Article: Fineness Modulus Of Sand | FM Calculation & Grading (Semi-Log)
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Sand is a natural resource obtained from pits, rivers, seas, and deserts, which can play an important part in Engineering Construction. Sand is a granular material that consists of particles of finely divided rock i.e. pure silica (SiO_2) Silicon dioxide. Using of sand in civil engineering such as filling under floors, basements, fine aggregate at concrete, mortar, and plaster, etc. But all types of sand are not suitable for such works. Determines sand properties such as **Fineness Modulus**, Specific Gravity, Bulking of Sand, Compressive strength, and Silt and clay content, which is best for mortar and concrete work or suitable for plastering and finishing work.

1.0 Classification of Sand

Sand is commonly acquired from rivers, seas, and deserts. It can be classified according to size and source.

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1.1 Classified According to Size:

Mostly in construction Sand is being used as a fine aggregate. That is into different-sized for different types of work. These can be divided into three types. Source Dr.MA.Aziz (Engineering Materials: Page-118)

- **Fine Sand:** This grain of sand is passed through Sieve No. 16 standard ASTM Sieve size.
- **Moderately Coarse Sand:** All the sand particles should pass through Sieve No. 8 standard ASTM Sieve size.
- **Coarse Sand:** All the particles should pass through Sive No. 4 standard ASTM Sieve size.

1.1.1 Grading Requirements for Fine Aggregate

Source ASTM This size is ASTM standard specification for concrete aggregate C33/C33M-18.

Sieve No.	Opening	Percent Passing
3/8"	9.5 mm	100
No. 4	4.75 mm	95 to 100
No. 8	2.36 mm	80 to 100
No. 16	1.18 mm	50 to 85
No. 30	600 µm or 0.6 mm	25 to 60
No. 50	300 µm or 0.3 mm	5 to 30
No. 100	150 µm or 0.15 mm	0 to 10
No. 200	75 µm or 0.075 mm	0 to 3

1.2 Classified According to Source:

There are four kinds of sand: Pit sand, river sand, sea sand, and desert sand.

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1. **Pit Sand:** This sand is obtained from a Pit that contains clay and other impurities which should be screened and washed before construction uses. The sand shapes are sharp angular and porous mostly free from salt, which is **suggested for mortar work** and the color is light browned or yellowish.
2. **River Sand:** Basically most of the sand comes from rivers in construction work. River sand is obtained from the River-bed and it is fine round and polished which contains earthy impurities like pebbles and gravel etc. Should be screened and washed before construction. It is more well-graded than other sources. Generally, three types of sand are obtained from rivers fine, medium, and coarse. source The Times of India [But, the fear is that there is a shortage of sand for rapid construction that the river stock cannot replenish.] source ResearchGate [Therefore the engineers are searching for another alternative way like sea and desert sand.]
3. **Sea Sand:** This sand is also fine, round, and polished but it is not useable in general conditions because it might contain sea salts that corrosion steel and absorb moisture from the atmosphere causing reduced structure durability and permanent dampness. source ResearchGate [However, due to the shortage of natural pit and river sand resources, people have been trying to use sea sand and desert sand instead in recent years. Fiber Reinforced Polymer (FRP) can be an extensive solution for the uses of different materials in construction as reducing corrosion of steel.]
4. **Desert Sand:** As a replacement for natural river sand, desert sand would be a great implementation in civil engineering in China and Meidle-East where there is the largest source of deserts. SourceResearchGate But the desert sand shape is fine and rounded which can weaken the structure.

