CHARACTERISTICS OF SOIL , SAND, FLY ASH AND CERAMICS MIX FOR USE AS SUB GRADE MATERIAL

Final Evaluation

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INTRODUCTION

- **FLY ASH** is a waste by-product from the thermal power plants, which uses coal as a fuel.
- At present about 100 thermal power plants in India produce about 130 million tones of fly ash every year.
- It is not being used fully for gainful purposes like brick making, cement manufacturing, soil stabilization and as fill material.
- Serious concern with its disposal, utilization and threat to public health.

INTRODUCTION

- CERAMICS such as tile waste, sanitary waste, crockery are also produced during manufacturing and construction processes.
- The construction of roads not only helps to consume bulk quantities of fly ash and ceramics solving its disposal problems to certain extent but also satisfies the construction requirement.

OBJECTIVE

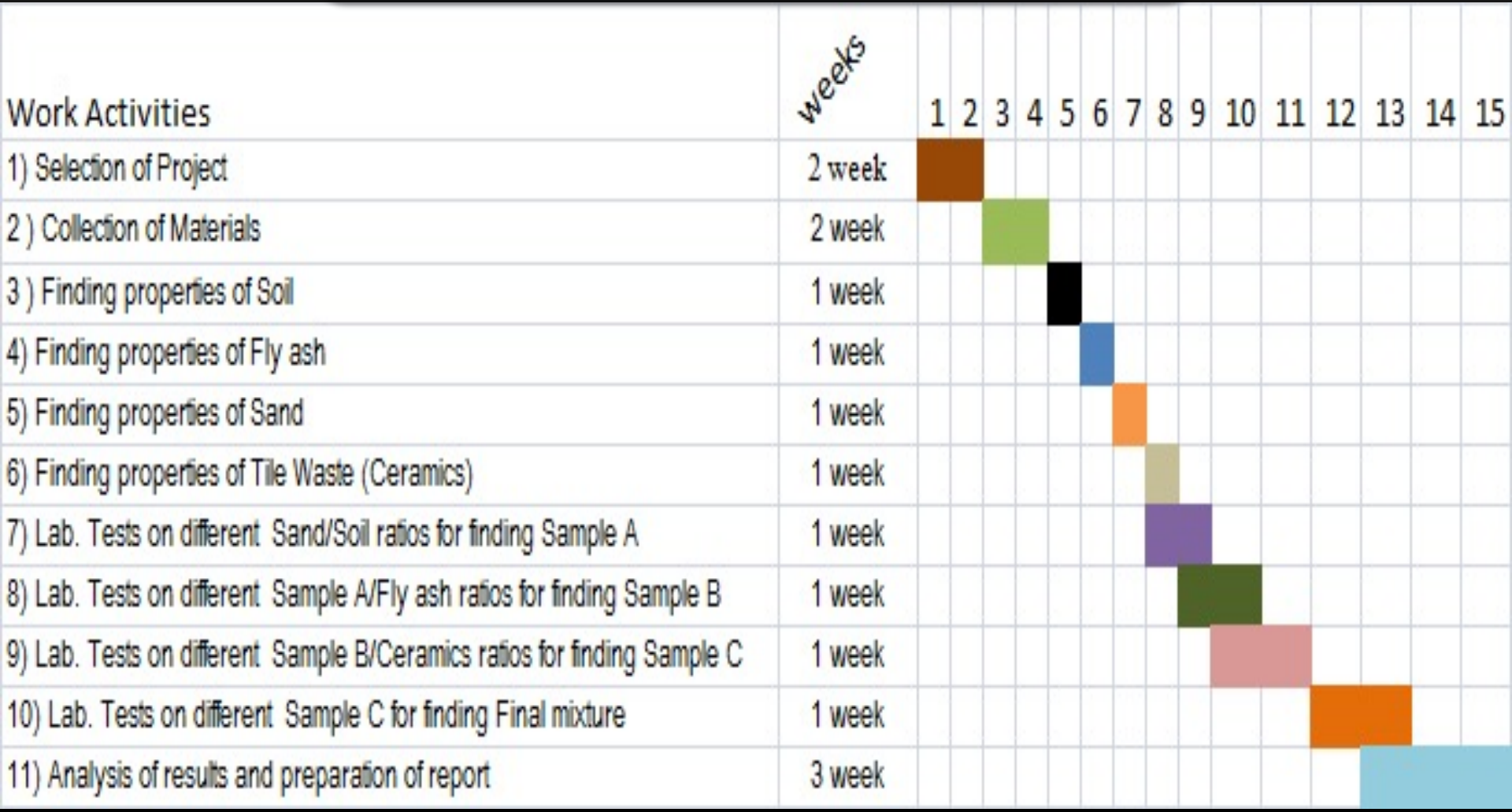
- The main aim of the project is to make a suitable mixture of Soil and Sand along with the waste materials such as Fly ash and Ceramics as subgrade; so as to minimize their dumping, thus to minimize pollution.

- To study the Compaction, Drainage and Strength characteristics of the composite mixture.

METHODOLOGY

- Fundamental properties of soil, sand, fly ash and ceramics (tile waste) are determined by conducting the preliminary tests.
- Compaction, Drainage and Strength characteristics of different mixtures are found.
- Mixture ‘A’ is from the best mix obtained from the combination of soil and sand.
- Fly ash will be added to the mixture ‘A’ in some proportion to get a resultant mixture ‘B’.
- Mixture ‘C’ will be made by adding ceramics (4.75-.075)mm in Mixture ‘B’ to get the best Strength.

WORK PLAN


Work Activities
weeks
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
1) Selection of Project
2 week
2) Collection of Materials
2 week
3) Finding properties of Soil
1 week
4) Finding properties of Fly ash
1 week
5) Finding properties of Sand
1 week
6) Finding properties of Tile Waste (Ceramics)
1 week
7) Lab. Tests on different Sand/Soil ratios for finding Sample A
1 week
8) Lab. Tests on different Sample A/Fly ash ratios for finding Sample B
1 week
9) Lab. Tests on different Sample B/Ceramics ratios for finding Sample C
1 week
10) Lab. Tests on different Sample C for finding Final mixture
1 week
11) Analysis of results and preparation of report
3 week

Activities	Total Weightage	08129	08105	08117	08137	7121	Completed
Proposal	5	1	1	1	1	1	5
Identification and collection of raw materials	10	2	2	2	2	2	10
Preparation of materials	10	2	2	2	2	2	10
Finding index properties of each material	20	4	4	4	4	4	20
Compaction properties of Mixture ‘A’	15	3	3	3	3	3	15
Compaction properties of Mixture ‘B’	10	2	2	2	2	2	10
Compaction properties of Mixture ‘C’	10	2	2	2	2	2	10
Suggesting the Best mix.	10	3	2	2	3	0	10
Report	10	2	3	3	2	0	10
Total	100	21	21	21	21	16	100

Material used and properties

SOIL

- Particle size distribution curve
- Plastic limit and Liquid limit.
- Specific Gravity.
- OMC and MDD.
- Permeability
- CBR

Sand

- Particle size distribution curve
- Specific Gravity.
- OMC and MDD.
- Permeability

FLY ASH

- Particle size distribution cur
- Plastic limit and Liquid limit.
- Specific Gravity.
- OMC and MDD.
- Permeability

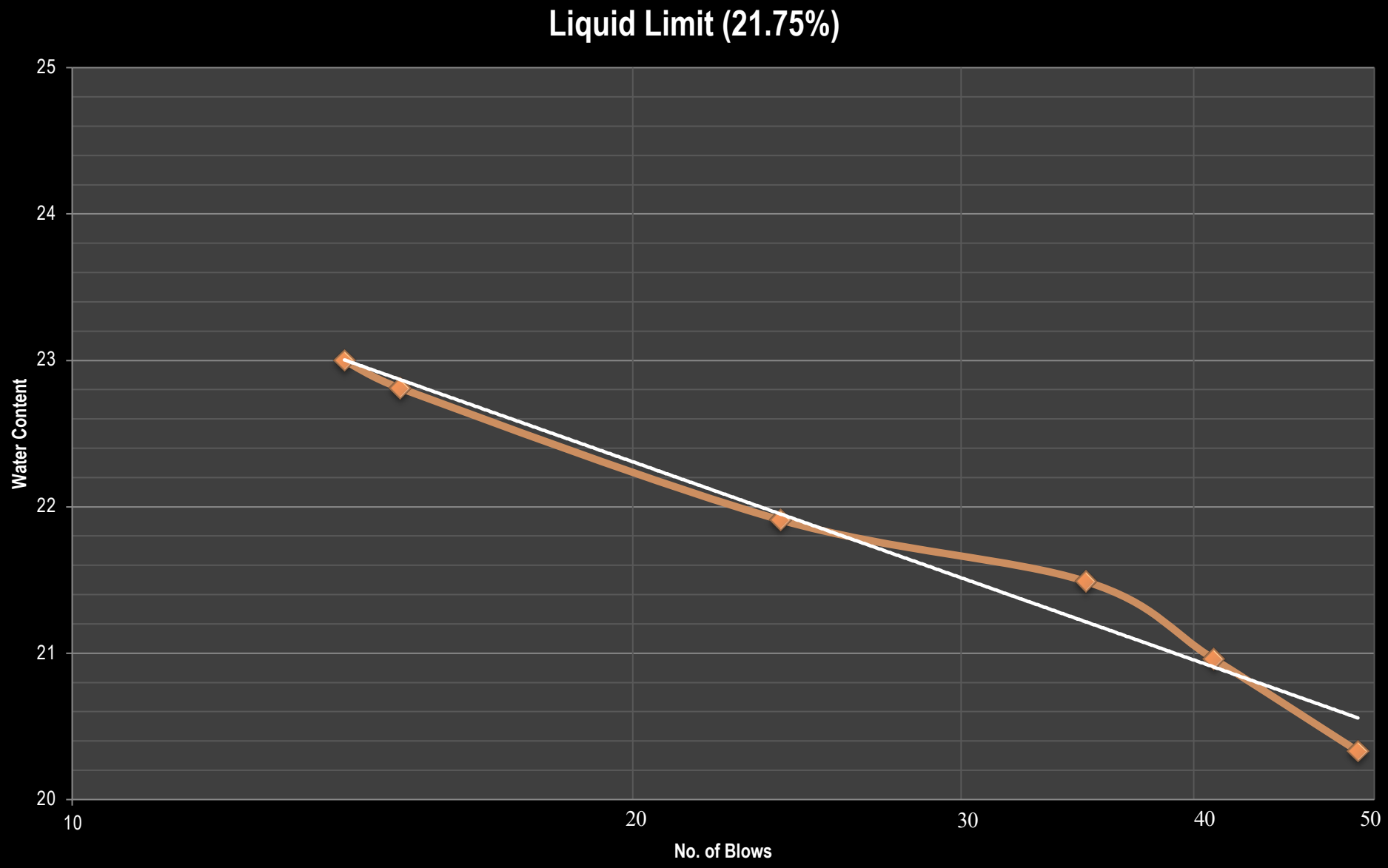
Ceramic

- Particle size distribution cu
- Specific Gravity.
- OMC and MDD.

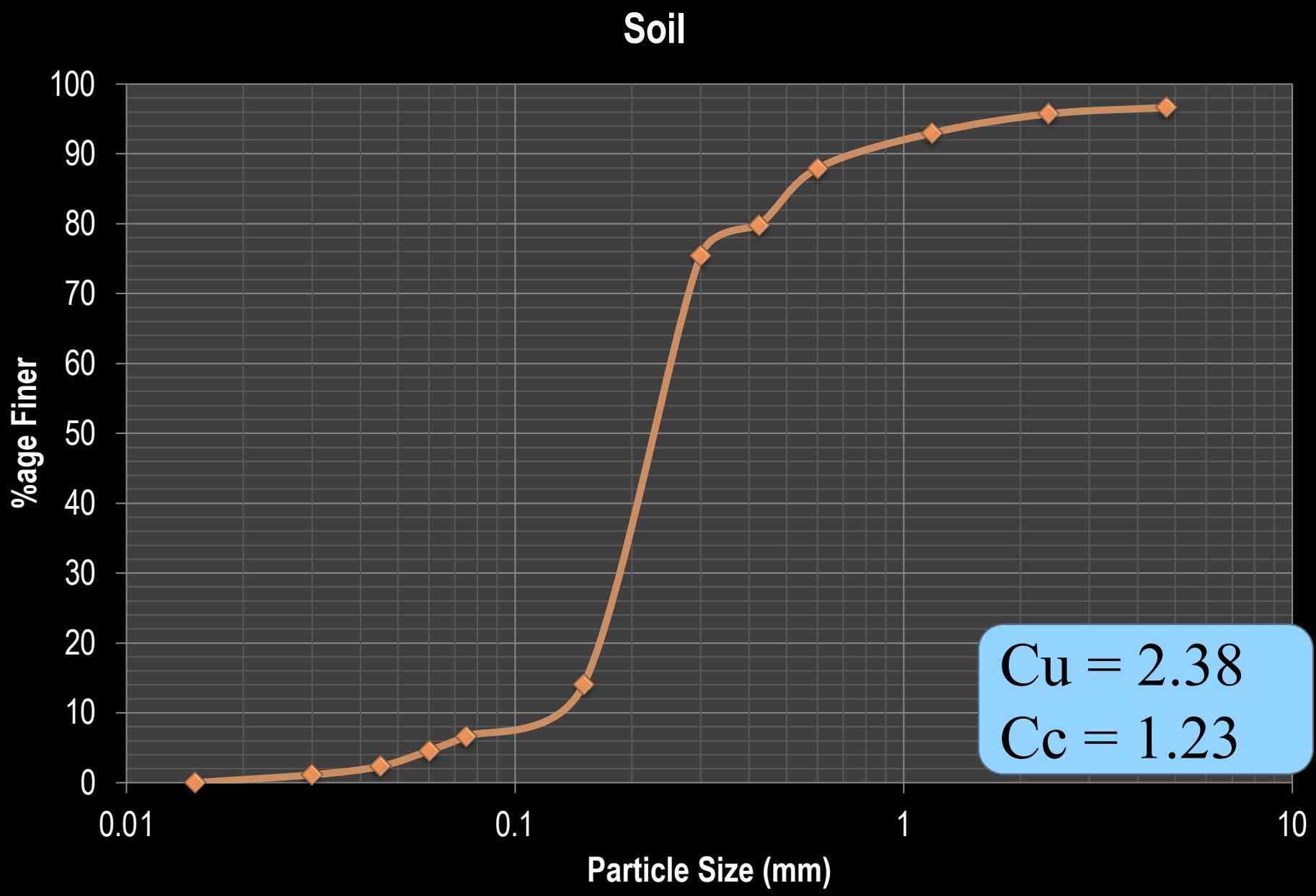
Specific Gravity

Sample	Specific Gravity
Sand	2.625
Soil	2.568
Fly ash	1.924
Ceramic	2.349

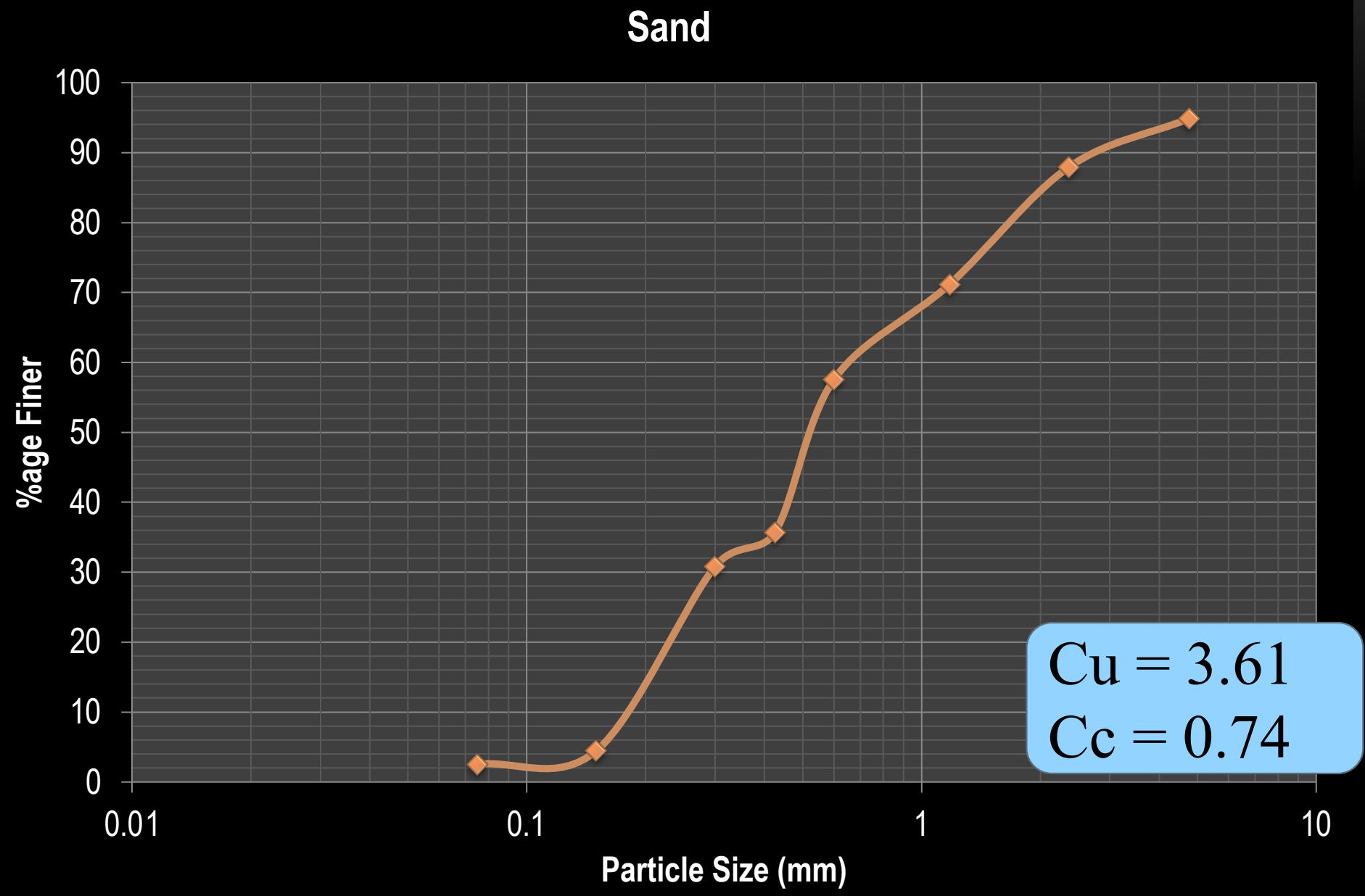
SOIL of Liquid Limit (21.75%) and Plastic-Limit of (17.48%)



