters, with detailed explanations, practical tips, and common pitfalls to avoid.

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## **Understanding Grain Size Distribution and Its Importance**

Before delving into the calculation process, it's crucial to understand what grain size distribution (GSD) represents. GSD is a graphical representation that shows the proportion of soil particles of different sizes within a sample. Usually, the data is presented as a cumulative percentage of particles finer than a specific size (percent finer) versus particle size (diameter).

Why are D10 and D60 important?

- D10 indicates the particle size below which 10% of the soil particles are finer. It reflects the fine-grained portion of the soil and influences filtration and permeability.
- D60 indicates the particle size below which 60% of the soil particles are finer. It helps determine the coefficient of uniformity, which indicates the range of particle sizes in the soil.

Applications include:

- Soil classification (such as the Unified Soil Classification System)
- Permeability and filtration properties
- Soil strength and compaction characteristics

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## Preparing Data for Excel Analysis

The initial step involves organizing your data properly in Excel.

### Data Collection

Typically, grain size data is obtained experimentally through sieve analysis or hydrometer tests. The data should include:

- Particle sizes (e.g., in mm or phi units)
- Corresponding cumulative percent finer (from 0% to 100%)

Sample data format:

| Particle Size (mm) | Percent Finer (%) |
|--------------------|-------------------|
| 4.75               | 100               |
| 2.00               | 85                |
| 1.00               | 70                |
| 0.50               | 50                |
| 0.25               | 30                |
| 0.125              | 10                |
| 0.0625             | 5                 |

Ensure data is sorted in descending order of particle size (from coarser to finer).

Tip: For better accuracy, use at least 10-20 data points covering the entire distribution.

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## Plotting the Grain Size Distribution Curve in Excel

Visualizing the data helps in understanding the distribution and aids in identifying the D10 and D60 points.

### Steps to plot the curve:

1. Create a scatter plot: Select the data columns (Particle Size and Percent Finer).
2. Insert Scatter Plot: Go to Insert > Scatter > Scatter with Straight Lines.
3. Configure axes:
  - Set particle size on the X-axis (preferably on a logarithmic scale for better visualization).



- Percent finer on the Y-axis.

4. Format axes:

- Right-click on the X-axis, choose Format Axis.

- Check the Logarithmic scale box to plot particle size on a log scale.

5. Label axes and add title for clarity.

Note: Using a logarithmic scale on particle size is standard practice because it linearizes the distribution for many soils.

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## **Finding D10 and D60 from the Distribution Curve**

Once the distribution curve is plotted, the next step involves determining D10 and D60.

### **Approach 1: Manual Interpolation**

This method is straightforward but requires careful reading.

Steps:

1. On the Y-axis, locate the 10% and 60% points.
2. Draw horizontal lines at 10% and 60% levels across the graph.
3. Find the intersection points of these lines with the distribution curve.
4. From the intersection points, project vertically down to the X-axis to read the corresponding particle sizes.

Limitations:

- Subjective; depends on visual estimation.
- Not precise for publication or technical reports.

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### **Approach 2: Numerical Interpolation in Excel**

For accuracy, numerical interpolation is preferred.

Steps:

1. Identify the data points around the target percent finer:
  - For D10: Find two data points where Percent Finer is just below 10% and just above 10%.
  - For D60: Do the same around 60%.

## 2. Apply linear interpolation:

For a target percent (e.g., 10%), interpolate between the two points:

$$D_{\text{target}} = D_{\text{lower}} + \left( \frac{P_{\text{target}} - P_{\text{lower}}}{P_{\text{upper}} - P_{\text{lower}}} \right) (D_{\text{upper}} - D_{\text{lower}})$$

Where:

- $P_{\text{target}}$  is 10% or 60%
- $P_{\text{lower}}$  and  $P_{\text{upper}}$  are the percent finer just below and above the target
- $D_{\text{lower}}$  and  $D_{\text{upper}}$  are the corresponding particle sizes

## 3. Example calculation:

Suppose for D10:

- At 5% finer: particle size = 0.075 mm
- At 10% finer: particle size = 0.050 mm

Interpolating for 10% finer (exact match here), D10 = 0.050 mm.

If the data points are not exact, perform the interpolation accordingly.

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# Implementing Interpolation in Excel

To automate the process, you can set up formulas in Excel.

Step-by-step guide:

## 1. Identify the two data points:

Use the `MATCH` function to find the positions of values just below and above 10% and 60%.

## 2. Extract corresponding particle sizes:

Use `INDEX` to retrieve particle sizes at those positions.

## 3. Write interpolation formulas:

```
```\excel
=Dx + ((TargetPercent - P_lower) / (P_upper - P_lower)) (Dx_upper - Dx_lower)
```\
```

Where:

- `Dx` and `Dx\_upper` are particle sizes at the lower and upper bounds.
- `P\_lower` and `P\_upper` are the corresponding percent finer.

Example formula for D10:

```
``excel
=INDEX(D2:D20, lowerIndex) + ((10 - INDEX(P2:P20, lowerIndex)) / (INDEX(P2:P20, upperIndex) - INDEX(P2:P20, lowerIndex))) (INDEX(D2:D20, upperIndex) - INDEX(D2:D20, lowerIndex))
``
```

Replace `lowerIndex` and `upperIndex` with the row numbers or use dynamic formulas.

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## Calculating Coefficient of Uniformity (Cu) and Other Parameters

Once D10 and D60 are determined, additional parameters can be calculated:

- Coefficient of Uniformity (Cu):

$$C_u = \frac{D_{60}}{D_{10}}$$

- Other parameters:

Depending on the classification system, you might also need D30, D50, or the effective size.

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## Features, Pros, and Cons of Using Excel for This Analysis

Features:

- User-friendly interface for plotting and calculations
- Flexibility to perform various interpolations and analyses
- Capable of handling large datasets and automating repetitive tasks

Pros:

- No specialized software required
- Customizable formulas and charts
- Suitable for educational purposes and quick analyses

Cons:

- Manual data entry can introduce errors
- Interpolation accuracy depends on data quality and density
- Visual estimation is less precise than computational methods
- Limited for very large datasets compared to specialized software

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## Best Practices and Tips for Accurate Results

- Ensure data is accurate and covers the entire distribution range.
- Use a logarithmic scale for particle size to linearize the distribution.
- Use at least 10-20 data points for better interpolation accuracy.
- Automate interpolation with formulas to reduce human error.
- Cross-verify interpolated values with visual inspection.
- Document all steps for reproducibility.

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## Conclusion

Finding D10 and D60 from the grain size distribution curve in Excel is an essential skill for geotechnical engineers, sedimentologists, and researchers working with soil properties. By plotting the distribution curve, identifying the relevant points either visually or through numerical interpolation, and applying simple formulas, one can accurately determine these critical parameters. While manual methods provide quick estimates, leveraging Excel's computational capabilities ensures precision and efficiency, especially when analyzing multiple datasets. Mastery of these techniques enhances the quality of soil classification, improves understanding of soil behavior, and supports informed engineering decisions.

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## References and Further Reading

- ASTM D422-63(2007) Standard Test Method for Particle-Size Analysis of Soils
- Das, B. M. (2016). Principles of

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