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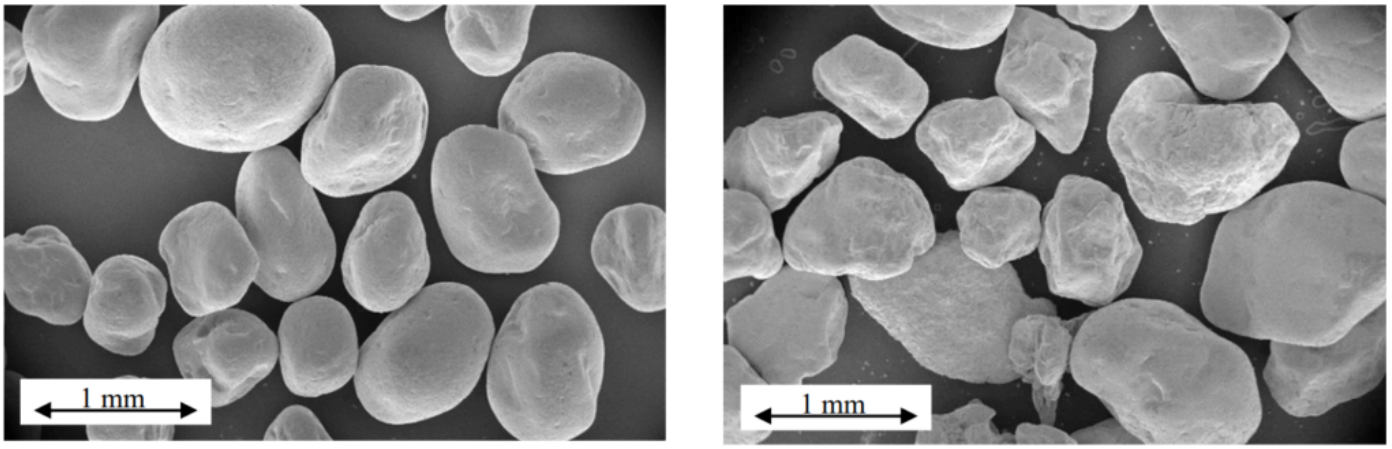

(a) 0.5 mm to 1.0 mm fraction from Libya. **(b)** 0.5 mm to 1.0 mm fraction from Algeria.

Fig: ESEM analysis of desert sand grains. Source ResearchGate

Source ScienceDirect [A recent research by **Central South University in China** has told us that desert sand and river sand composition of the same particles of SiO_2 and Al_2O_3. But the particles of size are smaller than river sand. Due to the stable composition and use as finer aggregate in cement-based material (CBM) prove that the incorporation of Desert Sand greatly improves by filling effect of ultrafine particles of the porosity, durability, and mechanical properties. The CBM annually adopted around the world about 32 to 50 billion tons of natural river sand as a result of the over-exploitation of natural sources, which burdens environmental pollution and further threatens in civil living environment.]

2.0 Fineness Modulus Of Sand (FM): Calculation & Grading

The fineness modulus is abbreviated as FM. FM of sand (fine aggregate ASTM standard) is an index number that represents the average size of the grain of sand. It is calculated by performing a Sieve Analysis with ASTM standard sieves 3″, 1/2″, 3/4″, 3/8″, No. 4, No. 16, No. 30, No. 50, and No. 100 and dividing the sum of the cumulative percentages retained on each sieve by 100 gives the fineness modulus value or FM.

FM or Fineness Modulus Calculation

This sand was collected from the Shari Ghat River-Bed located in the Sylhet area in Bangladesh.

Because of the vast amount of sand used from the Shari river bed in this region. Source ResearchGate (Sieve Analysis Data)

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2.1 Sieve Analysis: Fine Aggregate

Sieve Size	Standard Opening (mm)	Material retained (gm)	Percent of material retained (%)	Cumulative Percent Retained (%)	Percent Finer/ Pass	Fineness Modulus FM
No. 4	4.75	0	0.0	**0.0**	100.0	
No. 8	2.36	1	0.1	**0.1**	99.9	
No. 16	1.18	10	1.0	**1.1**	98.9	
No. 30	0.60	38	3.8	**4.9**	95.1	
No. 50	0.30	191	19.1	**24.0**	76.0	
No. 100	0.15	743	74.3	**98.3**	1.7	
No. 200	0.075	12	1.2	99.5	0.5	
Pan		5	0.5	100.0	0.0	
Total		1000				FM 1.28

FM= {(0+0.1+1.1+4.9+24.0+98.3)÷100}=1.28

This sand Fineness modulus is 1.28 which is a fine aggregate.

2.1.1 Gradation Curve of Sand in Semi-log

From percent fineer or pass and sieve size can draw particle size gradation curve of fine sand.