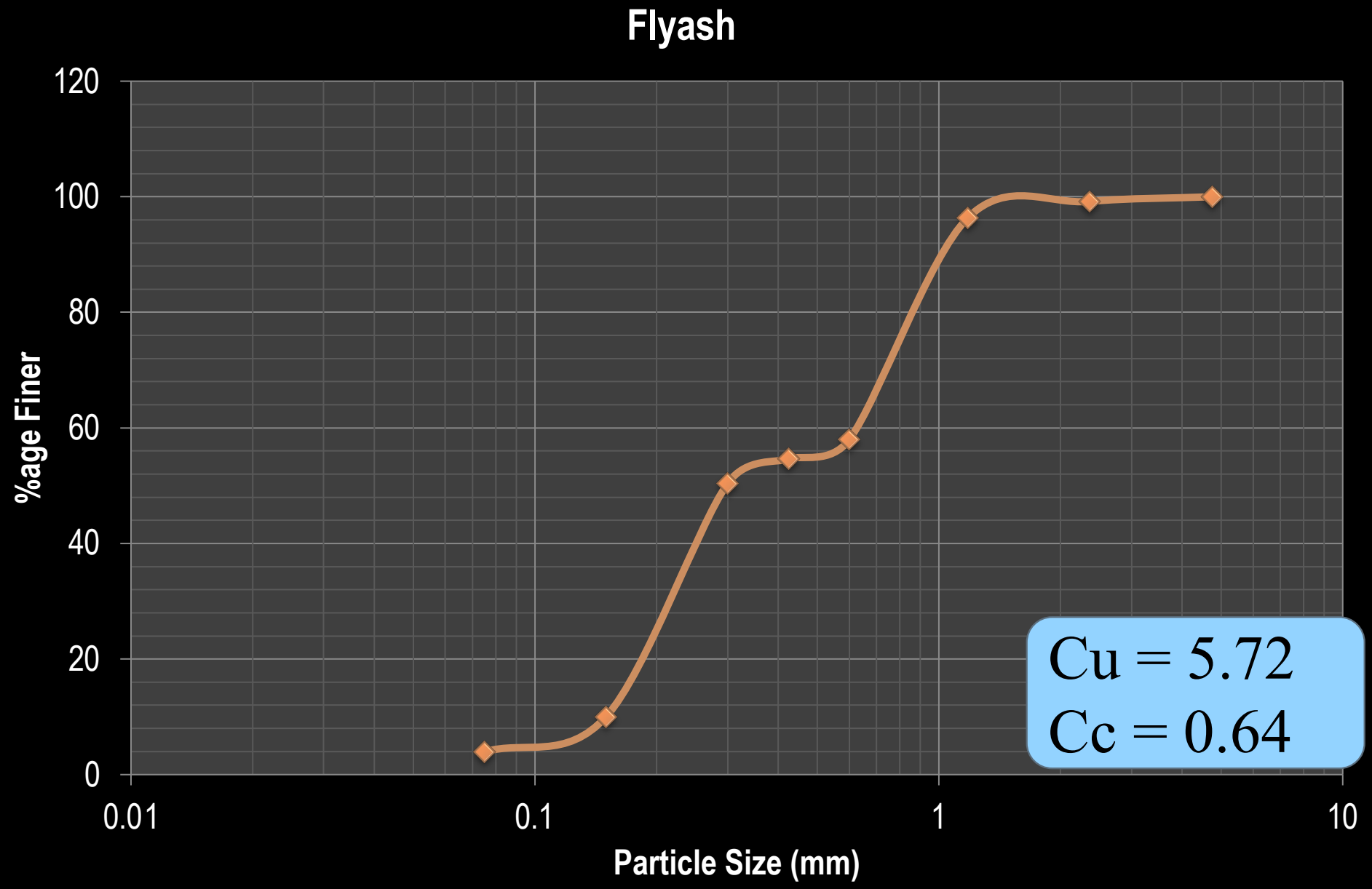
Particle size distribution



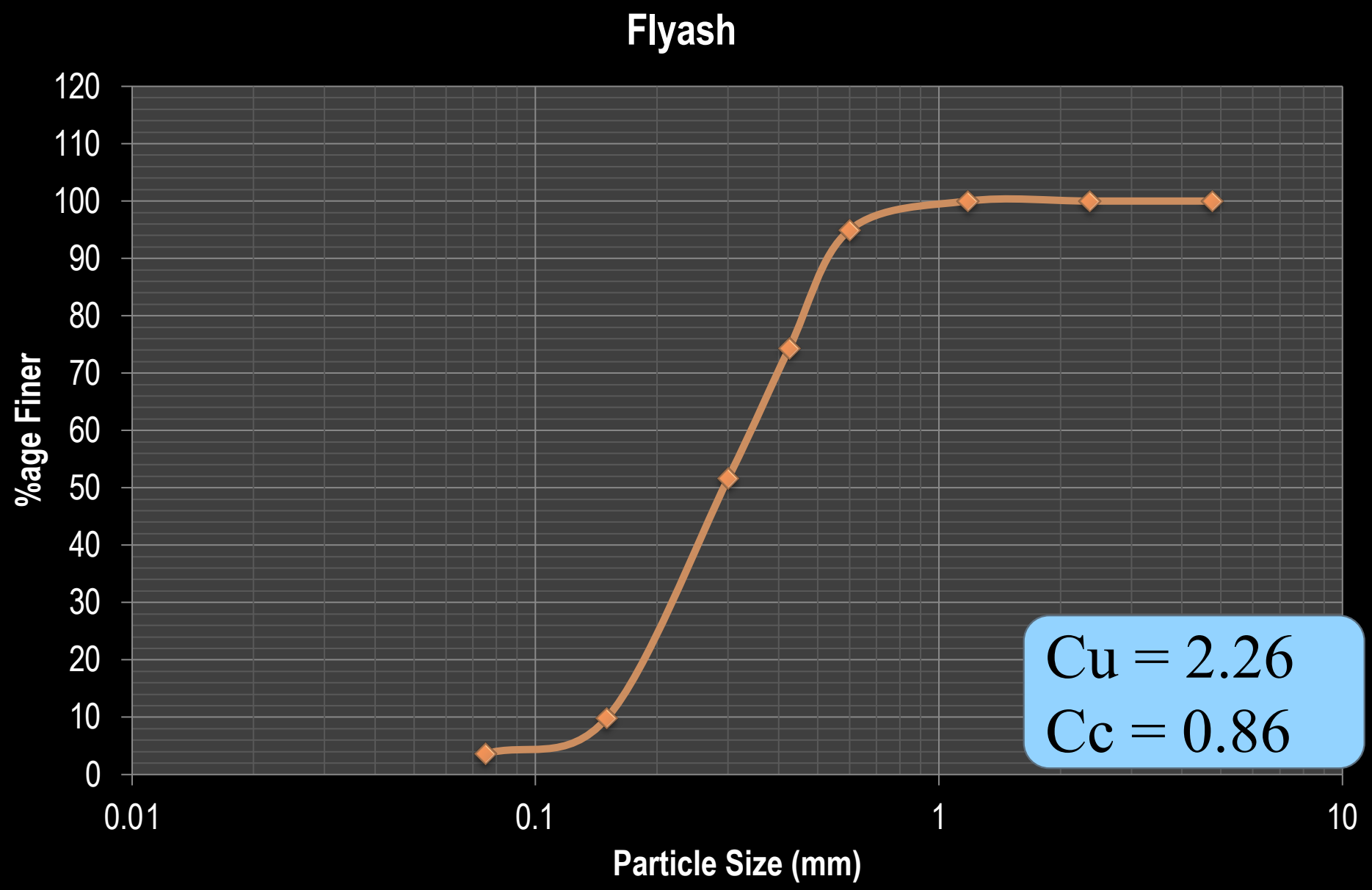
Particle size distribution



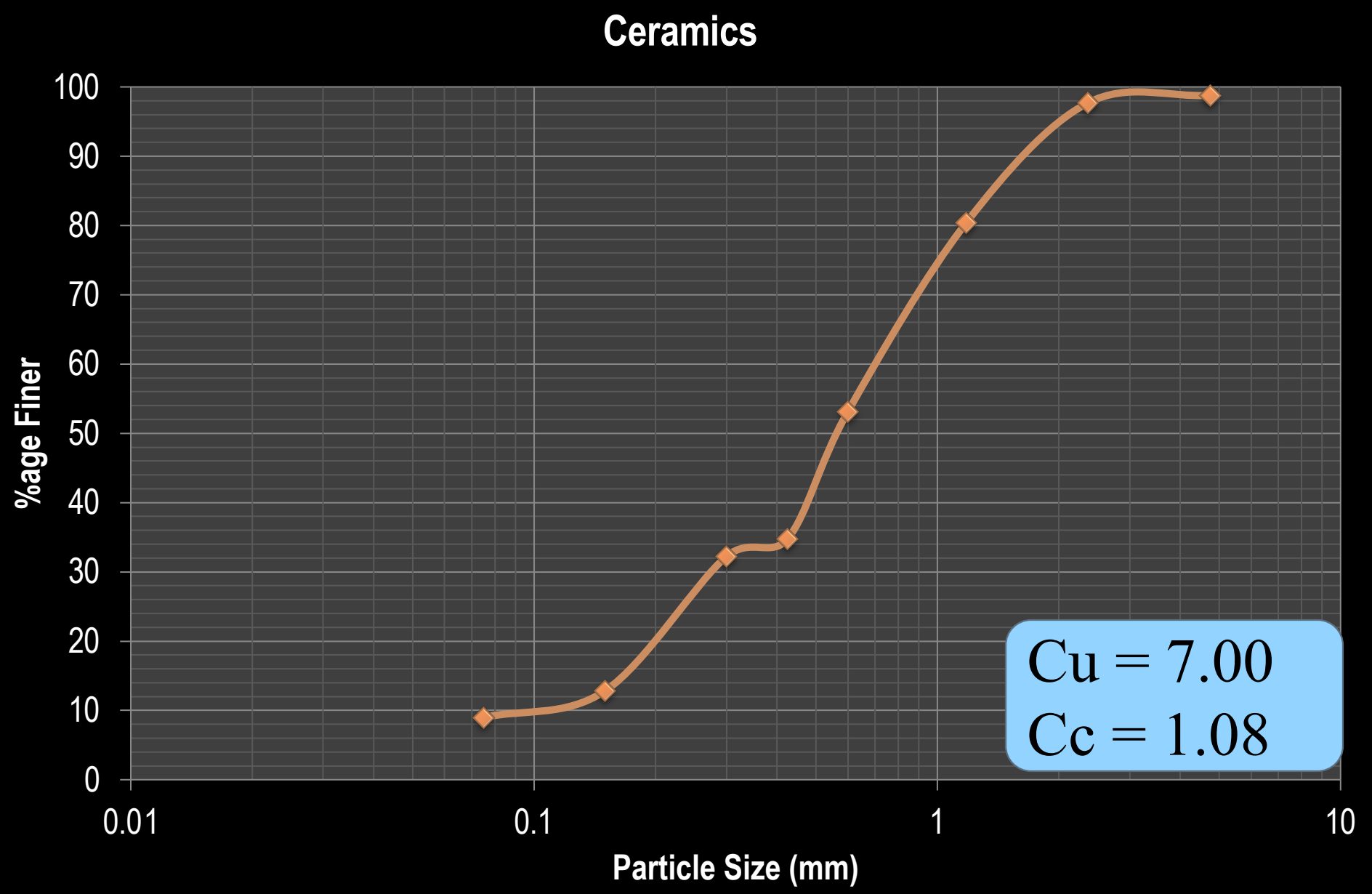
Particle size distribution



Particle size distribution

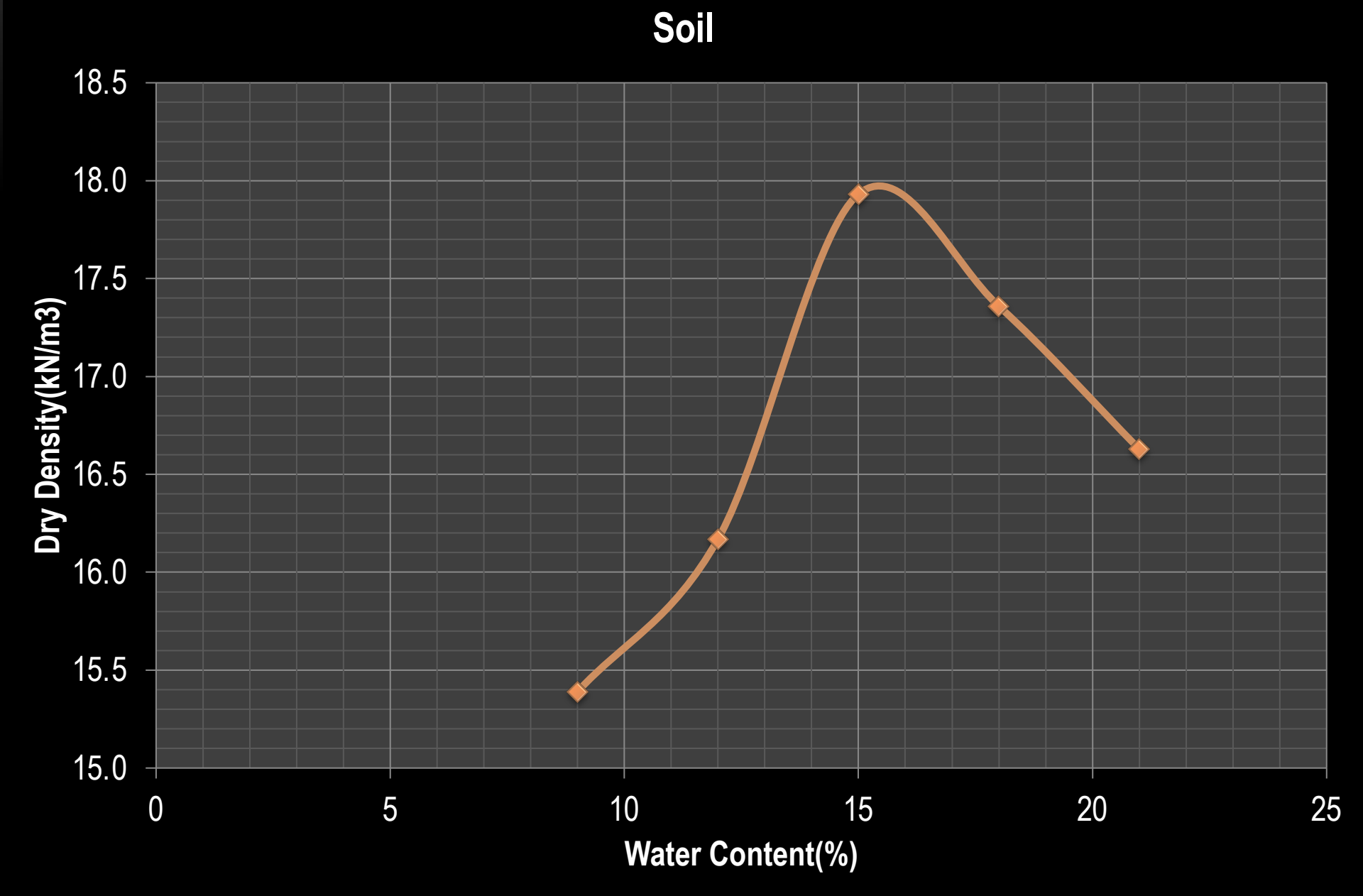


Particle size distribution



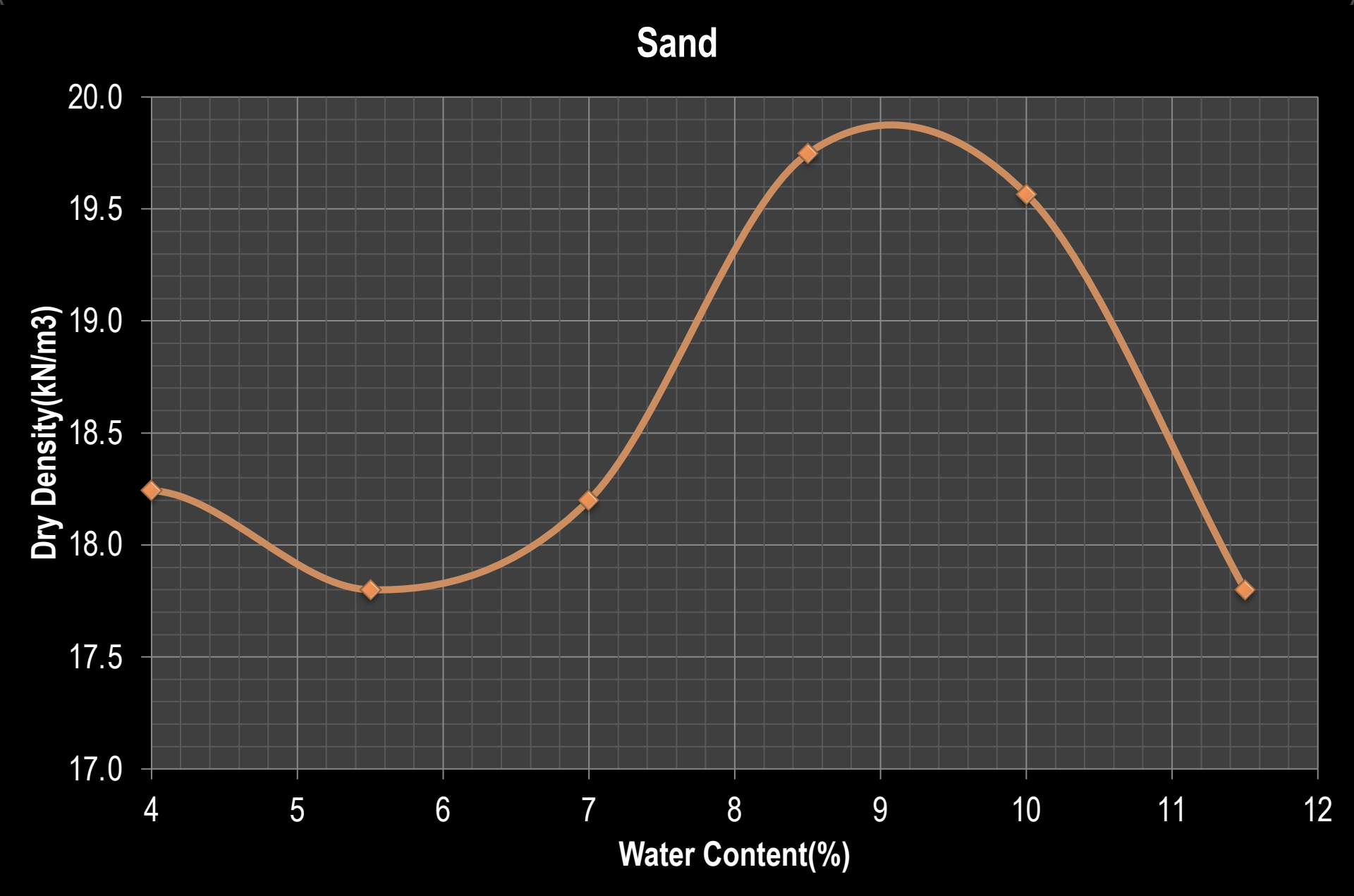
OMC and MDD (Soil)

OMC = 15.50 %
MDD = 18kN/m3



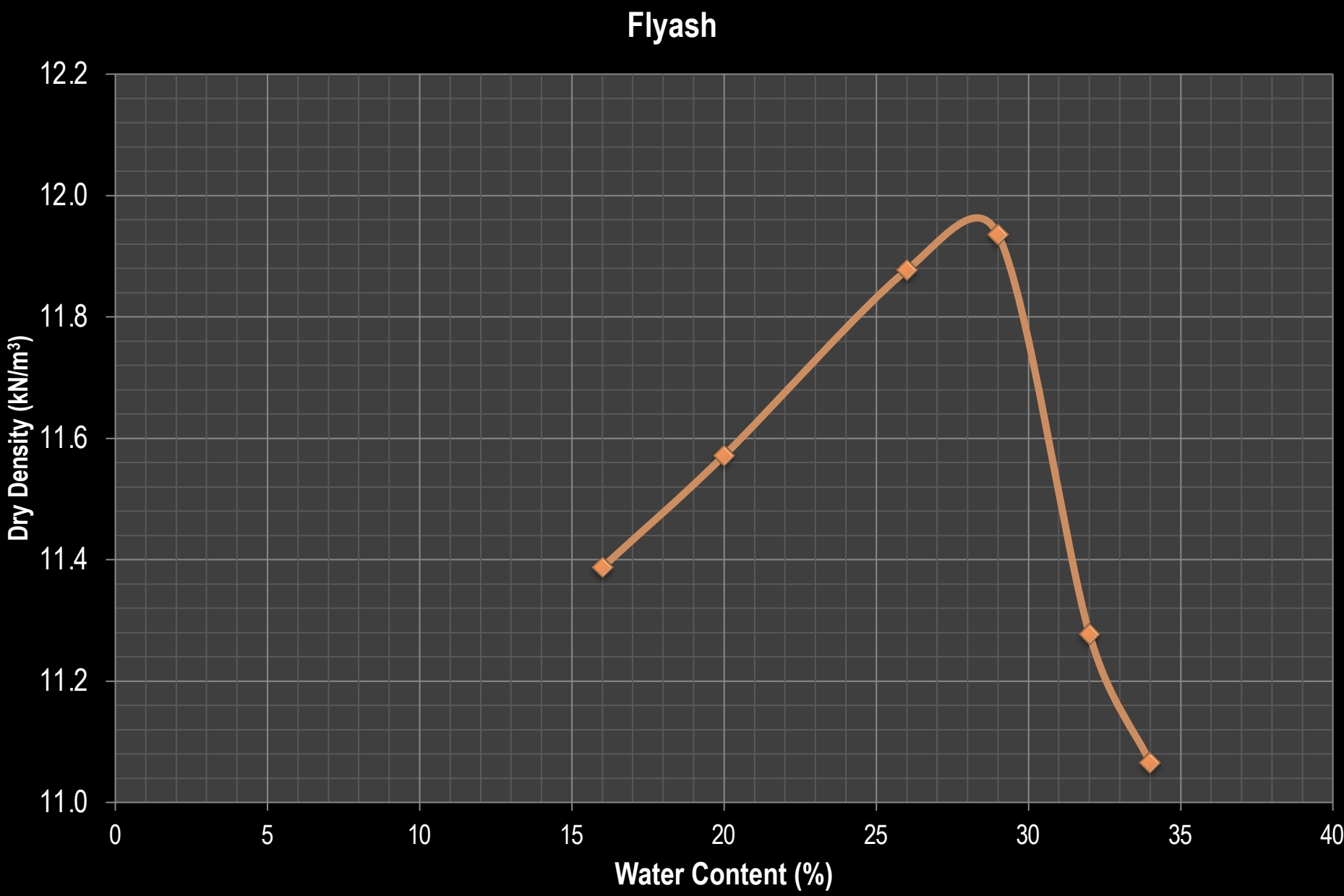
OMC and MDD

OMC = 9.0%.
MDD = 19.8kN/m³



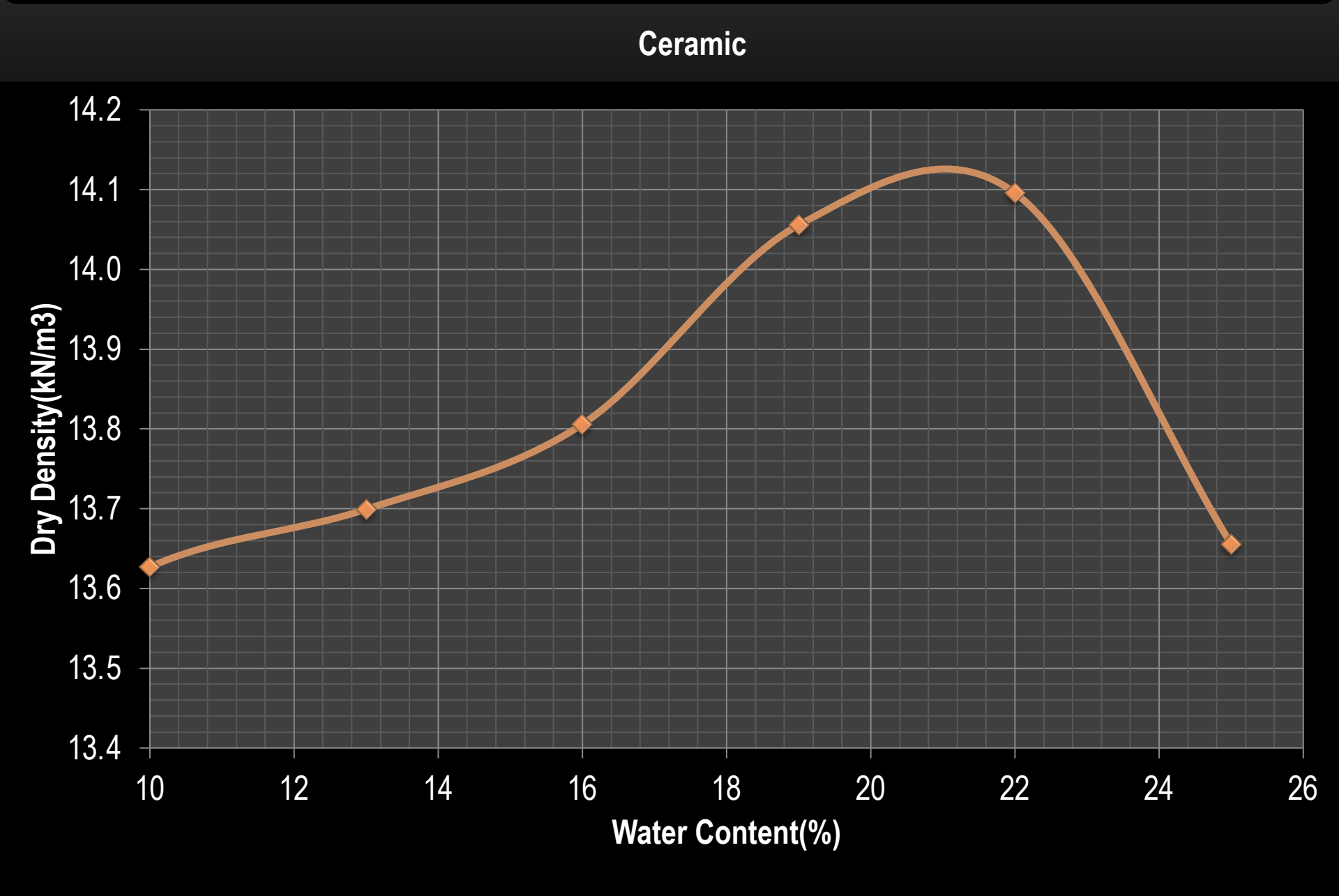
OMC and MDD

OMC = 28.5 %
MDD = 11.96kN/m3



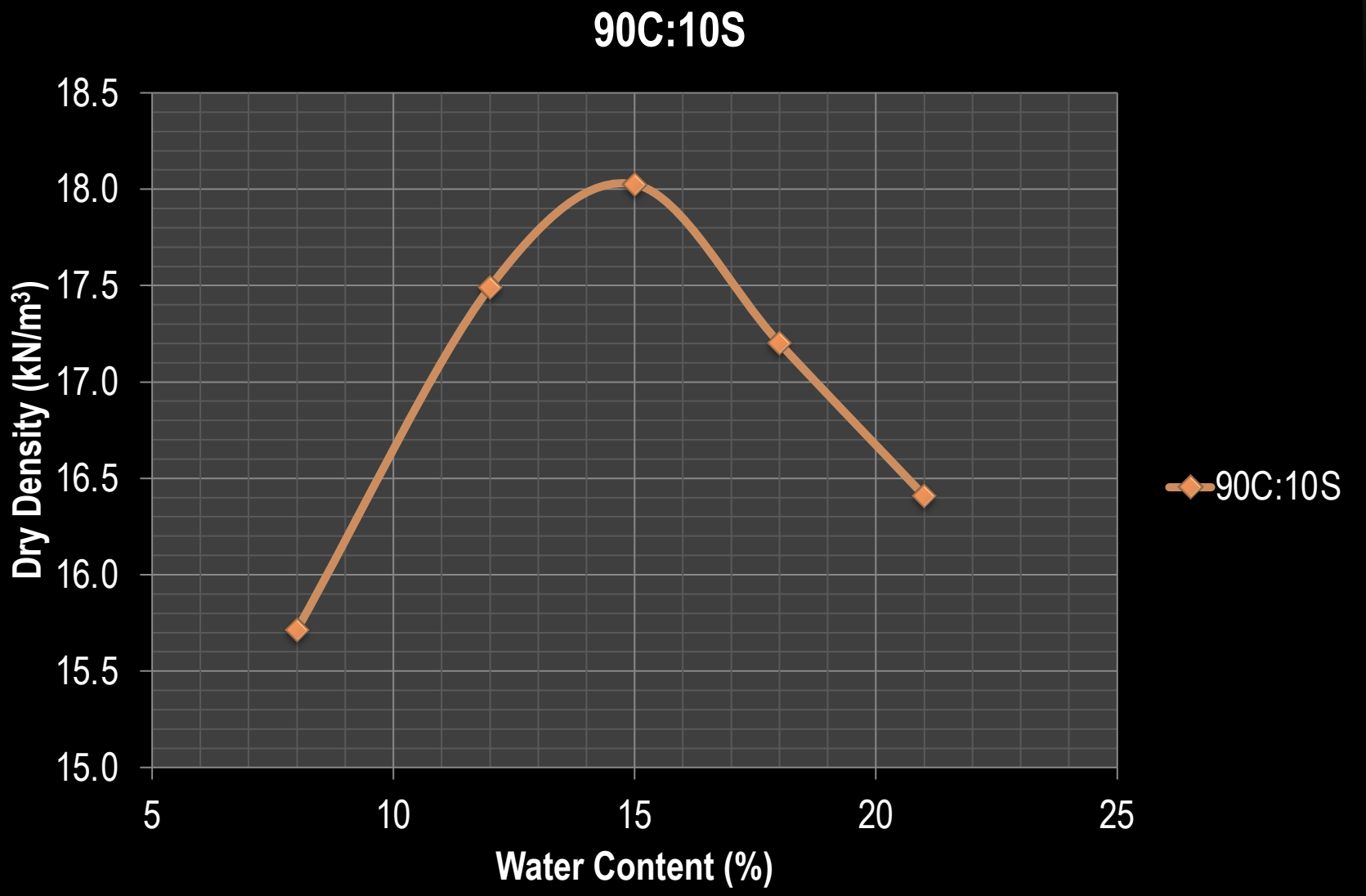
OMC and MDD

OMC = 21%
MDD = 14.1kN/m^3

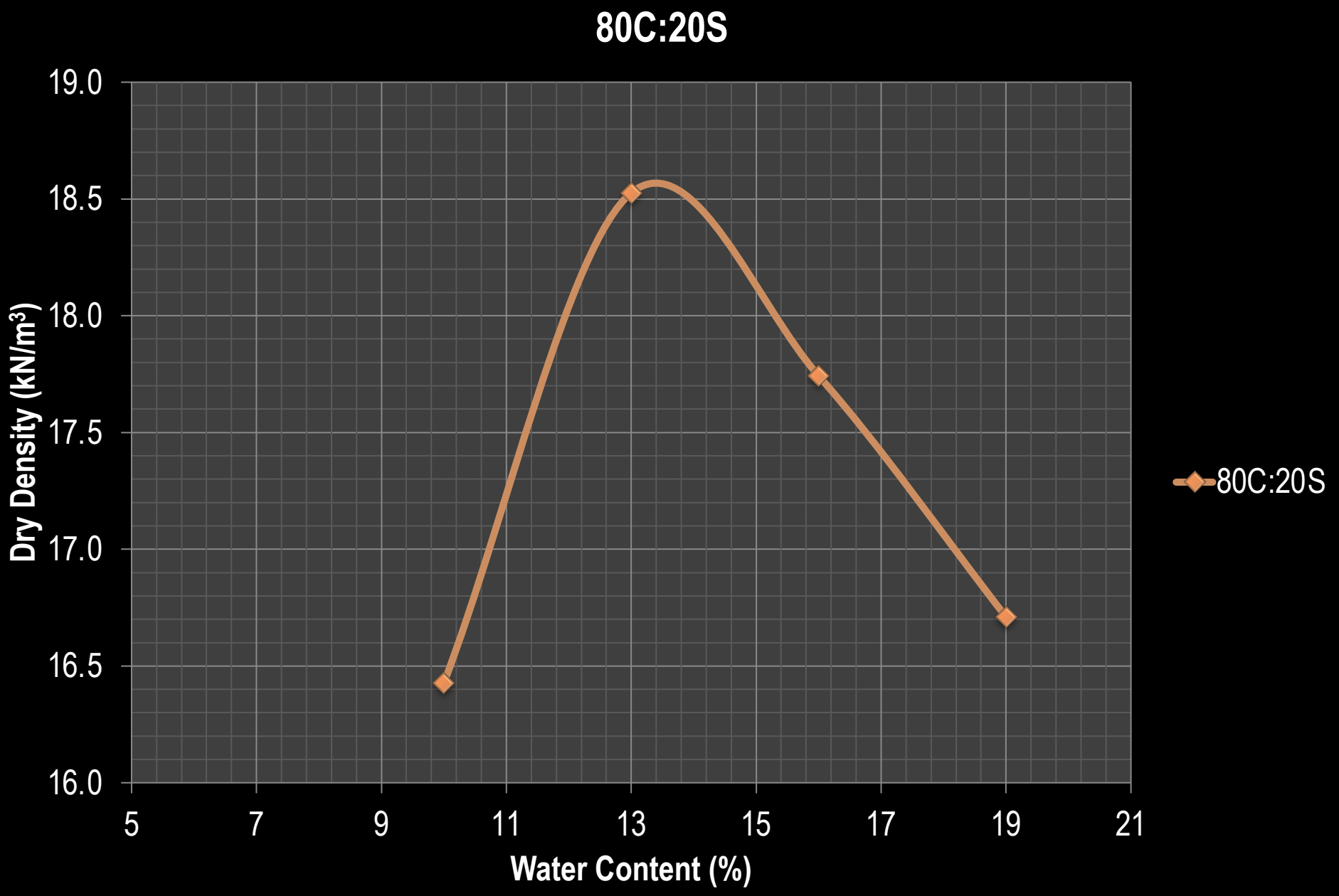


FOR MIXTURE ‘A’ PROCTOR WAS DONE FOR VARIOUS RATIOS

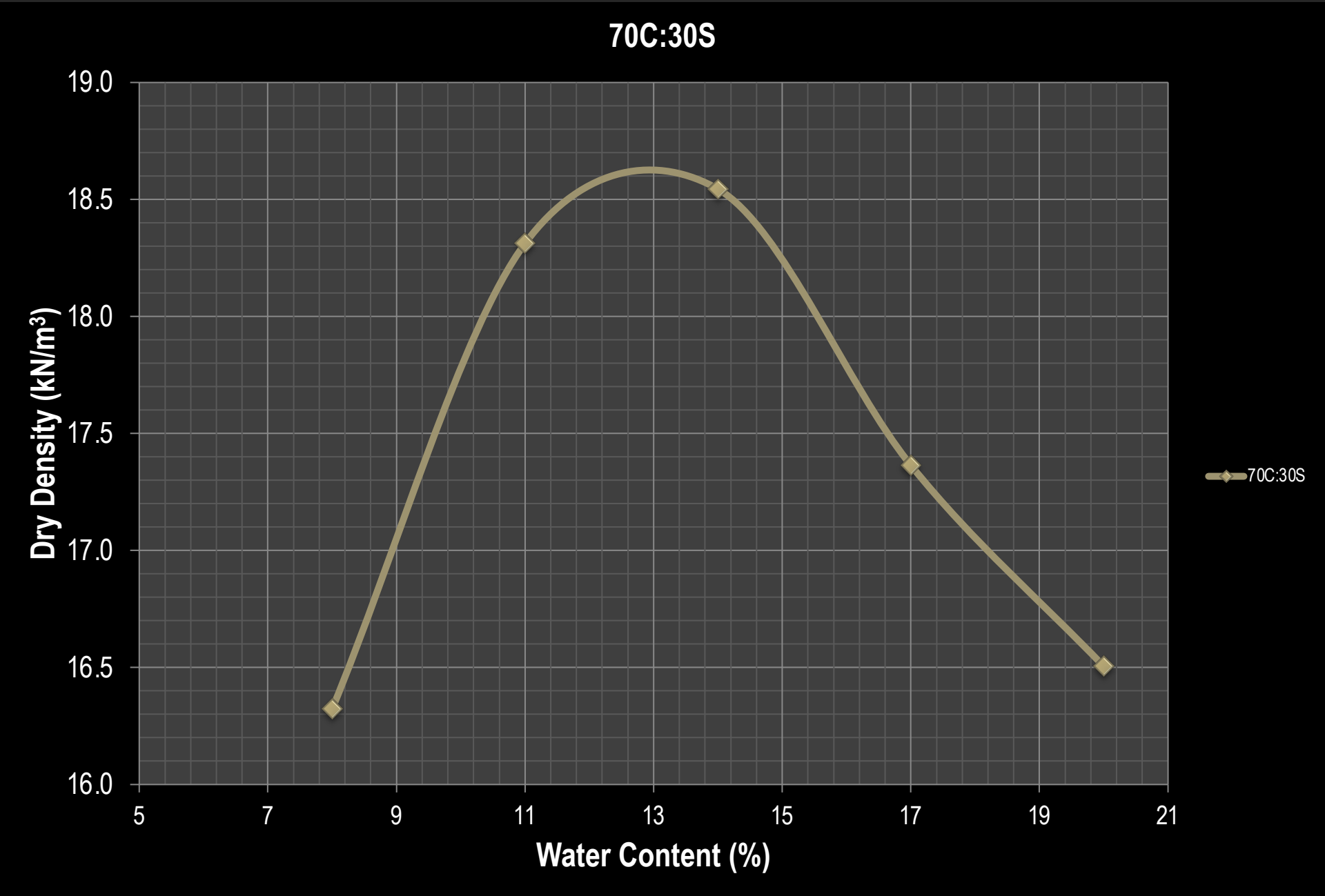
90(Soil):10(Sand)



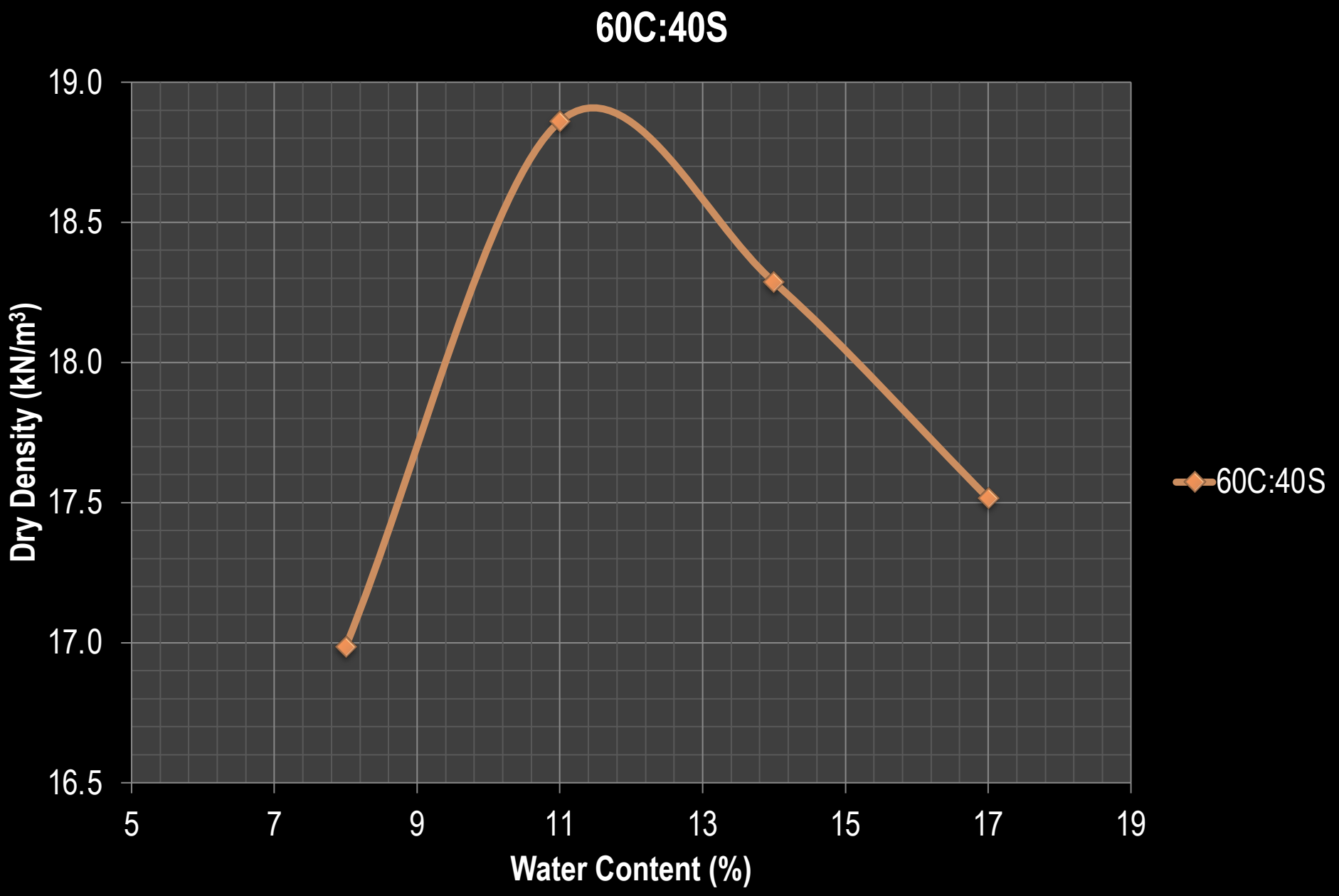
80(Soil):20(Sand)



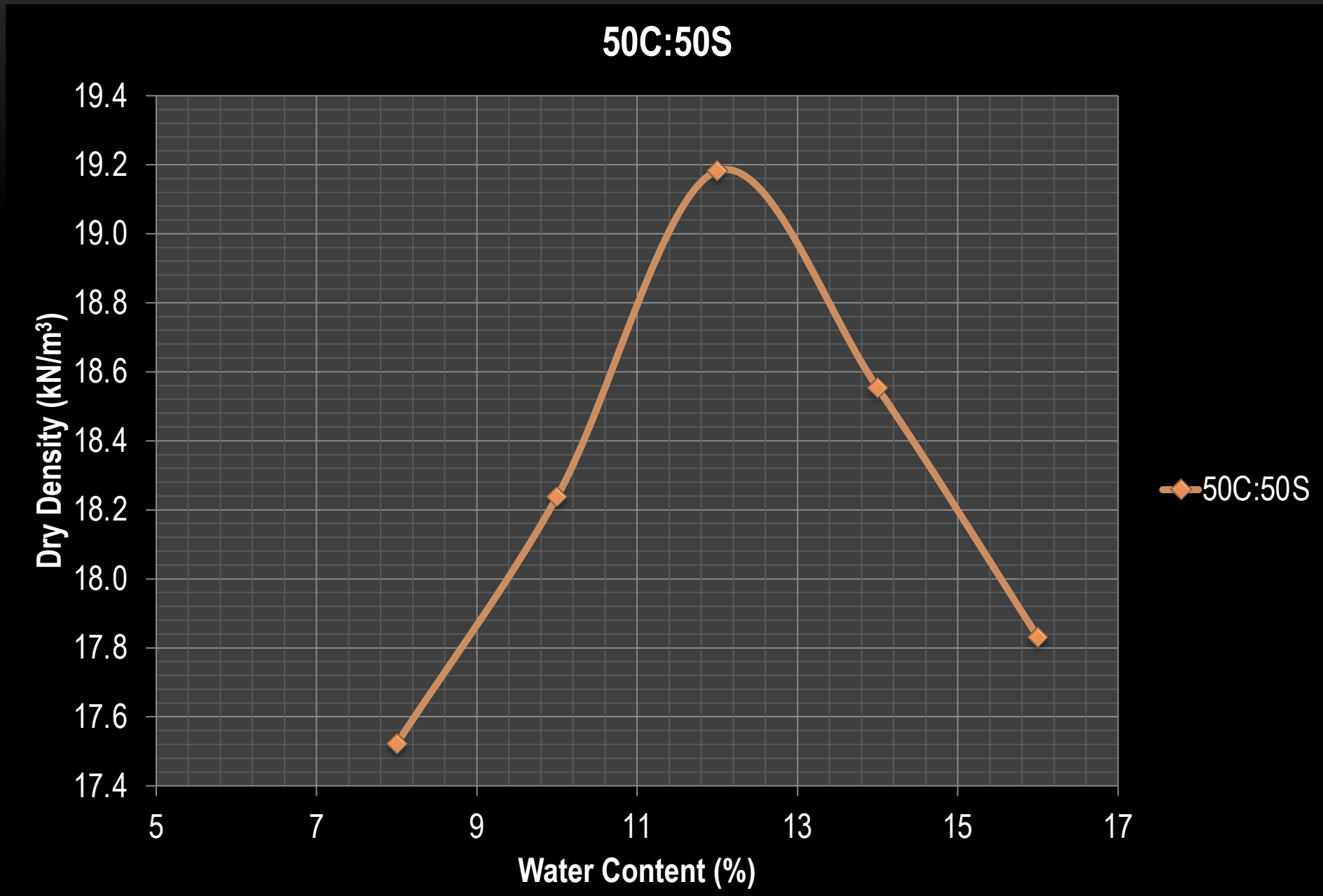
70(Soil):30(Sand)

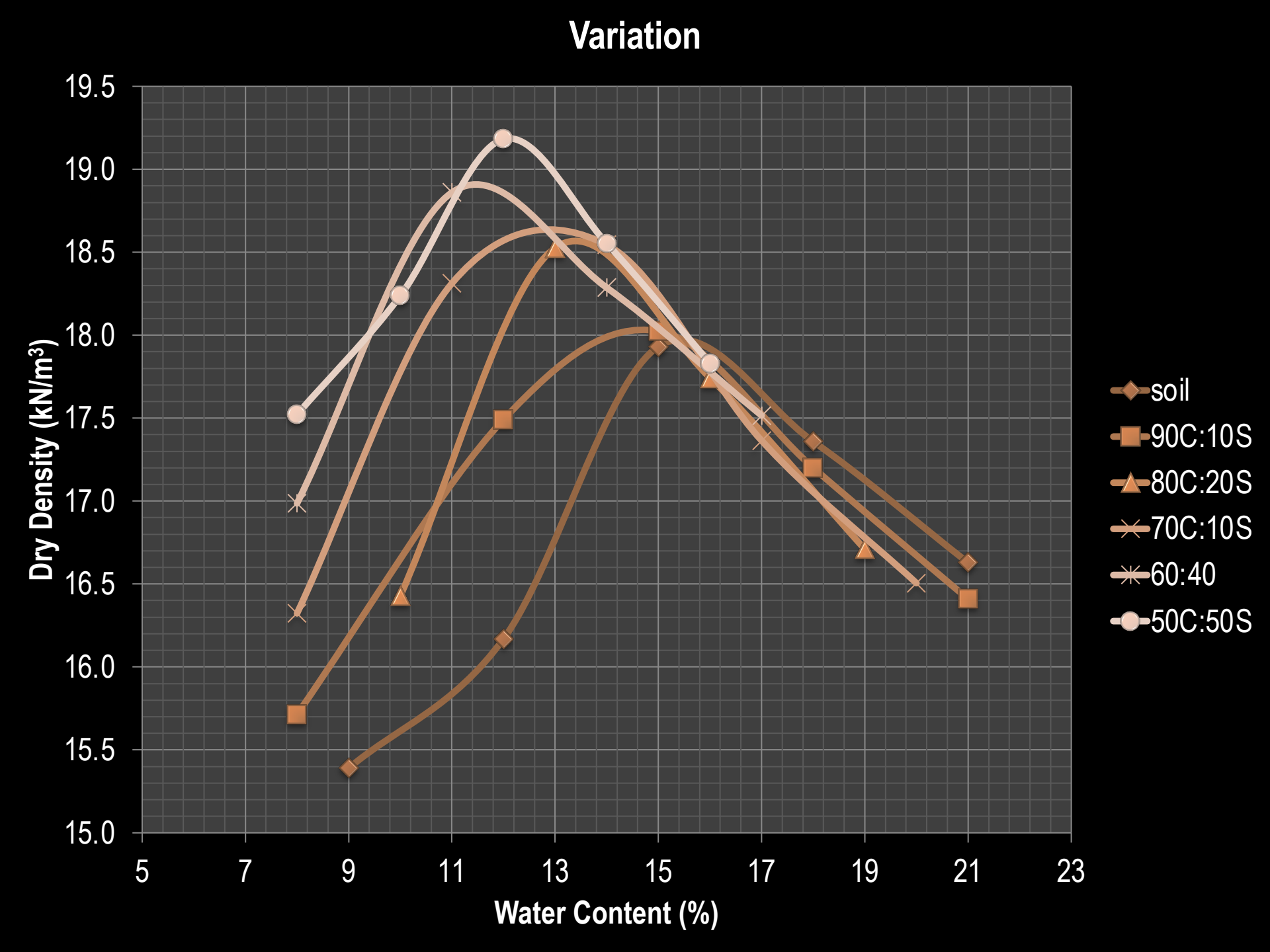


60(Soil):40(Sand)



50(Soil):50(Sand)