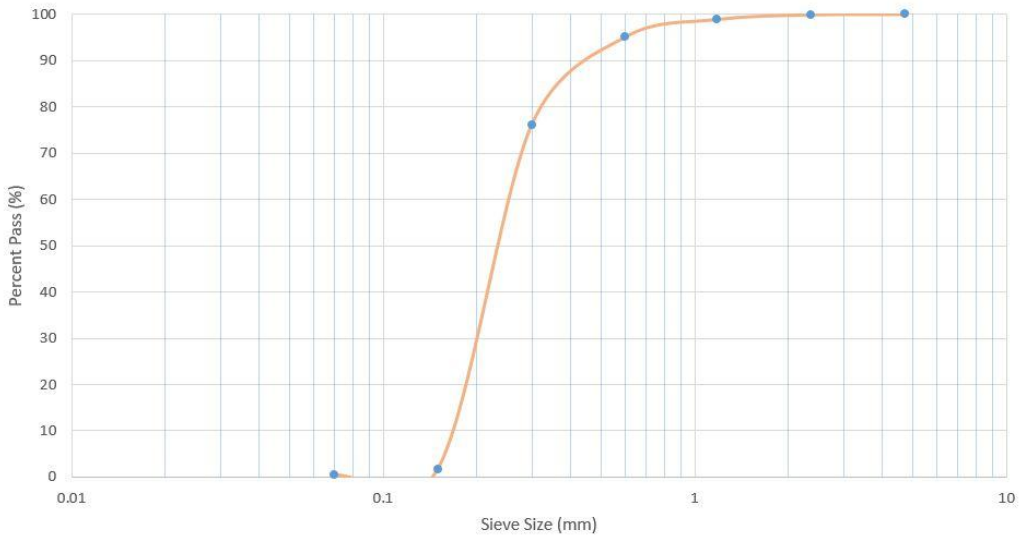

Fig: Gradation Curve of Sand (Fine)

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2.2 Sieve Analysis: Medium Aggregate

Sieve Size	Standard Opening (mm)	Material retained (gm)	Percent of material retained (%)	Cumulative Percent Retained (%)	Percent Finer/ Pass	Fineness Modulus FM
No. 4	4.75	11	1.1	**1.1**	98.9	
No. 8	2.36	31	3.1	**4.2**	95.8	
No. 16	1.18	284	28.4	**32.6**	67.4	
No. 30	0.60	354	35.4	**68.0**	32.0	
No. 50	0.30	205	20.5	**88.5**	11.5	
No. 100	0.15	111	11.1	**99.6**	0.4	
No. 200	0.075	3	0.3	99.9	0.1	
Pan		1	0.1	100.0	0.0	
Total		1000				FM 2.94

FM= {(1.1+4.2+32.6+68+88.5+99.6)÷100}=2.94

2.2.1 Gradation Curve of Sand in Semi-log

From percent fineer or pass and sieve size can draw particle size gradation curve of medium sand.

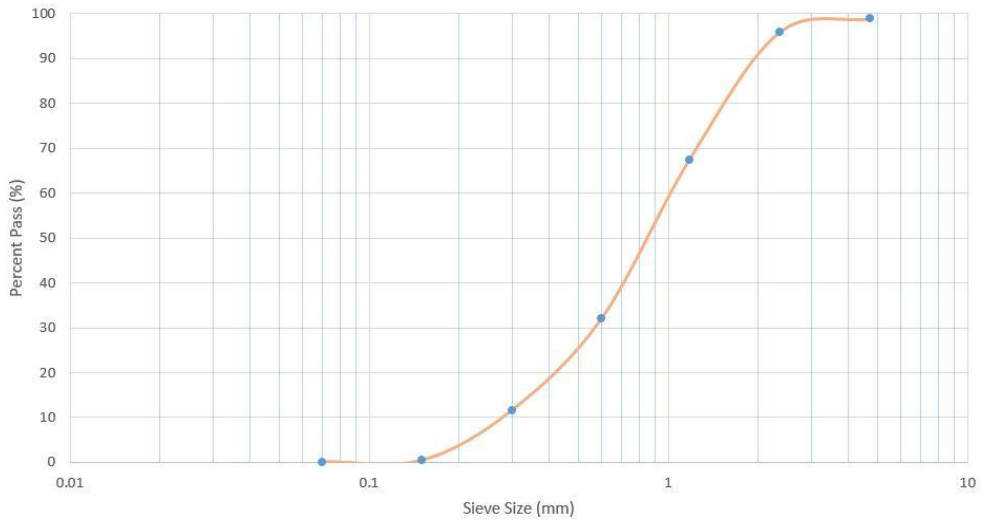

Fig: Gradation Curve of Sand (Medium)

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3.0 Conclusion

At present, we are getting sand from a few selected natural locations such as pits and river beds, but the scope should be increased by proper use of sea and desert sand. And assure the use of properties standard of ASTM for example fineness modulus, Bulking of Sand, Compressive strength, etc. which would provide more sustainability in the structure.