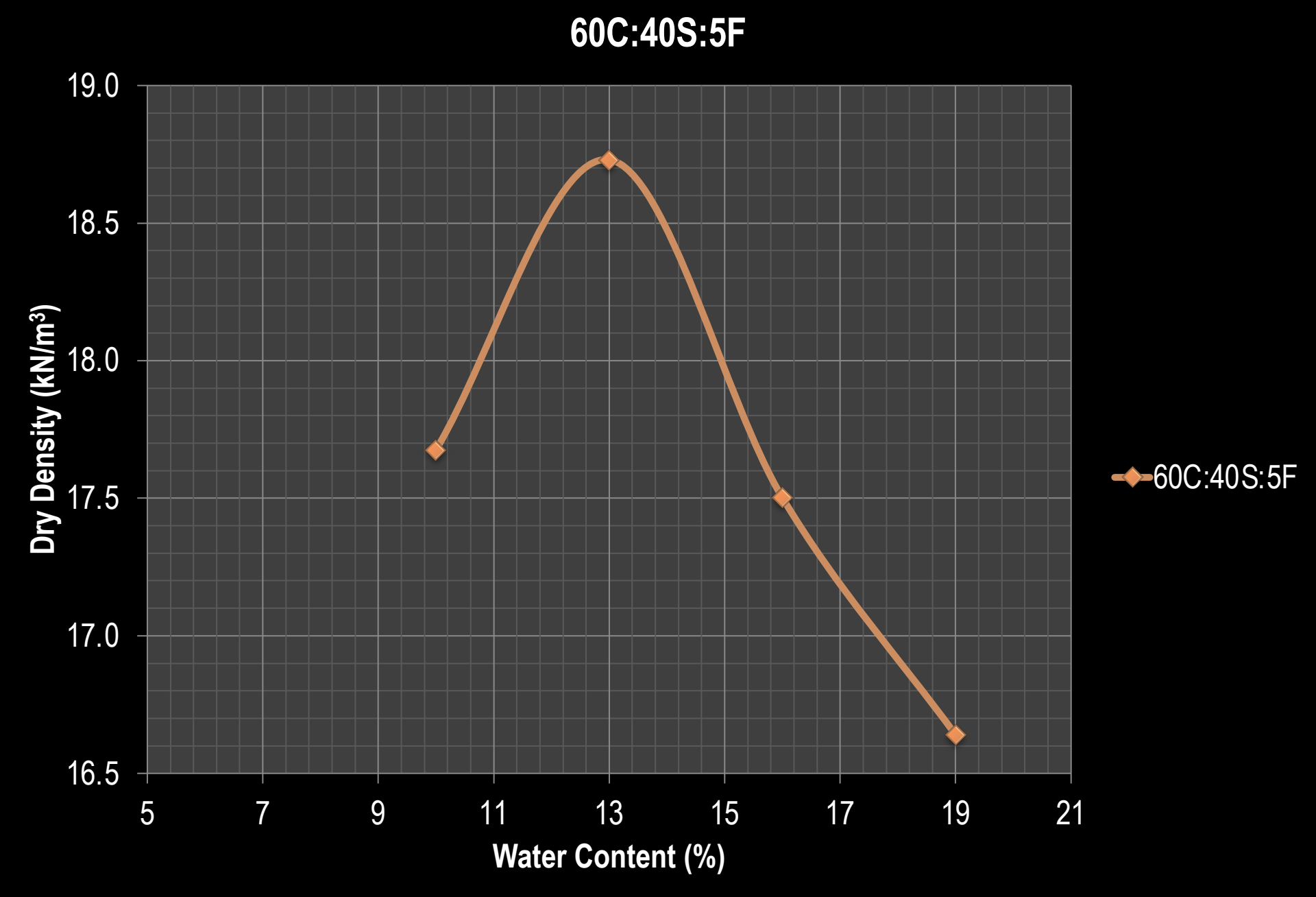

Variation
19.5
19.0
18.5
18.0
17.5
17.0
16.5
16.0
15.5
15.0
Dry Density (kN/m³)
5
7
9
11
13
15
17
19
21
23
Water Content (%)
soil
90C:10S
80C:20S
70C:10S
60:40
50C:50S

Mixture C: Clay S: Sand	Dry Density (kN/m^3)	Optimum Moisture Content (%)
100C:0S	18.0	15.5
90C:10S	18.1	15.0
80C:20S	18.5	13.5
70C:30S	18.6	13.0
60C:40S	18.9	12.5
50C:50S	19.2	12.0

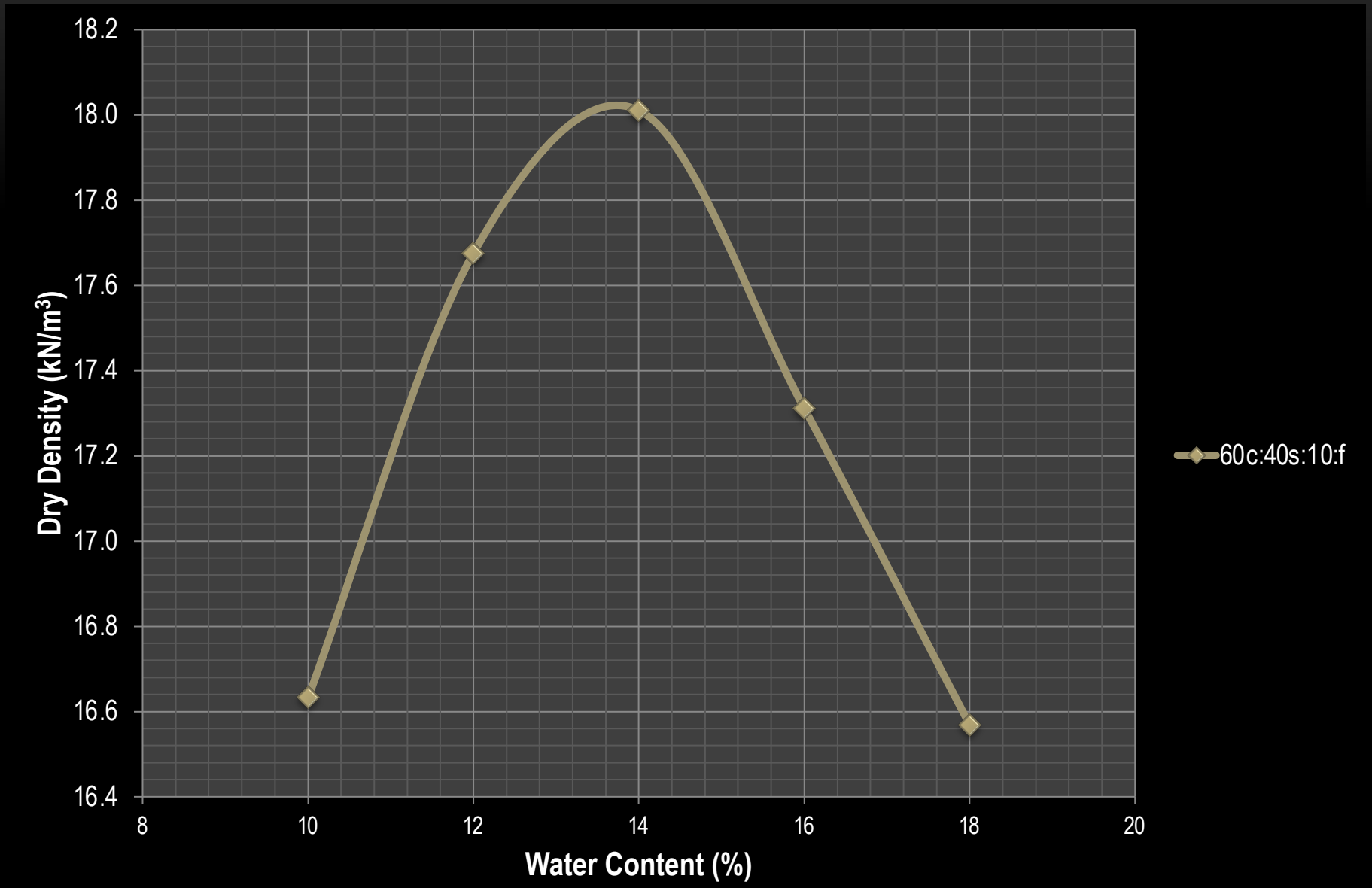
FOR MIXTURE ‘B’ PROCTOR WAS DONE FOR VARIOUS RATIOS

1) 60:40 and 70:30 are selected as the optimum mixers for making Mixture B.
2) Mixture B was made by adding fly-ash into Mixture A.
3) Various ratios are:
   - Mixture A(60:40): 5(Fly-ash)
   - Mixture A(60:40):10(Fly-ash)
   - Mixture A(60:40):15(Fly-ash)
   - Mixture A(60:40):20(Fly-ash)
   - Mixture A(70:30): 5(Fly-ash)
   - Mixture A(70:30):10(Fly-ash)
   - Mixture A(70:30):15(Fly-ash)
   - Mixture A(70:30):20(Fly-ash)

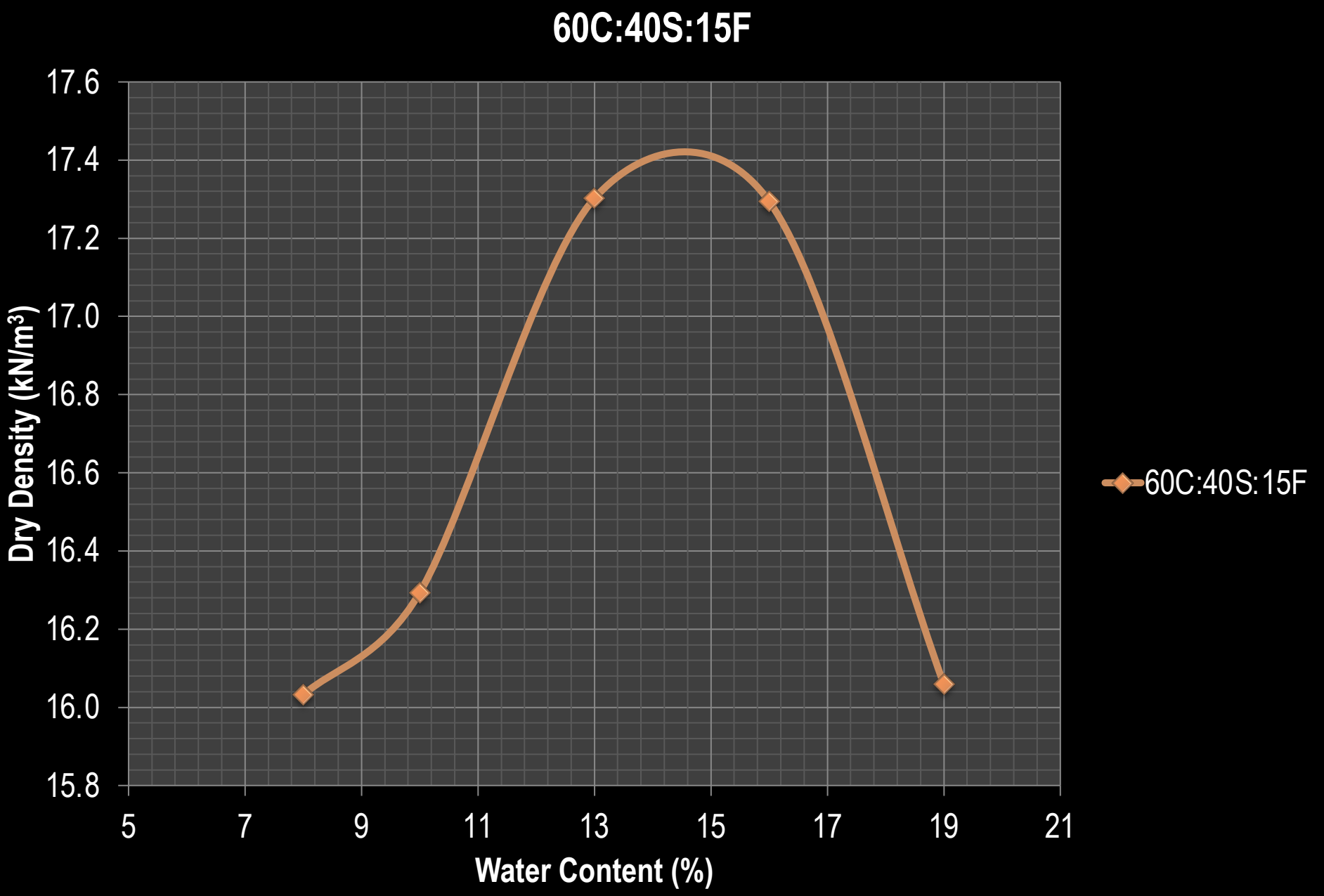
(60(Soil):40(Sand)):5(Fly-ash)



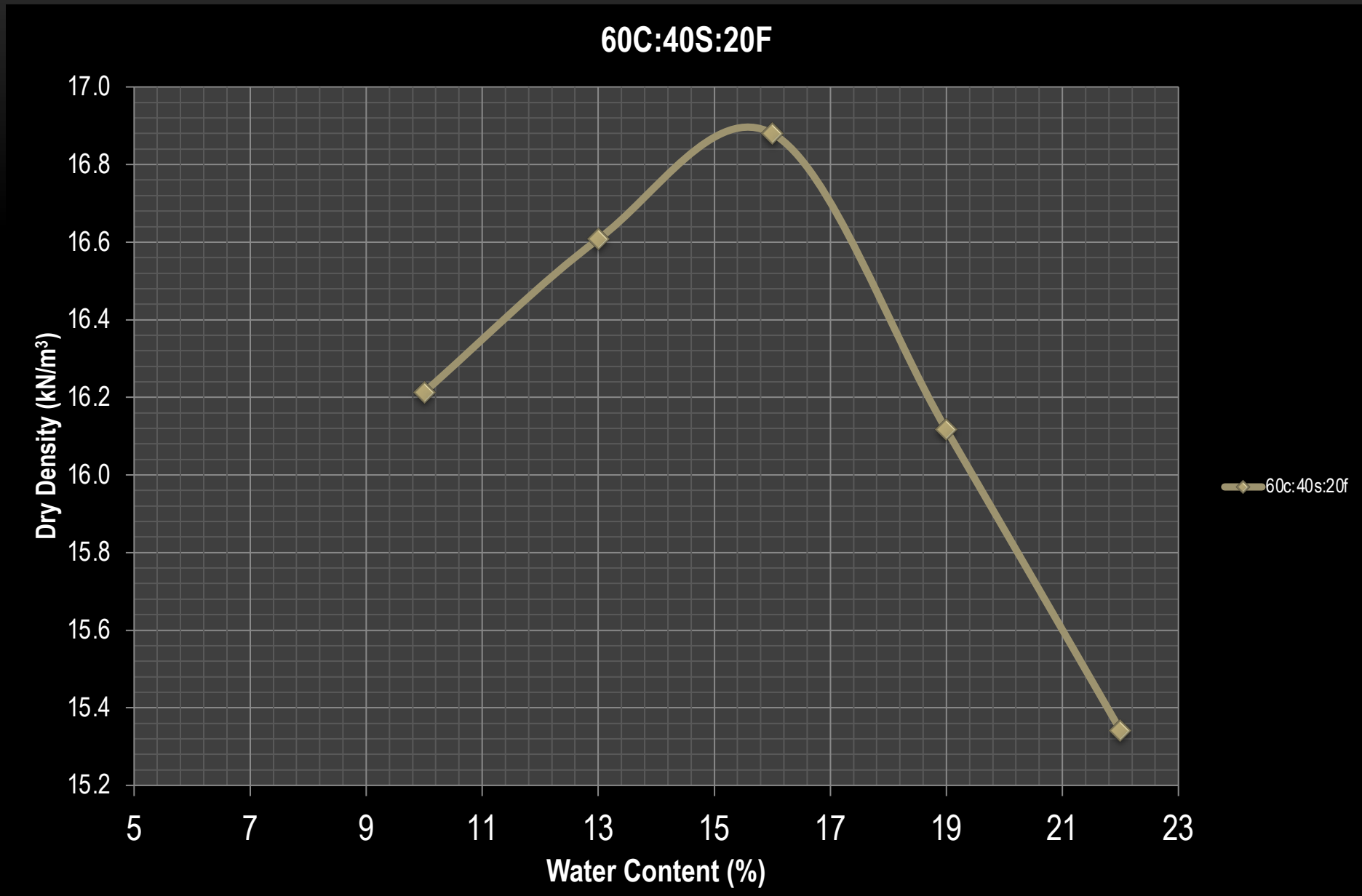
(60(Soil):40(Sand)):10(Fly-ash)

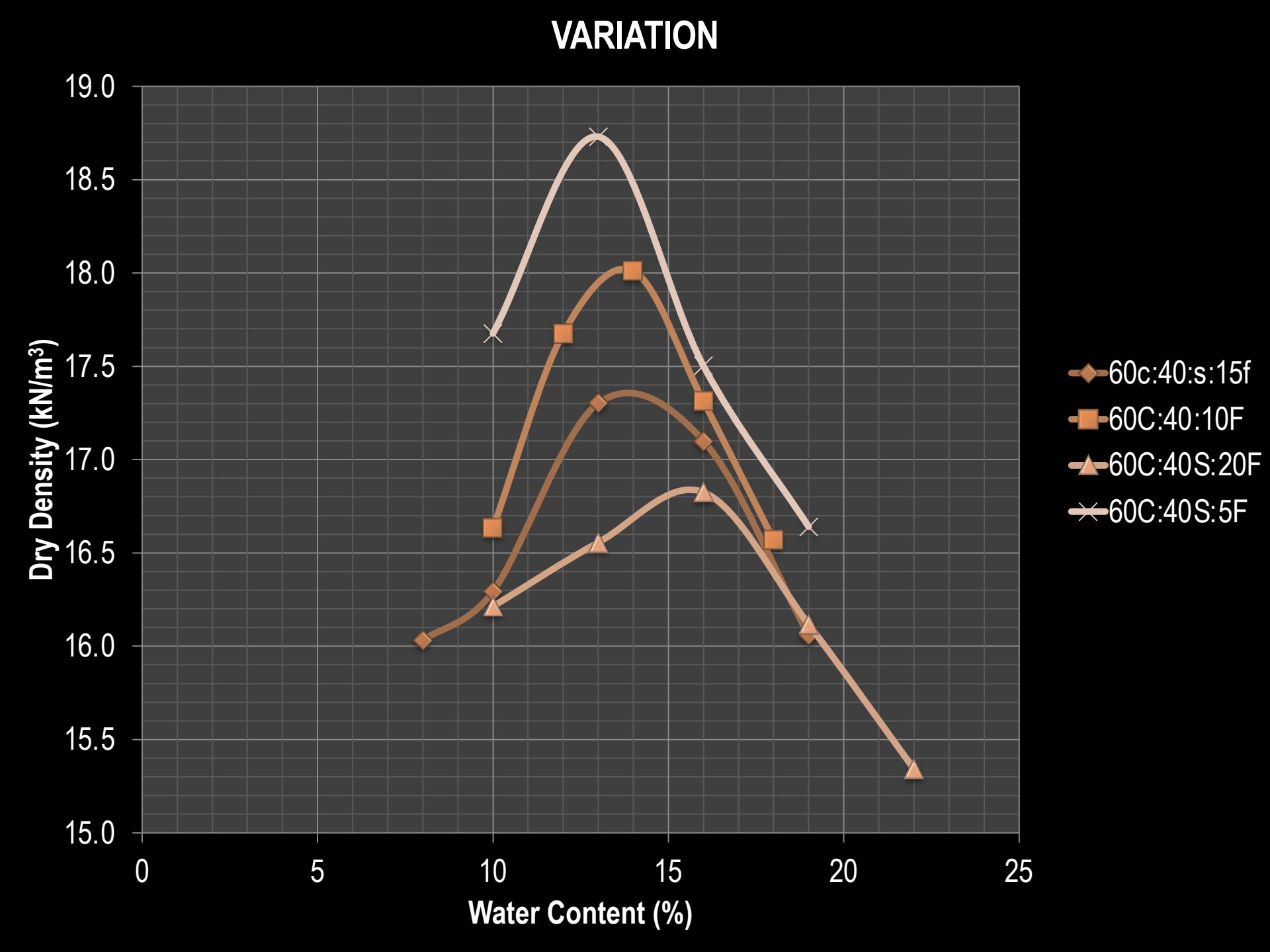


(60(Soil):40(Sand)):15(Fly-ash)

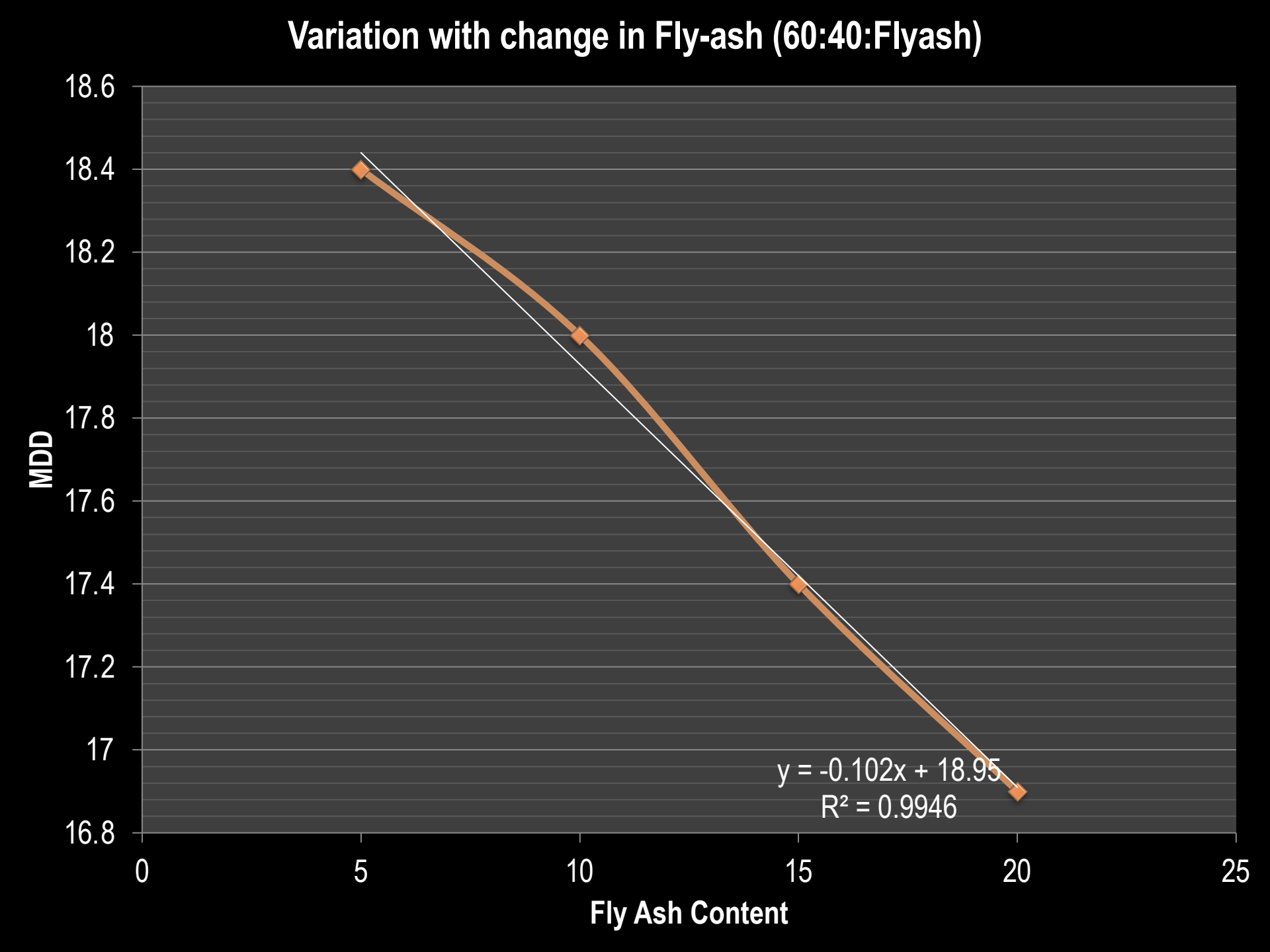


(60(Soil):40(Sand)):20(Fly-ash)

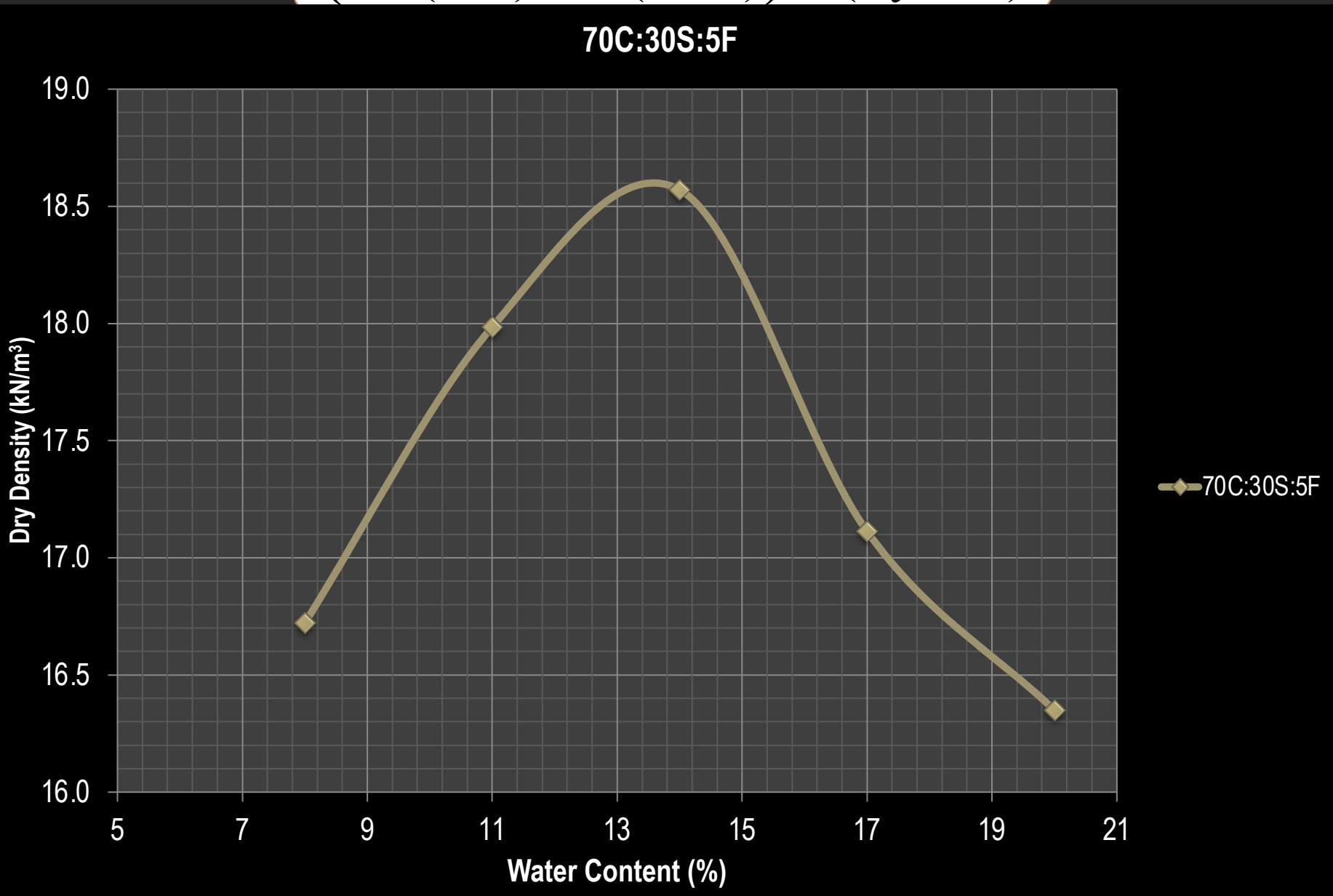



VARIATION
19.0
18.5
18.0
17.5
17.0
16.5
16.0
15.5
15.0
Dry Density (kN/m³)
0
5
10
15
20
25
Water Content (%)
60c:40:s:15f
60C:40:10F
60C:40S:20F
60C:40S:5F

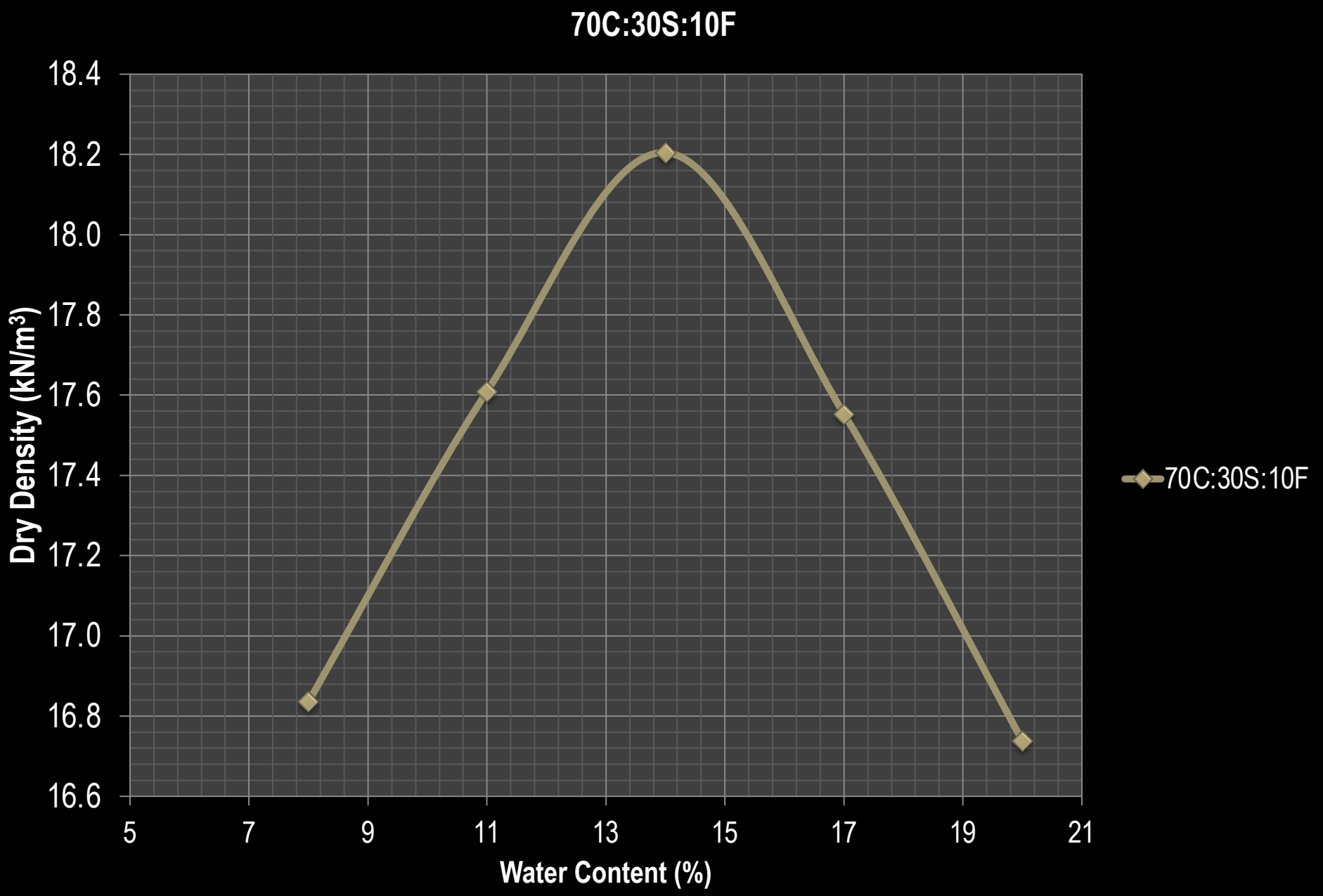
Ratio	Maximum Dry Density (KN/m^3)	Optimum Moisture Content (%)
60C:40S:5F	18.7	13.0
60C:40S:10F	18.0	14.0
60C:40S:15F	17.4	15.0
60C:40S:20F	16.9	16.0


Variation with change in Fly-ash (60:40:Flyash)
MDD
18.6
18.4
18.2
18
17.8
17.6
17.4
17.2
17
16.8
0
5
10
15
20
25
Fly Ash Content
y = -0.102x + 18.95
R² = 0.9946

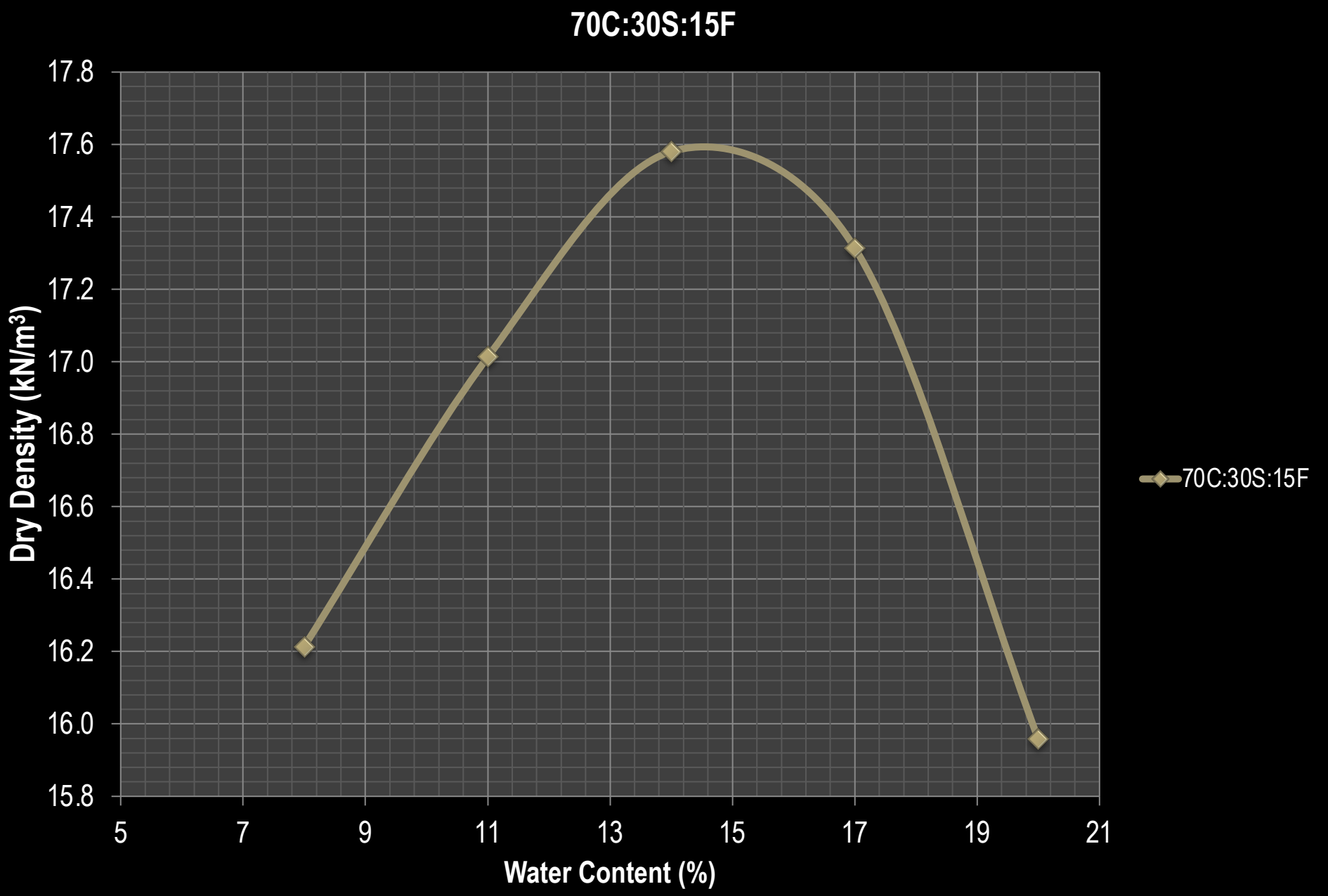
(70(soil):30(sand)):5(fly-ash)



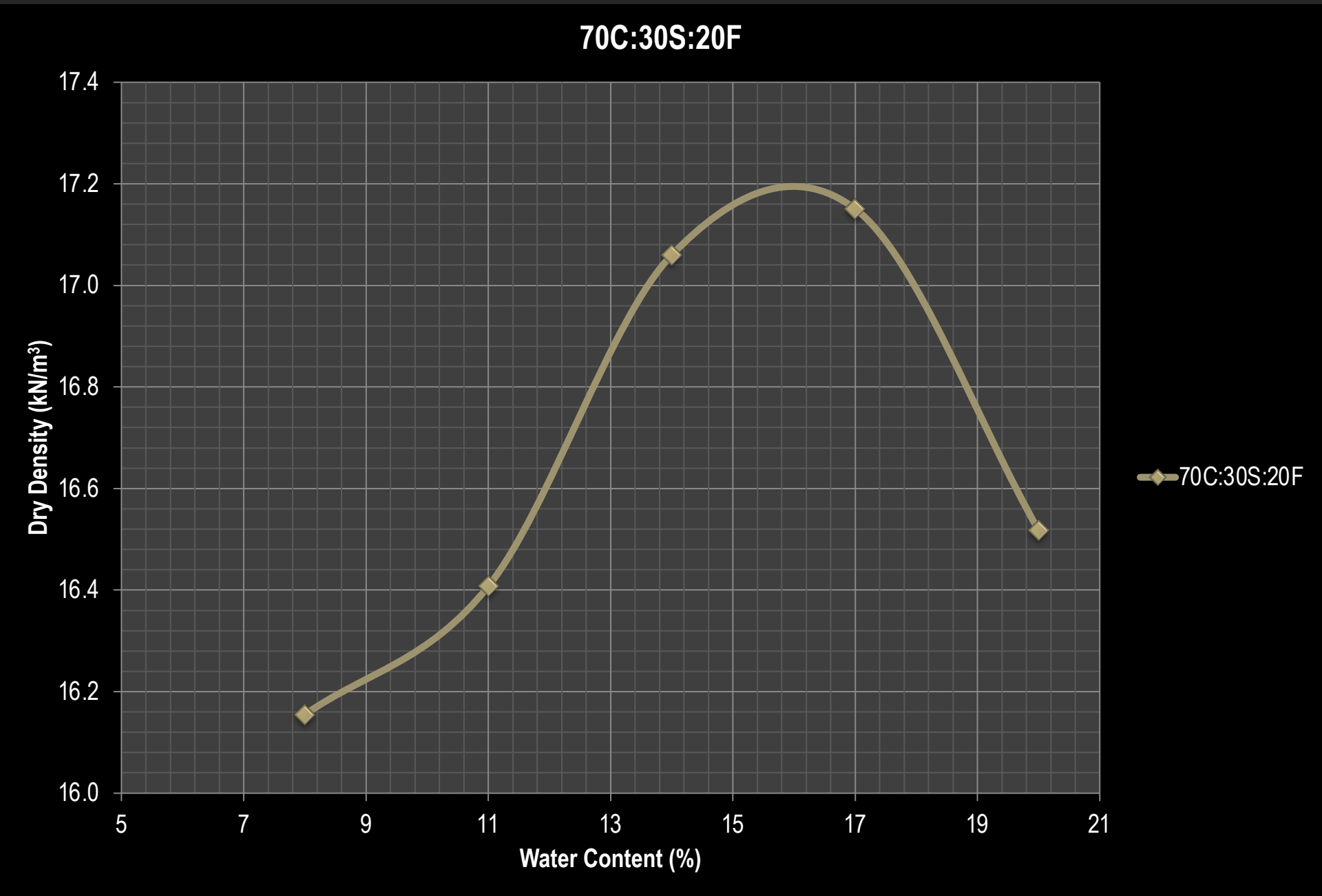
(70(soil):30(sand)):10(fly-ash)

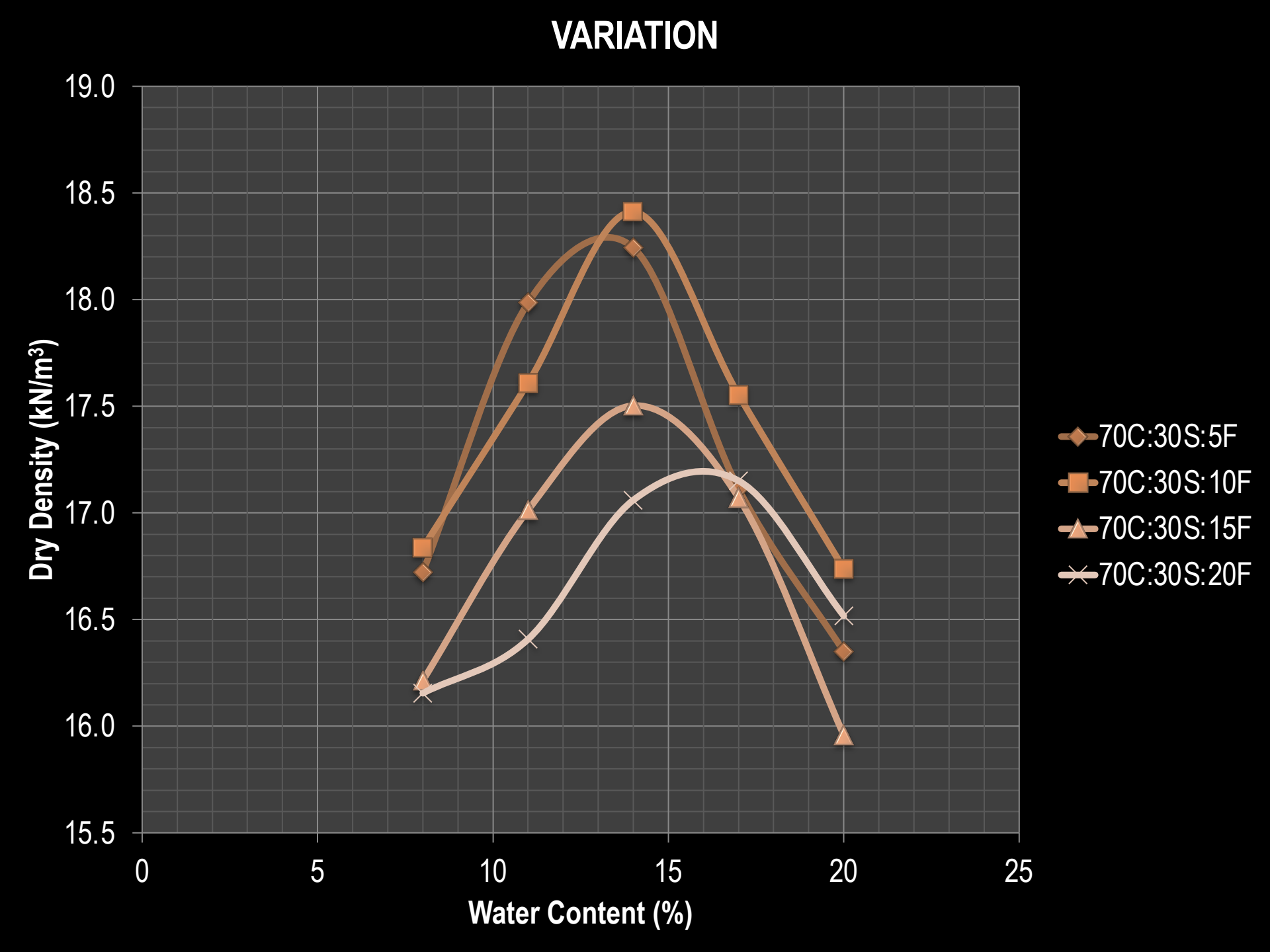


(70(soil):30(sand)):15(fly-ash)

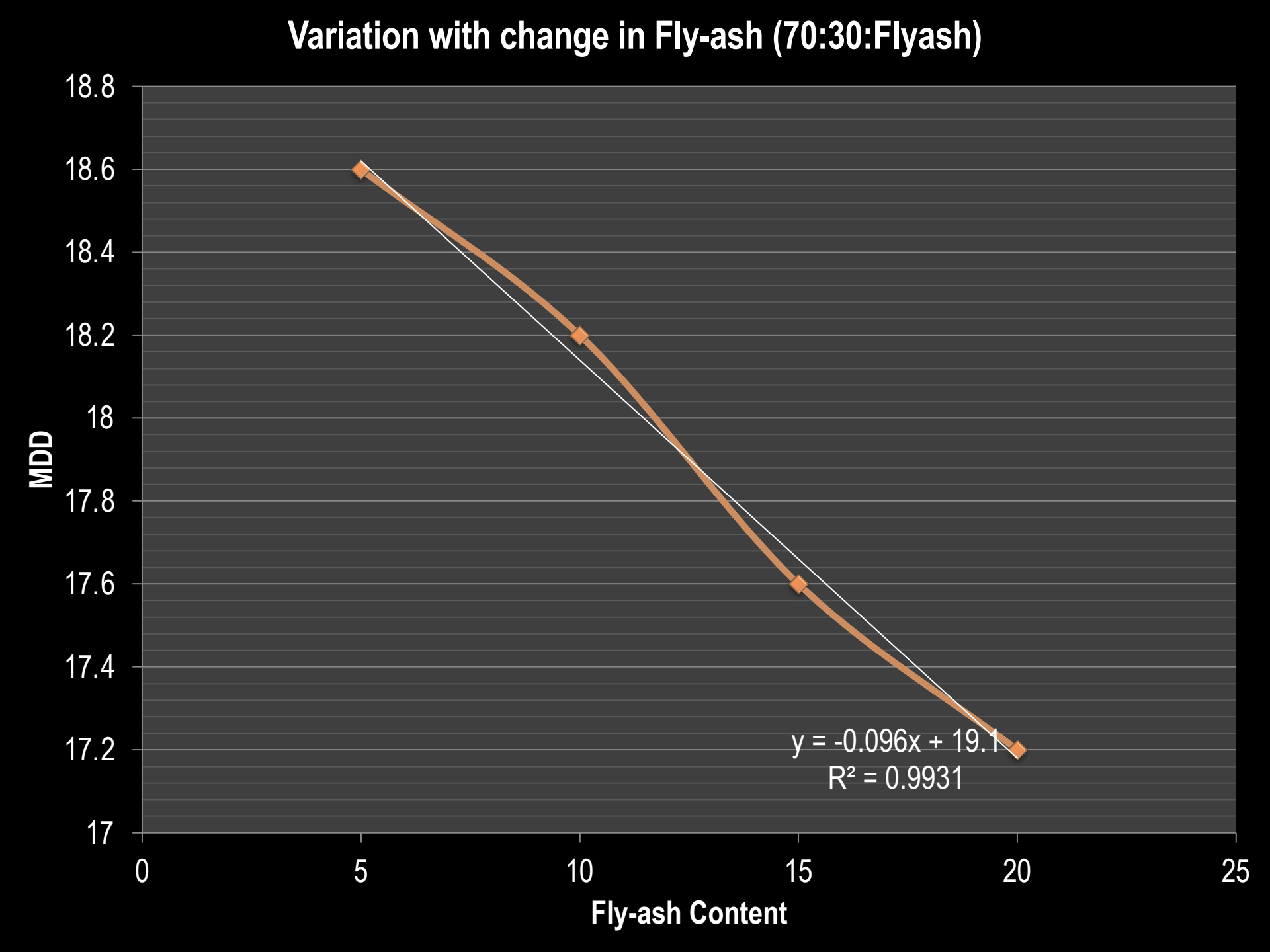


(70(soil):30(sand)):20(fly-ash)




VARIATION
19.0
18.5
18.0
17.5
17.0
16.5
16.0
15.5
Dry Density (kN/m³)
0
5
10
15
20
25
Water Content (%)
70C:30S:5F
70C:30S:10F
70C:30S:15F
70C:30S:20F

Ratio	Maximum Dry Density (KN/m^3)	Optimum Moisture Content (%)
(70C:30S):5F	18.6	13
(70C:30S):10F	18.2	14
(70C:30S):15F	17.6	15
(70C:30S):20F	17.2	16.5

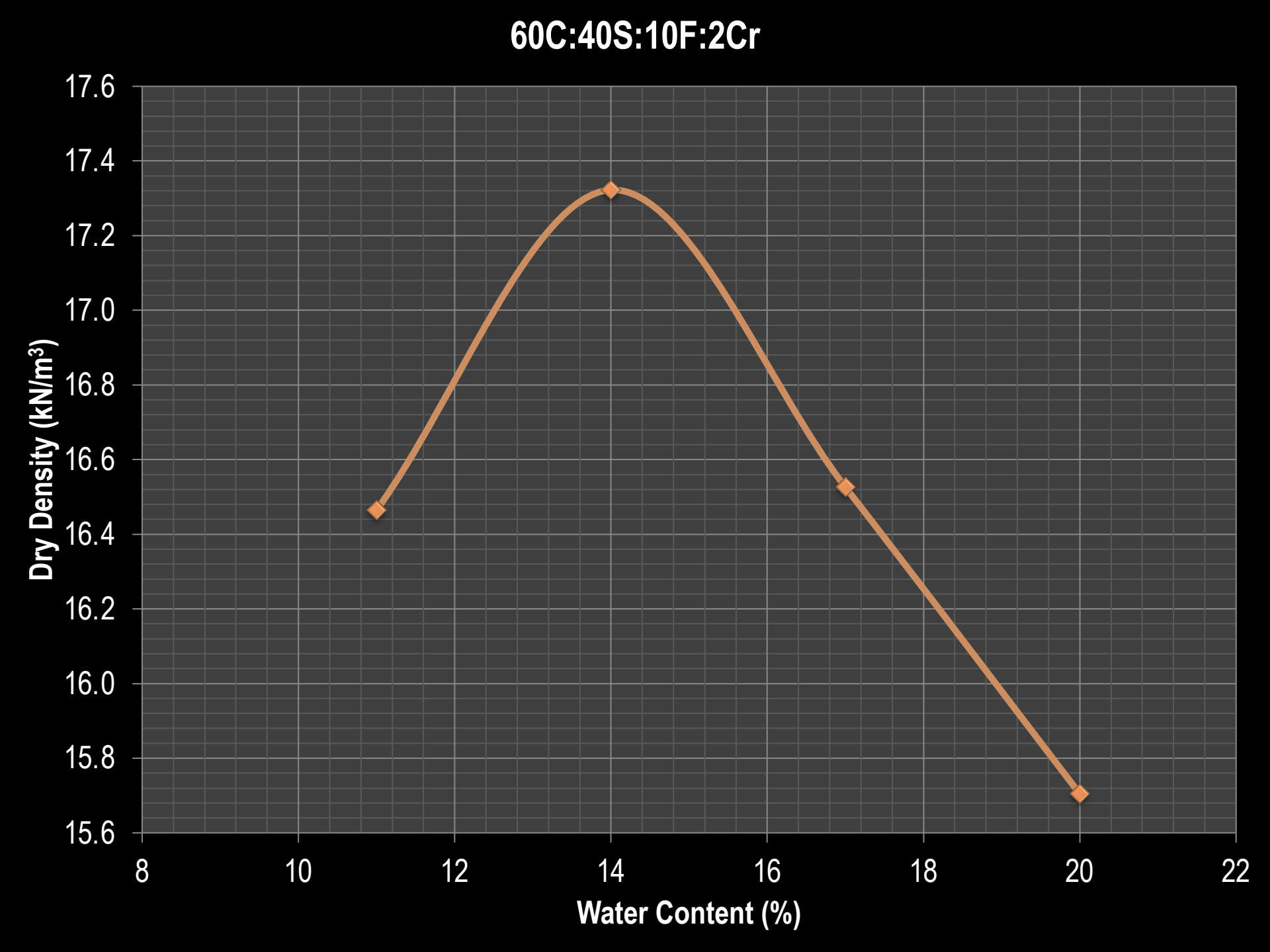

Variation with change in Fly-ash (70:30:Flyash)
MDD
18.8
18.6
18.4
18.2
18
17.8
17.6
17.4
17.2
17
0
5
10
15
20
25
Fly-ash Content
y = -0.096x + 19.1
R² = 0.9931

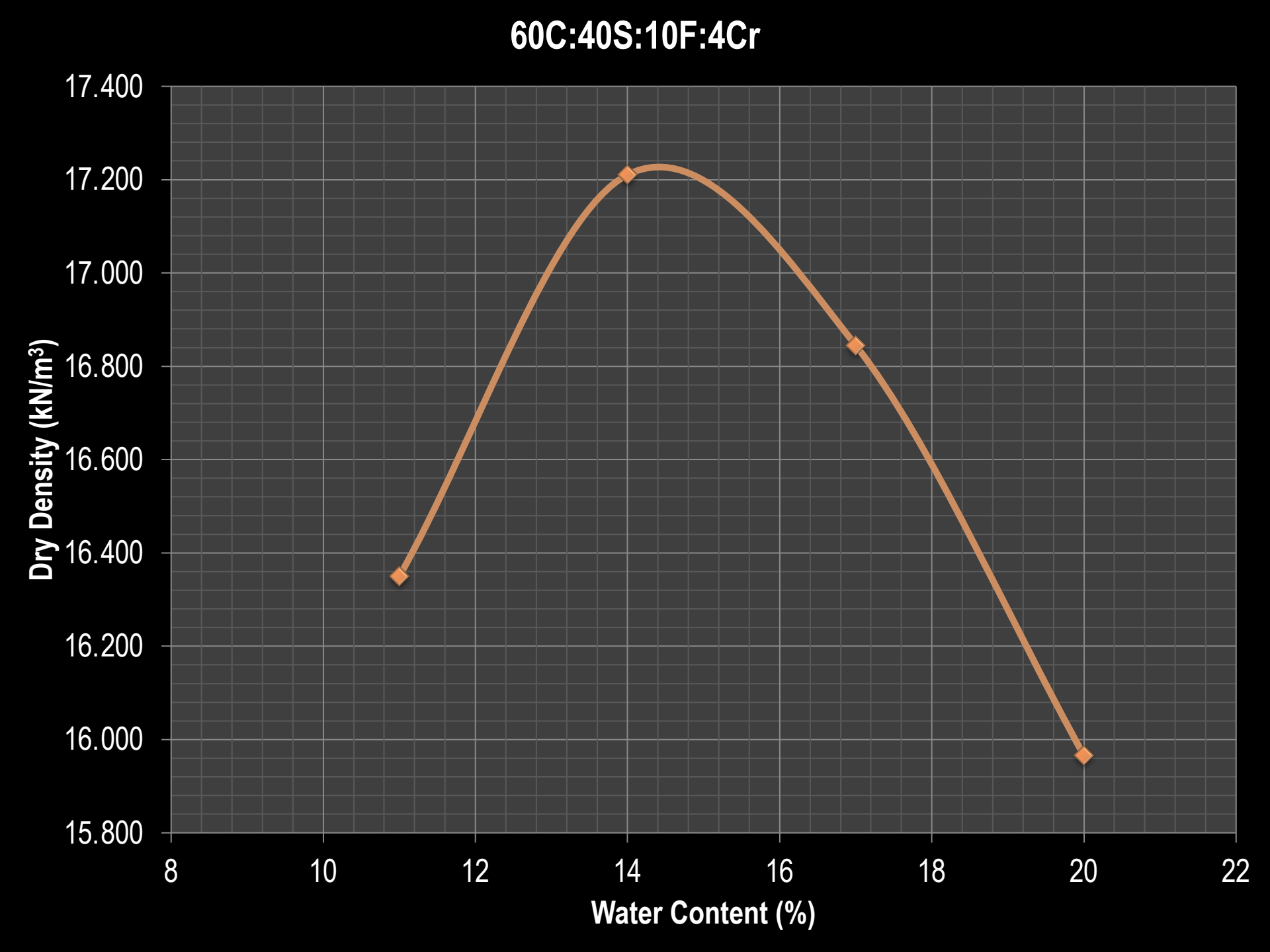
FOR MIXTURE ‘C’ PROCTOR WAS DONE FOR VARIOUS RATIOS

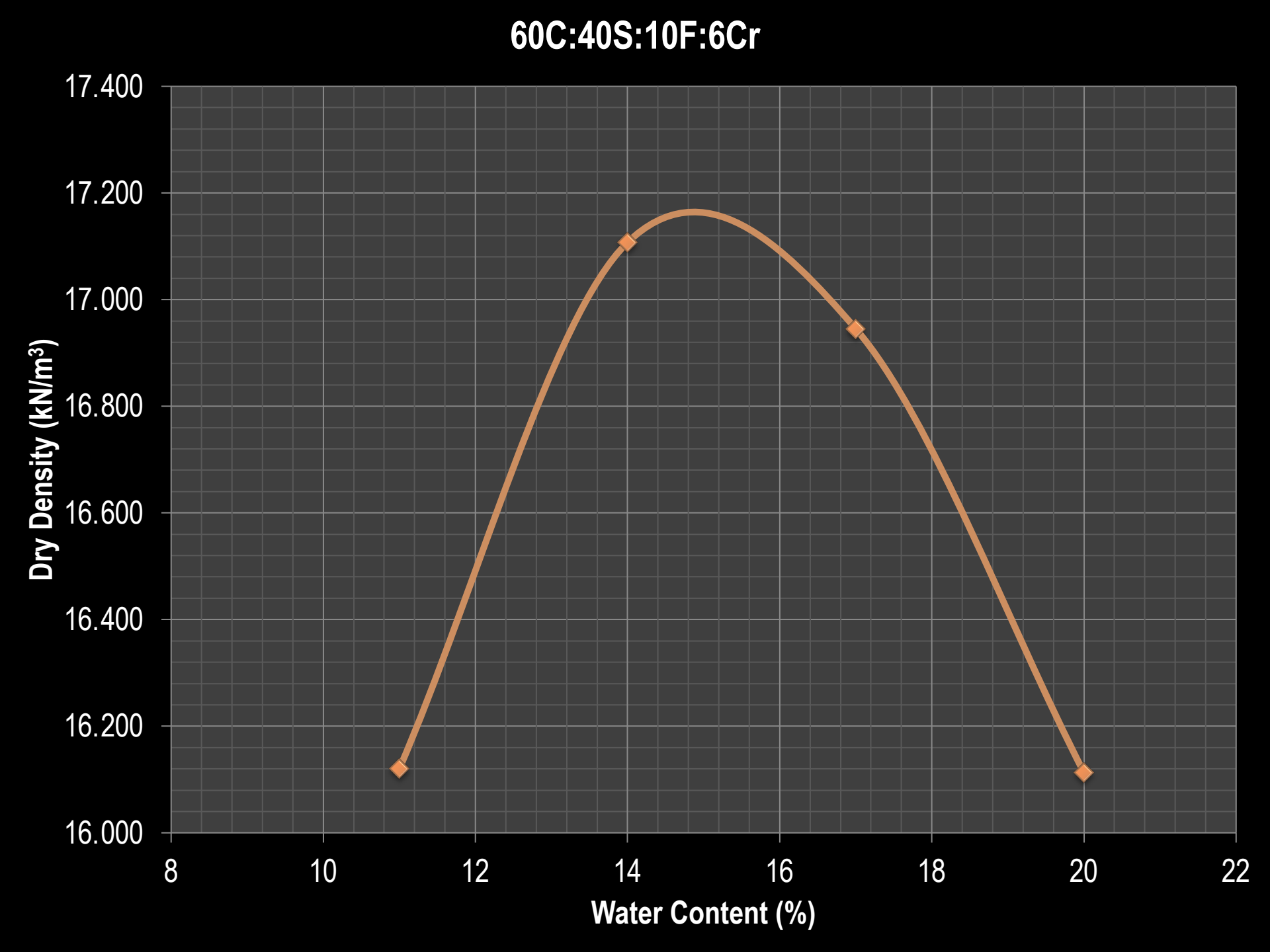
1) (60C:40S):10F and (70C:30S):10F are selected as the optimum mixers for making Mixture C.
2) Mixture C was made by adding ceramics into Mixture B.
3) Various ratios are:

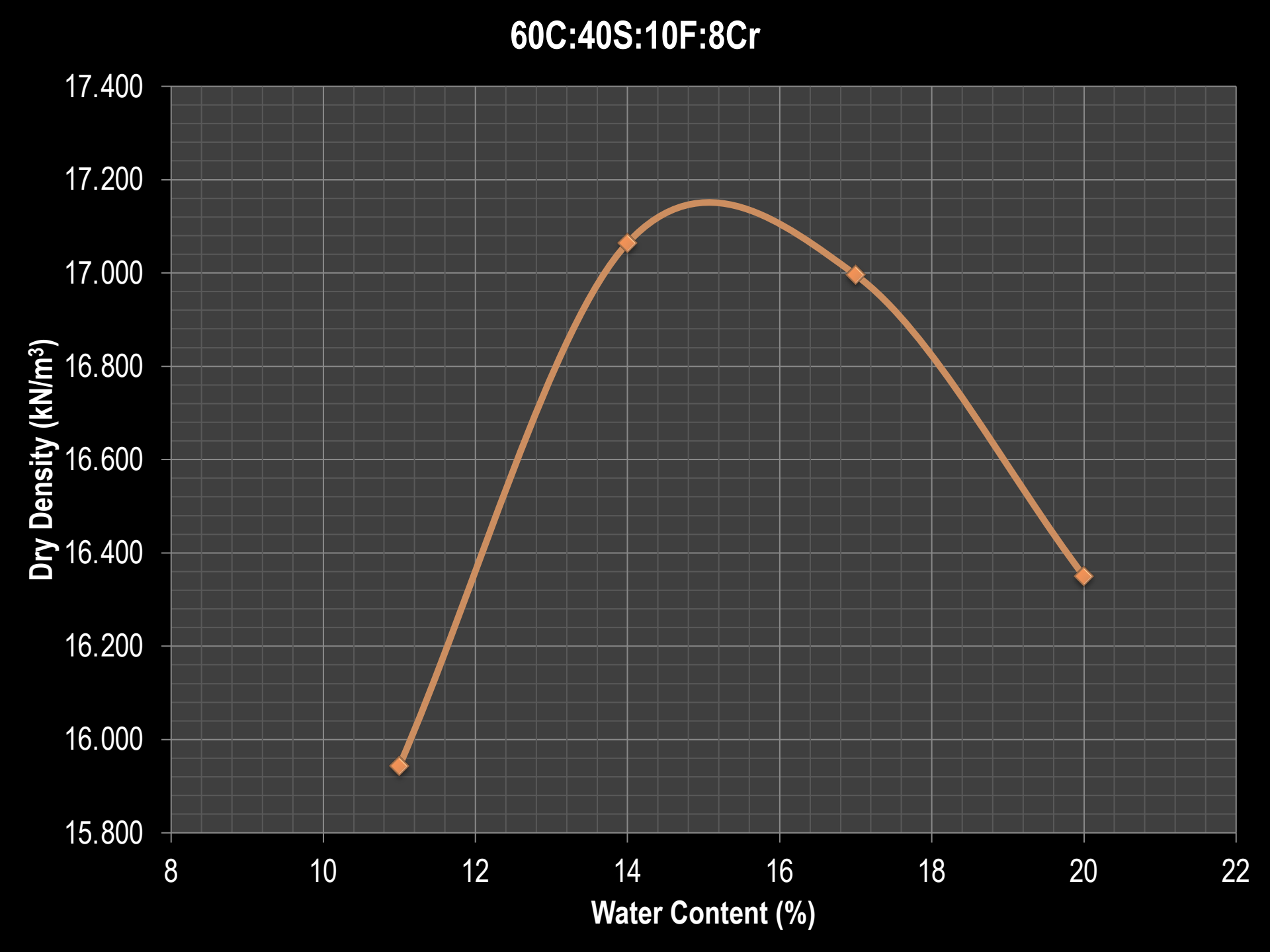
- [(60C:40S):10F]: 2 Ceramics
- [(60C:40S):10F]: 4 Ceramics
- [(60C:40S):10F]: 6 Ceramics
- [(60C:40S):10F]: 8 Ceramics

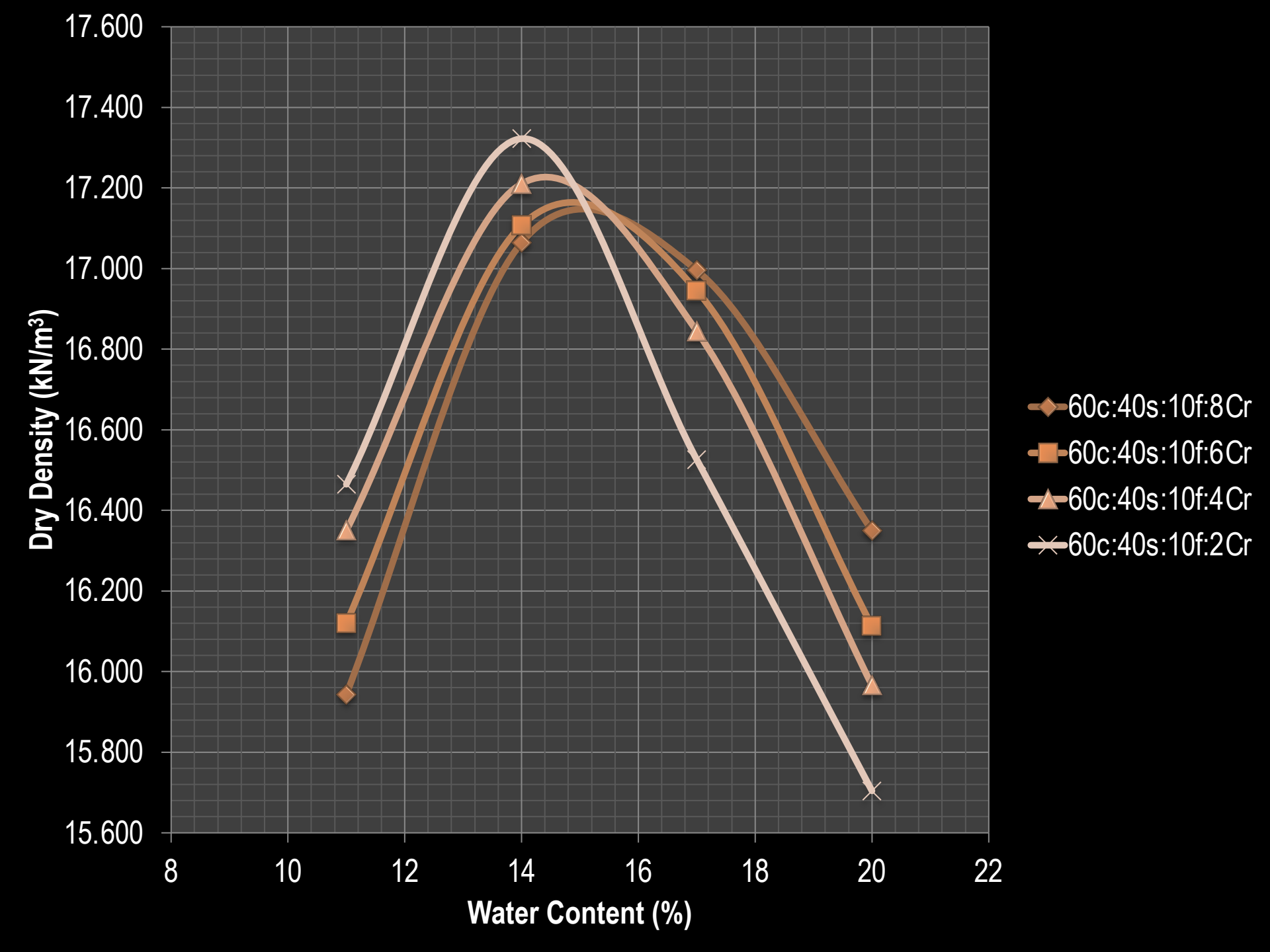
- [(70C:30S):10F]: 2Ceramics
- [(70C:30S):10F]: 4Ceramics
- [(70C:30S):10F]: 6Ceramics


60C:40S:10F:2Cr
17.6
17.4
17.2
17.0
16.8
16.6
16.4
16.2
16.0
15.8
15.6
Dry Density (kN/m³)
8
10
12
14
16
18
20
22
Water Content (%)

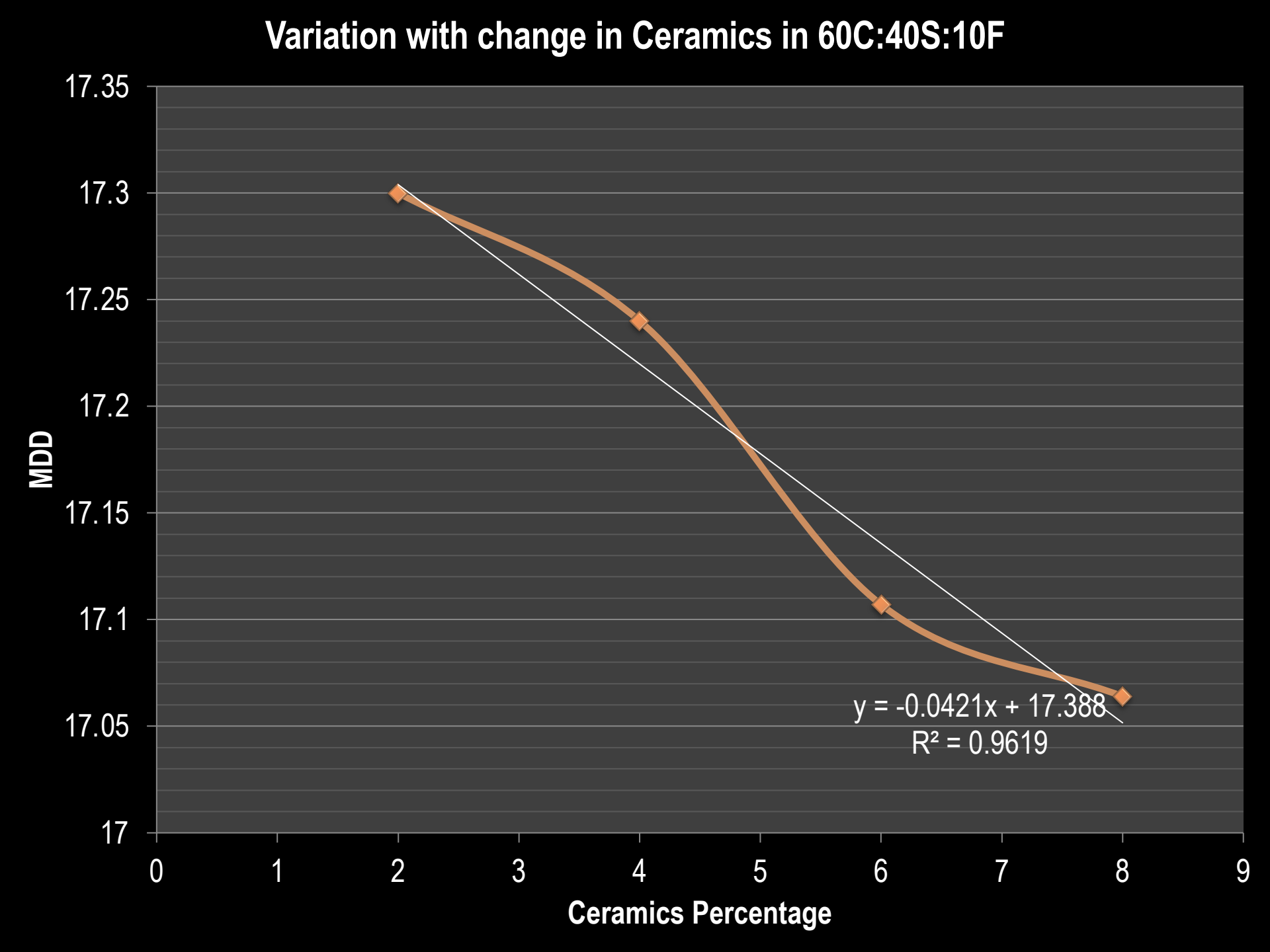

60C:40S:10F:4Cr
17.400
17.200
17.000
16.800
16.600
16.400
16.200
16.000
15.800
Dry Density (kN/m³)
8
10
12
14
16
18
20
22
Water Content (%)

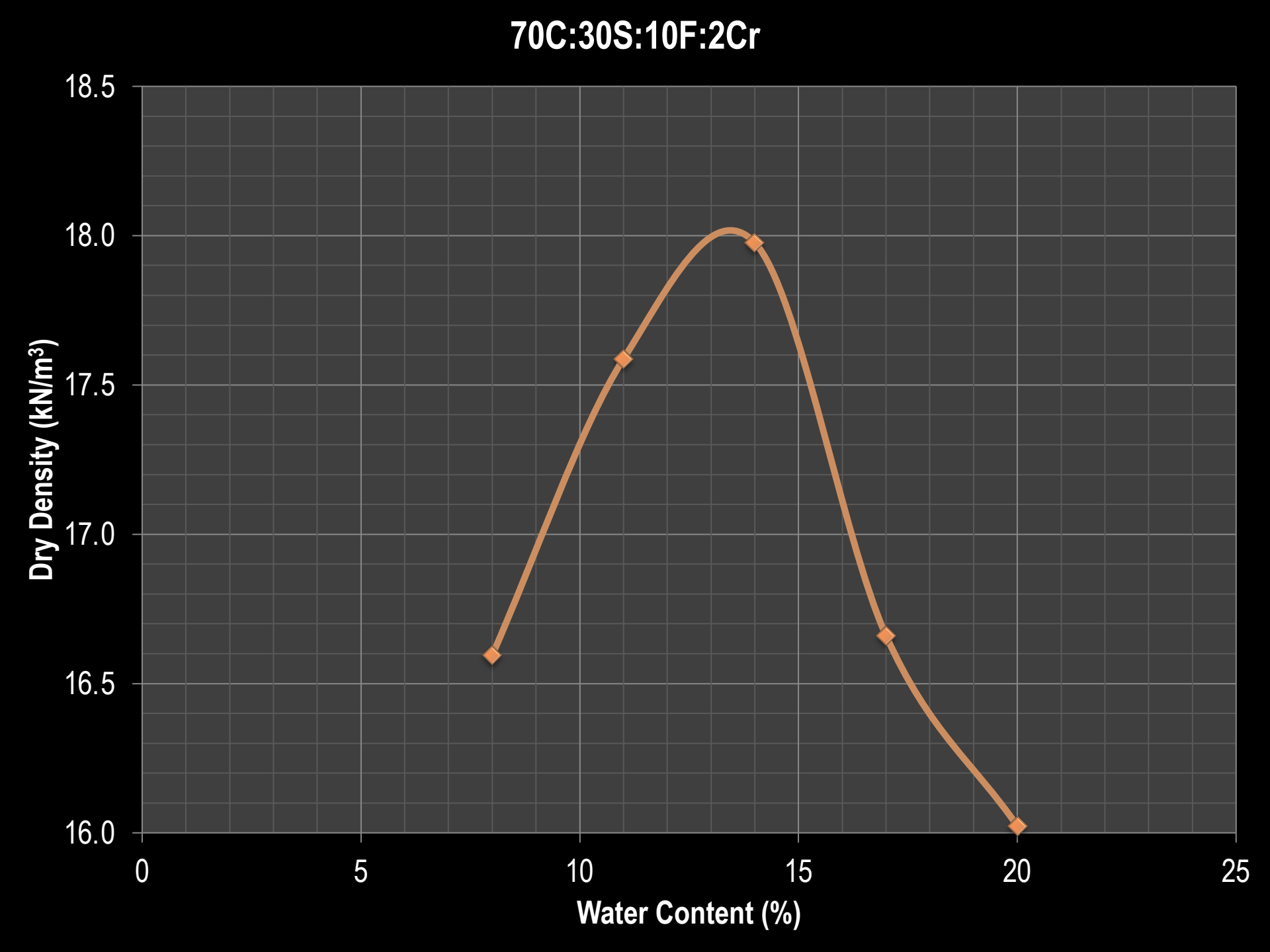

60C:40S:10F:6Cr
17.400
17.200
17.000
16.800
16.600
16.400
16.200
16.000
Dry Density (kN/m³)
8
10
12
14
16
18
20
22
Water Content (%)

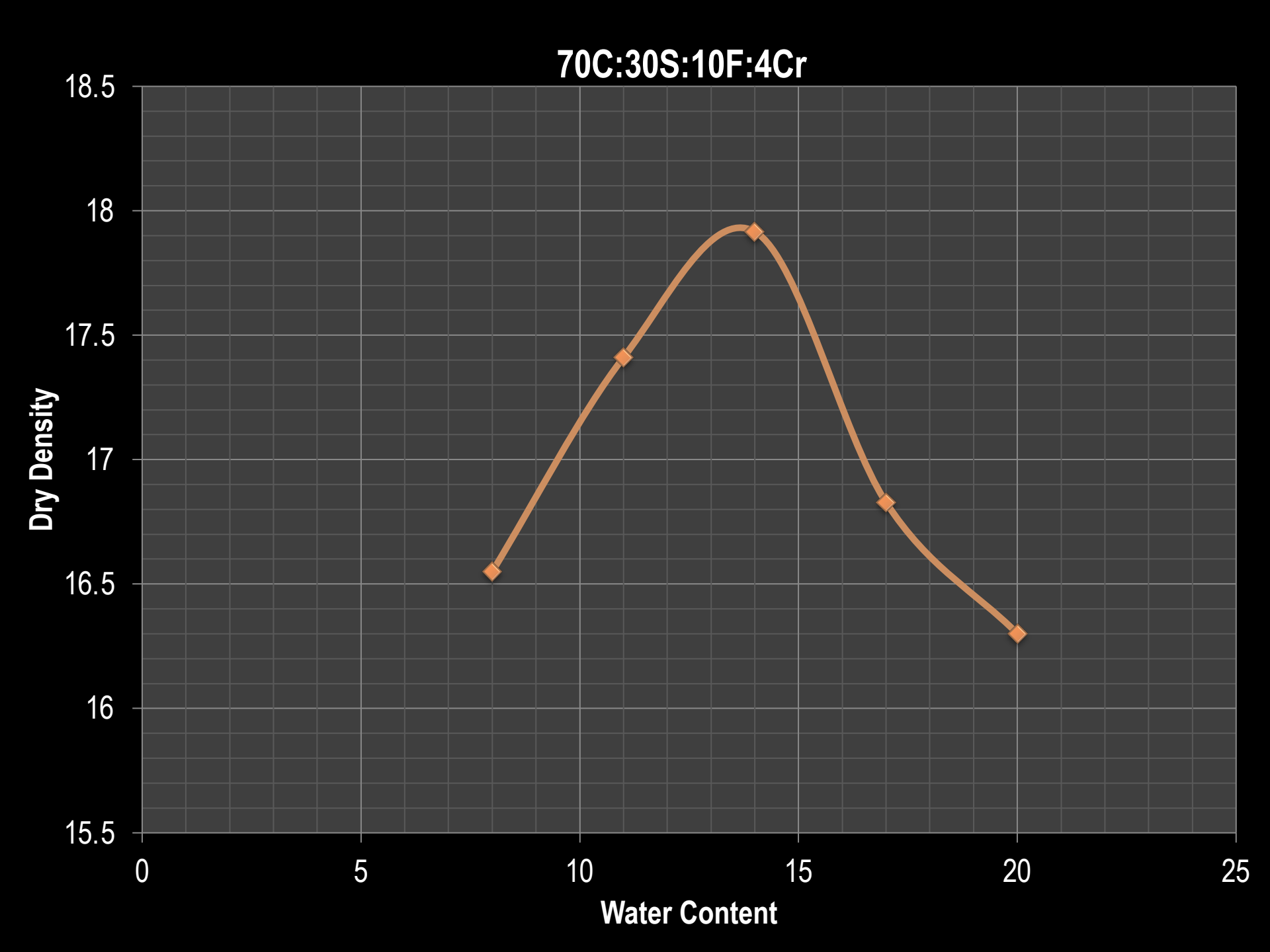

60C:40S:10F:8Cr
17.400
17.200
17.000
16.800
16.600
16.400
16.200
16.000
15.800
Dry Density (kN/m³)
8
10
12
14
16
18
20
22
Water Content (%)

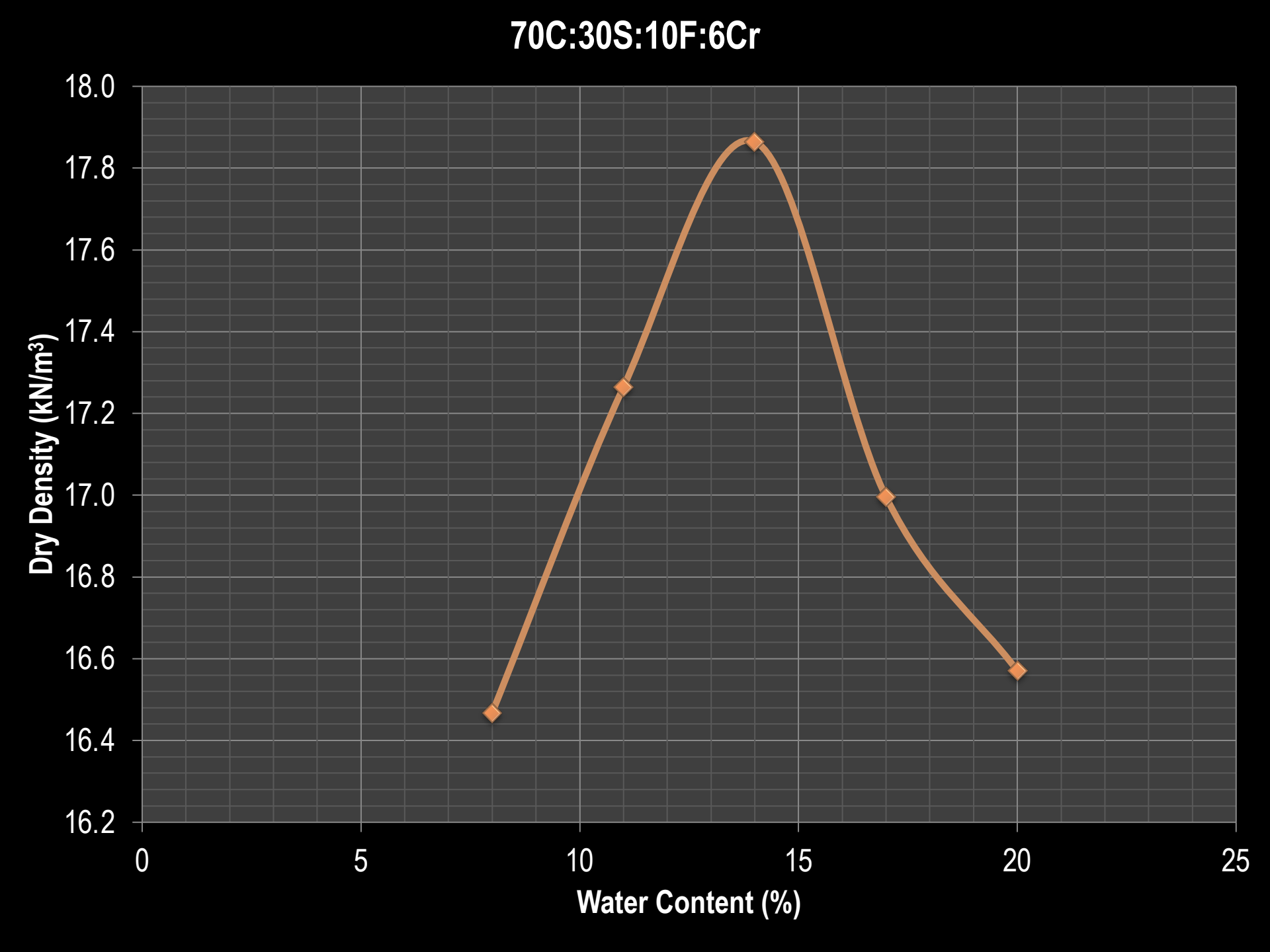

17.600
17.400
17.200
17.000
16.800
16.600
16.400
16.200
16.000
15.800
15.600
Dry Density (kN/m³)
8
10
12
14
16
18
20
22
Water Content (%)
60c:40s:10f:8Cr
60c:40s:10f:6Cr
60c:40s:10f:4Cr
60c:40s:10f:2Cr

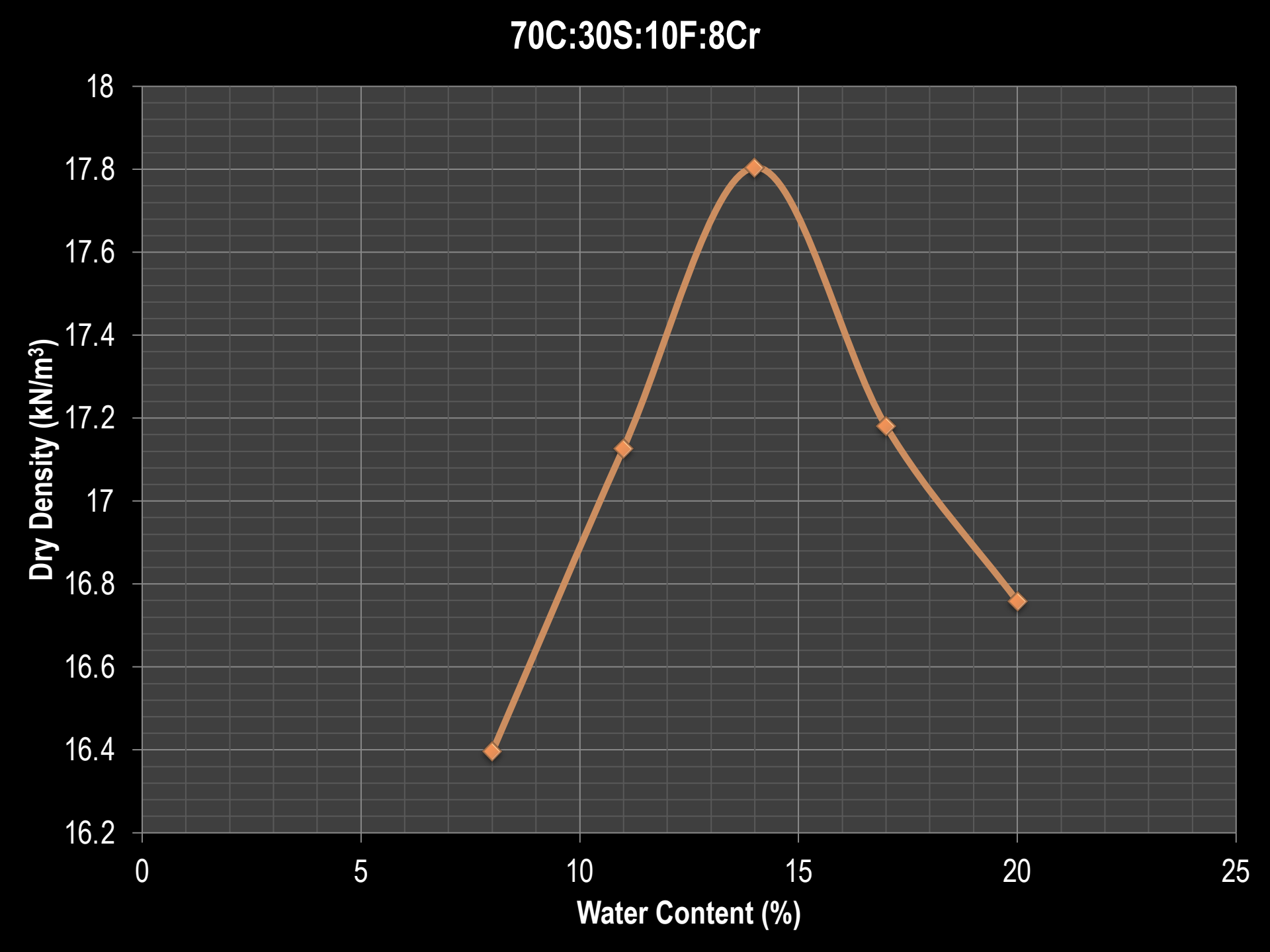
Ratio	Maximum Dry Density (KN/m^3)	Optimum Moisture Content (%)
60C:40S:10F:2Cr	17.32	14
60C:40S:10F:4Cr	17.2	14.4
60C:40S:10F:6Cr	17.16	14.7
60C:40S:10F:8Cr	17.1	15

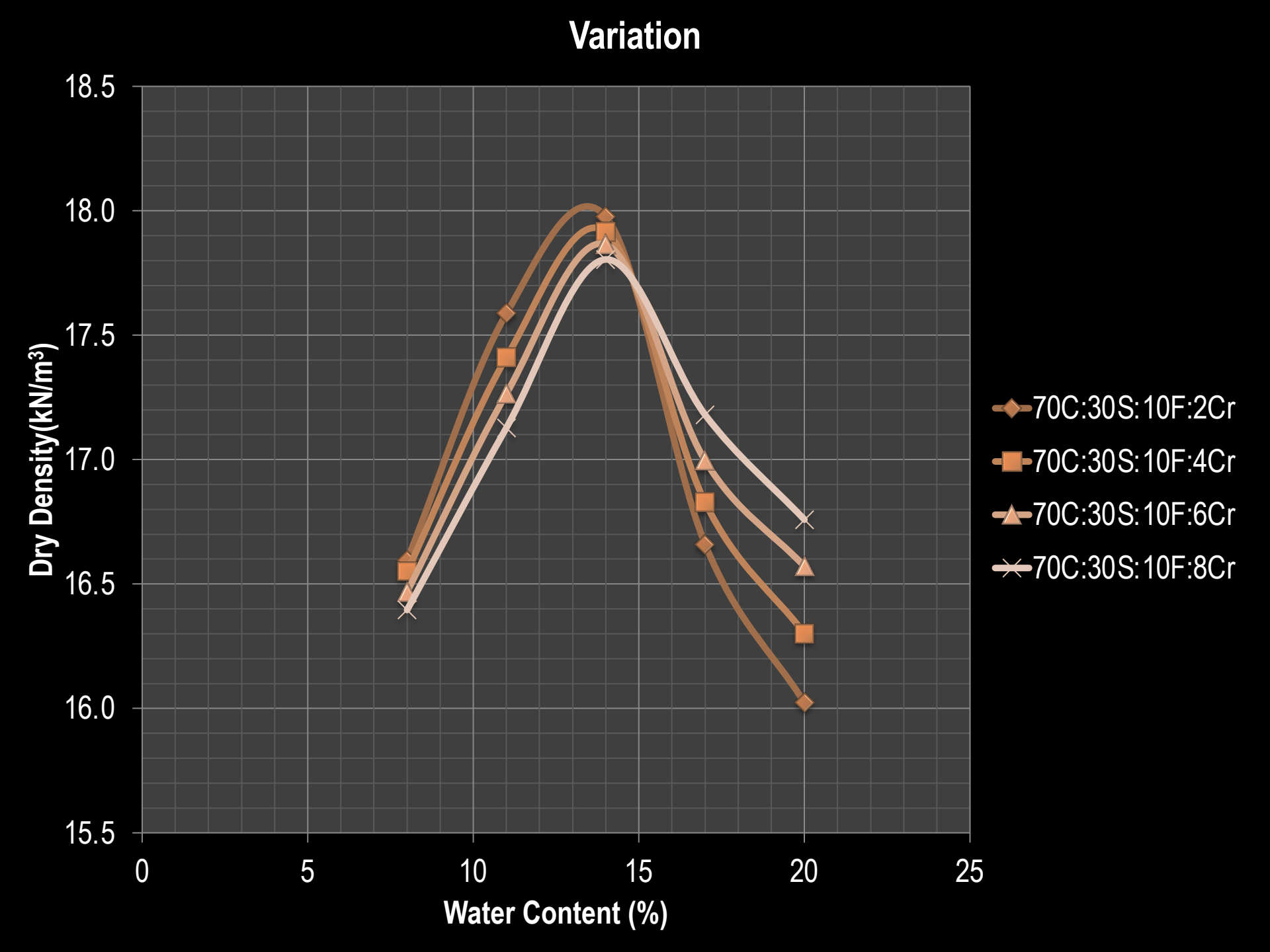

Variation with change in Ceramics in 60C:40S:10F
17.35
17.3
17.25
17.2
17.15
17.1
17.05
17
MDD
0
1
2
3
4
5
6
7
8
9
Ceramics Percentage
y = -0.0421x + 17.388
R² = 0.9619


70C:30S:10F:2Cr
18.5
18.0
17.5
17.0
16.5
16.0
Dry Density (kN/m³)
0
5
10
15
20
25
Water Content (%)

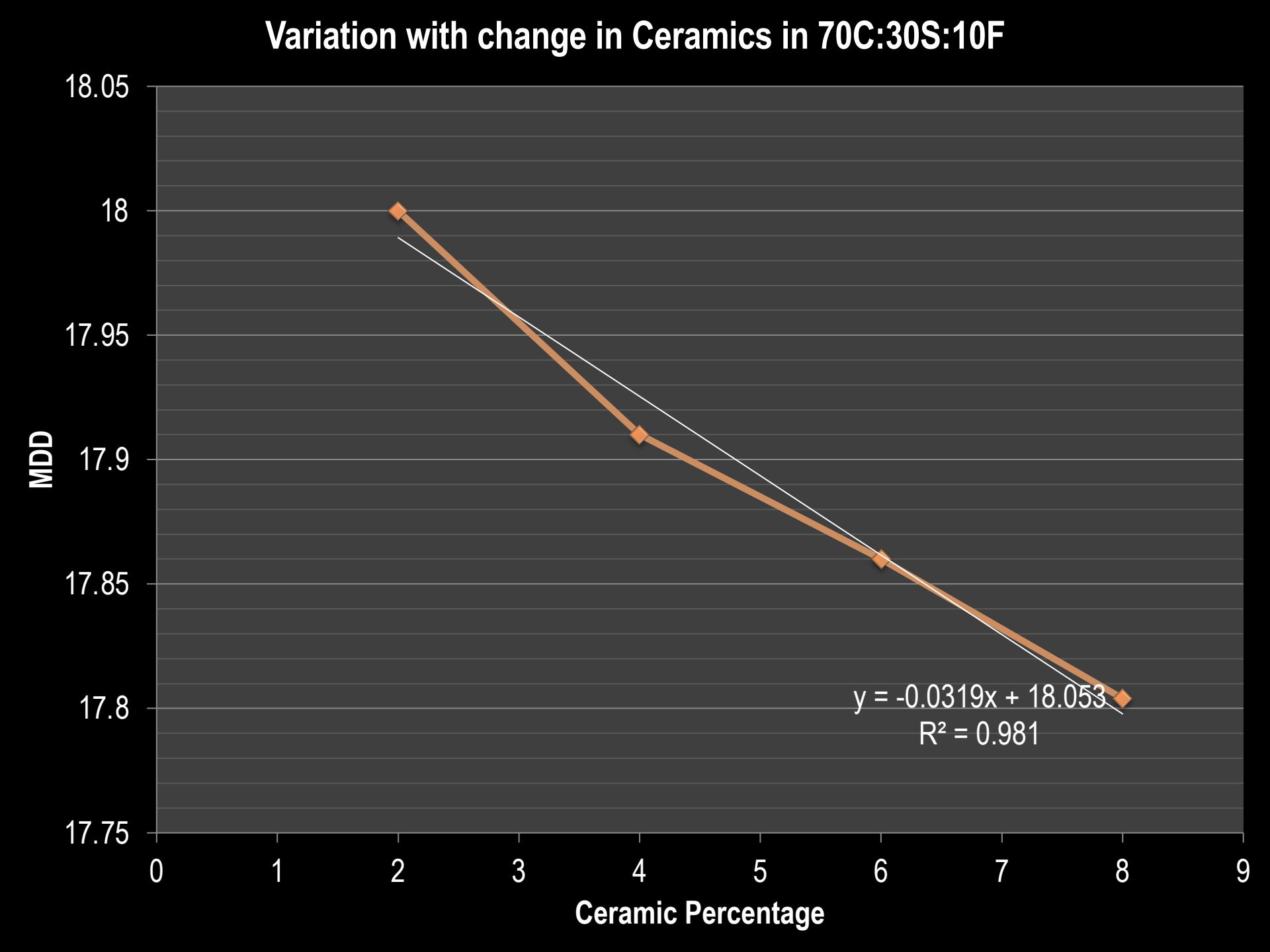

70C:30S:10F:4Cr
18.5
18
17.5
17
16.5
16
15.5
Dry Density
0
5
10
15
20
25
Water Content


70C:30S:10F:6Cr
18.0
17.8
17.6
17.4
17.2
17.0
16.8
16.6
16.4
16.2
Dry Density (kN/m³)
0
5
10
15
20
25
Water Content (%)


70C:30S:10F:8Cr
18
17.8
17.6
17.4
17.2
17
16.8
16.6
16.4
16.2
Dry Density (kN/m³)
0
5
10
15
20
25
Water Content (%)


Variation
18.5
18.0
17.5
17.0
16.5
16.0
15.5
Dry Density(kN/m³)
0
5
10
15
20
25
Water Content (%)
70C:30S:10F:2Cr
70C:30S:10F:4Cr
70C:30S:10F:6Cr
70C:30S:10F:8Cr

Ratio	Maximum Dry Density (KN/m^3)	Optimum Moi Content (%
(70C:30S):10F:2Cr	18.0	13.5
(70C:30S):10F:4Cr	17.9	14
(70C:30S):10F:6Cr	17.85	14.1
(70C:30S):10F:8Cr	17.8	14.2


Variation with change in Ceramics in 70C:30S:10F
18.05
18
17.95
17.9
17.85
17.8
17.75
MDD
0
1
2
3
4
5
6
7
8
9
Ceramic Percentage
y = -0.0319x + 18.053
R² = 0.981

PERMEABILITY TEST RESULTS

The permeability tests were done on different proportion of Clay, Sand, Fly-ash and Ceramic. It was done with Constant head permeameter

Fly ash	8×10^{-6}
Sand	6×10^{-4}
Clay : Sand:: 70:30	7.28×10^{-5}
Clay : Sand: Fly ash:: 70:30:10	1.45×10^{-5}
Clay : Sand : Fly ash :Ceramic :: 70:30:10:2	2.56×10^{-5}

From the above we concluded that permeability increases with increase with the concentration of Sand in the mixture and then decreases with the addition of Fly-ash and successively increases with increasing Ceramics.

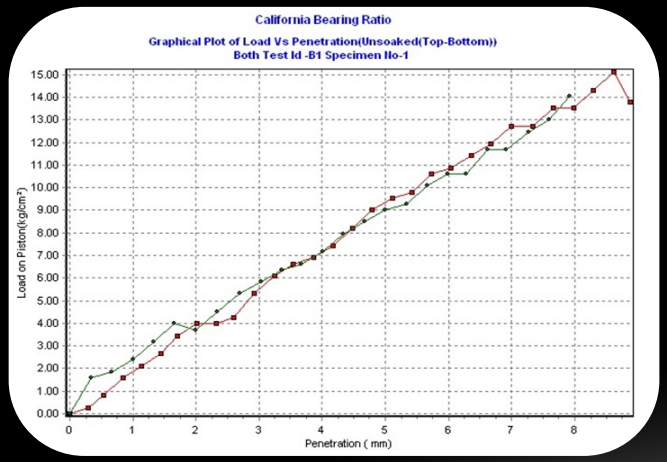
CBR test was done on the Computerized California Bearing Ratio Testing Machine

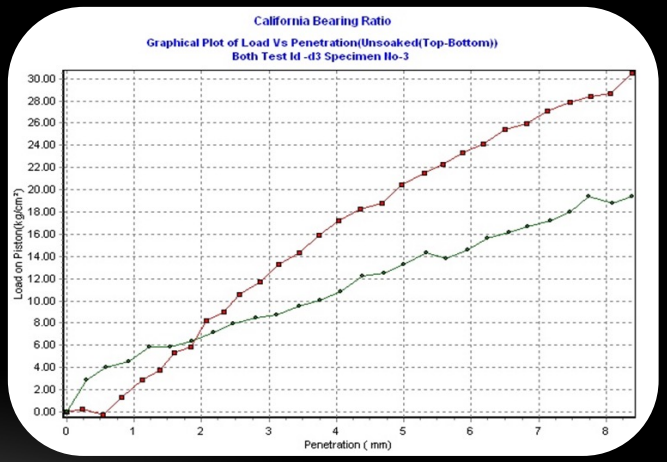
Clay

CBR:5.11%

70C:30S

CBR: 8.58%



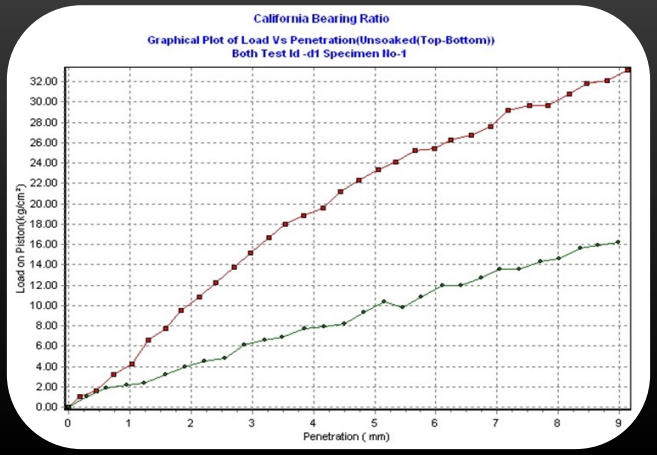


60C:40S

CBR:9.36%

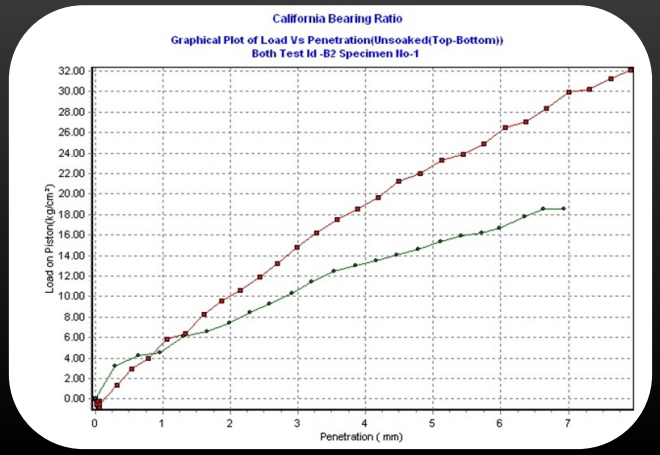
70C:30S:10F

CBR:12.70%



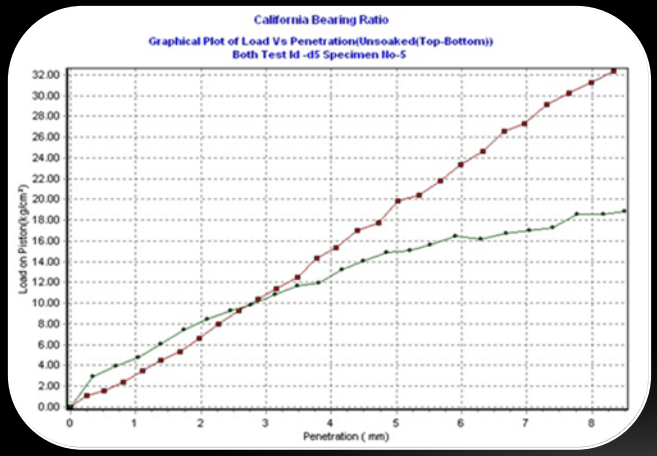
60:40:10

CBR:12.18%



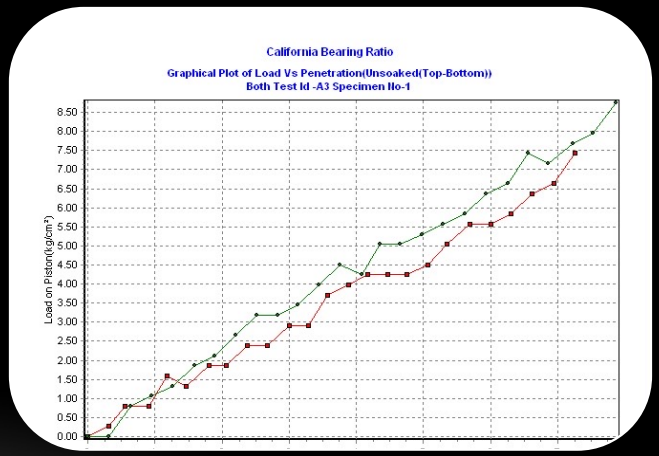
70:30:10:2

CBR:14.44%



70:30:10:4

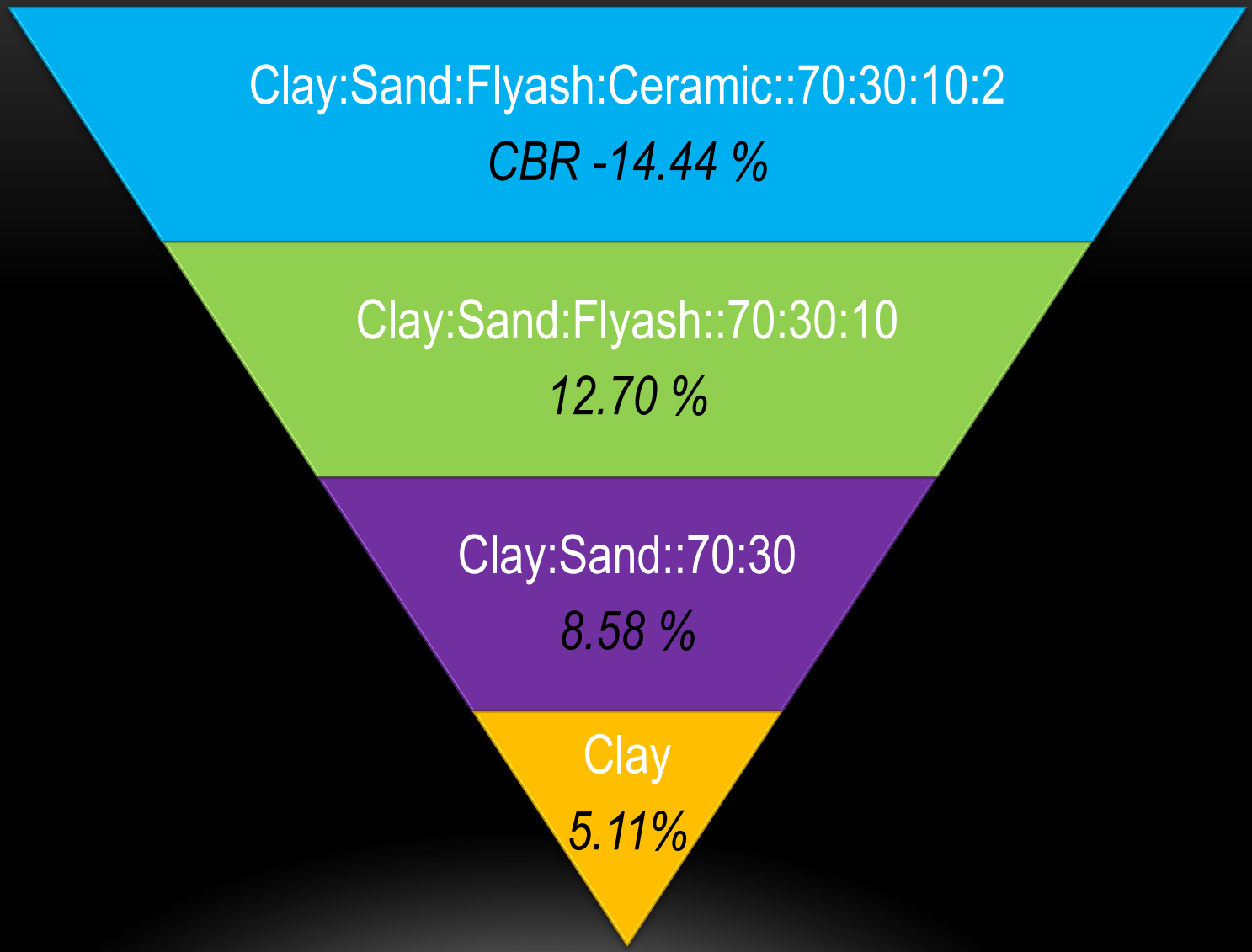
CBR:14.11%



70:30:10:6

CBR:13.90%

Combination	CBR (%)
Clay	5.11
Clay:Sand::70:30	8.58
Clay:Sand::60:40	9.36
Clay:Sand:Flyash::70:30:10	12.70
Clay:Sand:Flyash::60:40:10	12.18
Clay:Sand:Flyash:Ceramic::70:30:10:2	14.44
Clay:Sand:Flyash:Ceramic::70:30:10:4	14.11
Clay:Sand:Flyash:Ceramic::70:30:10:6	13.90


Clay:Sand:Flyash:Ceramic::70:30:10:2
CBR -14.44 %
Clay:Sand:Flyash::70:30:10
12.70 %
Clay:Sand::70:30
8.58 %
Clay
5.11%

CONCLUSION

- The addition of sand resulted in an increase in MDD and decrease in OMC.
- Further there was also a significant increase in the CBR value with the

The addition of Sand, Ceramics and Fly-ash improves the properties of the composite thus formed, and allows its application in the construction of roads leading to engineered use of Fly-Ash and Ceramics.

- Now fly-ash is added to Mixture A
- The addition of fly-ash further led to a decrease in MDD but there was also an increase in the CBR value and the composite was found to be more stable.
- Out of all ratios (60C:40S):10F and (70C:30S):10F were selected as ***Mixture B***.

CONCLUSION

- Now ceramics are added to Mixture B.
- The addition of ceramics further led to a decrease in MDD but there was an increase in the CBR value and the composite was found to be more stable.
- Out of all ratios the most stable was with 2% of ceramics.

Permeability was increased with the addition of sand in the Soil – Sand mixture. Further addition of Fly-ash in the composite resulted in the decrease in permeability and addition of ceramics increased the permeability.

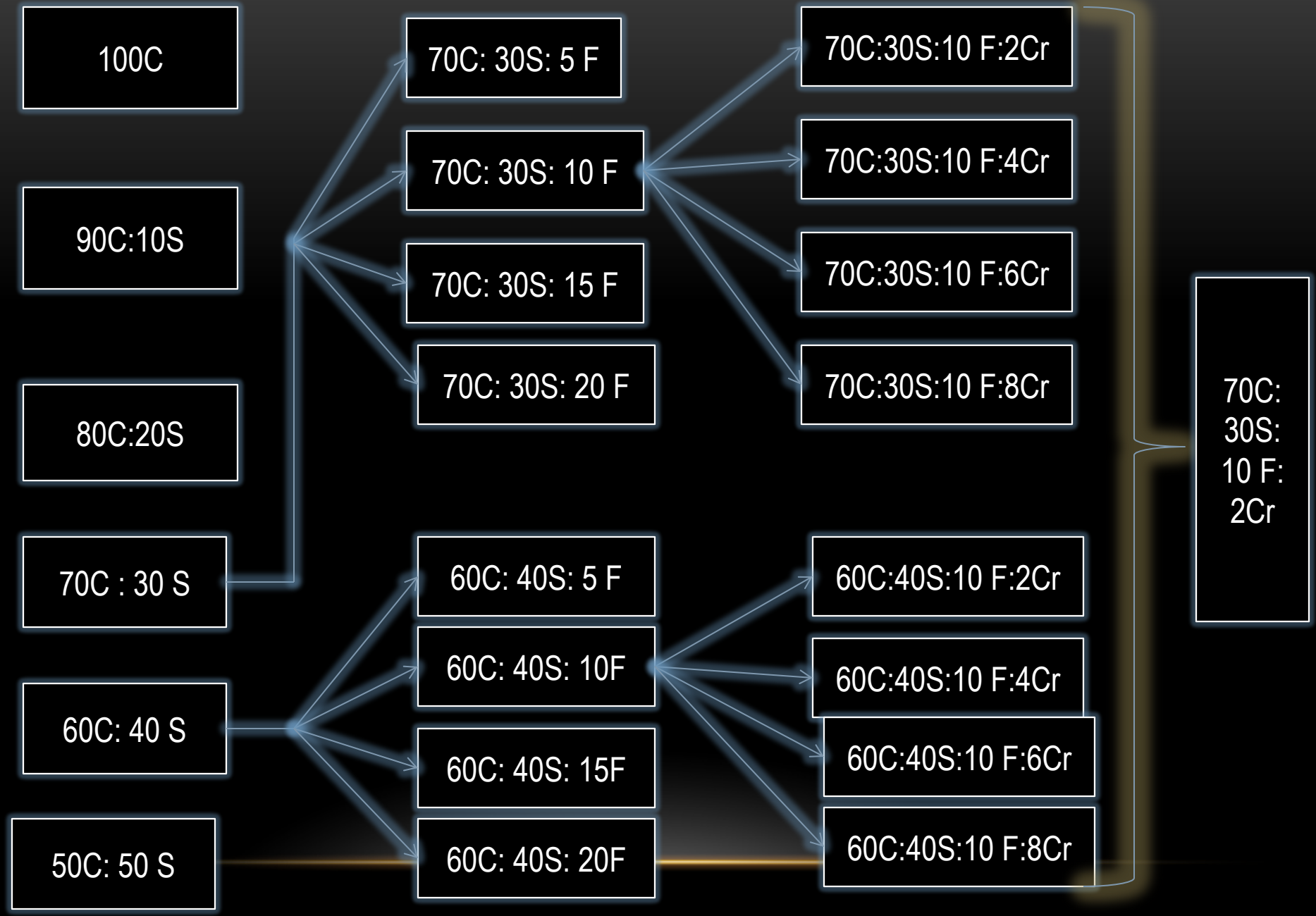
CONCLUSION

- Based on the results it was suggested that 70(Soil):30(Sand):10(Fly-ash):2(Ceramics) was the best composite mixture. The final composite was having the
- CBR value of 14.44%
- MDD of 18.0 kN/m^3
- Permeability of 2.56 X 10^{-5} m/s.

Composition PERCENTAGE :

1. **Clay : 62.5%**
2. **Sand : 26.8%**
3. **Fly ash : 8.9%**
4. **Ceramic : 1.8%**

The final composite can be considered for applications in construction of embankments, soil sub-grade and foundation bases particularly in rural roads and low cost roads.


100C
90C:10S
80C:20S
70C : 30 S
60C: 40 S
50C: 50 S
70C: 30S: 5 F
70C: 30S: 10 F
70C: 30S: 15 F
70C: 30S: 20 F
60C: 40S: 5 F
60C: 40S: 10F
60C: 40S: 15F
60C: 40S: 20F
70C:30S:10 F:2Cr
70C:30S:10 F:4Cr
70C:30S:10 F:6Cr
70C:30S:10 F:8Cr
60C:40S:10 F:2Cr
60C:40S:10 F:4Cr
60C:40S:10 F:6Cr
60C:40S:10 F:8Cr
70C: 30S: 10 F: 2Cr

- Thank You All