**Program for Concrete Mix Design**

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**Abstract**. Concrete is the most widely used construction material and designing a concrete mix is an important aspect. Concrete consists of cement, sand, coarse aggregate and water and each of these ingredients have different properties. The properties of these materials affect the properties of concrete. Hence performing mix design has become imperative. The concrete mix design is based on IS 10262: 2009 and follows a certain set of design steps. Manual calculation of the mix proportion for varied mixes as per the requirement is laborious. Hence in this project a MATLAB program has been developed which gives the mix proportions for the various grades of concrete.

**Key words**: Mix proportions, MATLAB program, mix design, compressive strength, m-file.

# Introduction

The concrete mix design involves various steps, calculations and laboratory testing to find right mix proportions. This process is usually adopted for structures which require higher grades of concrete such as M 25 and above and in large construction projects where quantity of concrete required is large.Benefits of concrete mix design are that it provides the right proportions of materials for the required strength, thus ensuring that the construction is economical. As the quantity of concrete required for large constructions are huge, economy in quantity of materials makes the construction project economical.

# Objectives

* + 1. *To calculate the mix ratio for M 30 grade of concrete as per IS10262:2009.*
    2. *To determine the compressive strength of the designed M 30 grade concrete after 7, 14, 28 days of curing.*
    3. *To develop a MATLAB program for calculating the mix ratio for different grades of concrete.*

# Methodology

Tests on materials to determine the specific gravity, fineness modulus for cement, coarse aggregate and fine aggregate were conducted and based on the data the mix design as per IS 10262:2009 was carried out. As per the mix ratios obtained nine cubes were cast and tested at the end of 7 days, 14 days and 28 days of curing.

A MATLAB program was developed to determine the quantities of sand, cement, aggregate and water required for the 1m3 of concrete of grades M 25 to M 60.

3.1. Development of the m-file

The m-file development involves three steps: coding, debugging and testing. About seven processes are involved in the mix design as outlined in the flowchart shown in Figure 1.

3.1.1. Coding of the m-file

Here the task is broken down into seven sections to tally with the steps shown in the flowchart. For each step MATLAB code is written in the m-file. The m-file program is shown in the appendix. It commences with a brief introduction by stating the name of the m-file and title of the program.

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**Figure1**. MATLAB LOGICAL APPROACH

3.1.2. Debugging of the m-file

The MATLAB program written contains error (syntax, logical, and run-time errors). This made it impossible to run the program accurately. The error was removed by effecting the necessary correction. The process of removing this error is known as debugging.

3.1.3. Testing of the m-file

The m-file was tested to ascertain its capability by calculating the mix ratios for the different grades of concrete.

1. **Results**

The compressive strength for the M 30 grade cubes when tested at the end of 7, 14 and 28 days of curing are shown in Table 1.

**Table 1.** Compressive strength of cubes

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **SL.NO** | **Load (kN)** | | | **Compressive strength (N/mm2)** | | | **Average compressive strength (N/mm2)** | | |
|  | 7 days | 14 days | 28days | 7 days | 14 days | 28days | 7days | 14days | 28days |
| 1 | 441.45 | 716.13 | 752.56 | 19.62 | 31.828 | 33.436 | 20.34 | 32.47 | 33.32 |
| 2 | 470.88 | 735.75 | 745.94 | 20.928 | 32.7 | 33.152 |
| 3 | 461.07 | 737.25 | 755.37 | 20.942 | 32.76 | 33.572 |  |  |  |

**Table 2.** Comparison ofValues obtained from the MATLAB and manual calculation as per IS 10262:2009

|  |  |  |
| --- | --- | --- |
|  | **MATLAB** | **CALCULATONS as per IS 10262:2009** |
| Volume of concrete | 1m3 | 1m3 |
| Volume of cement | 0.107954m3 | 0.111 m3 |
| Volume of water | 0.136022m3 | 0.140 m3 |
| Mass of admixture | 0.68 kg | 0.7 kg |
| Volume of all in aggregate | 0.750 m3 | 0.743 m3 |
| Mass of coarse aggregate | 1150 kg | 1262.0 kg |
| Mass of fine aggregate | 896 kg | 773.0 kg |

**Mix ratio obtained by the MATLAB is 1 :2.5: 3.3 with a water cement ratio of 0.40**

**Mix ratio obtained by manual calculations is 1 :2.2: 3.6 with a water cement ratio of 0.40**

1. **Conclusion**

The mix proportion as per IS10262:2009 has been done. Based on the mix design, cubes were cast and tested at the end of 7, 14, 28 days of curing. The MATLAB program was developed to give the various mix proportions from M 25 to M 60. The output results from the MATLAB are quantity of coarse aggregate, fine aggregate, cement content and water content for 1m3 of concrete. The values obtained by the program are in agreement to those obtained by manual calculations.

# References

1.M S Shetty, (2006) .Concrete technology: theory and practice . S Chand publications

2. IS 10262 (2009): Guidelines for concrete mix design proportioning [CED 2: Cement and Concrete.

3. Peter I. Kattan, (2010). MATLAB for Beginners: A Gentle Approach . Petra Books

**ANNEXURE**

**ANNEXURE 1.1** TESTS ON FINE AGGREGATE AND COARSE AGGREGATE

**TABLE 1.** Fineness modulus of coarse aggregate test

|  |  |  |  |
| --- | --- | --- | --- |
| **Sieve size** | **Weight retained(g)** | **Cumulative weight retained (g)** | **Cumulative % retained (g)** |
| 80mm | 0 | 0 | 0 |
| 40mm | 250 | 250 | 5 |
| 20mm | 1750 | 2000 | 40 |
| 10mm | 1600 | 3600 | 72 |
| 4.75mm | 1400 | 5000 | 100 |
| 2.36mm | 0 | 5000 | 100 |
| 1.18mm | 0 | 5000 | 100 |
| 0.6mm | 0 | 5000 | 100 |
| 0.3mm | 0 | 5000 | 100 |
| 0.15mm | 0 | 5000 | 100 |
|  | Sum | = | 717 |

Therefore, **fineness modulus of coarse aggregates** = sum (cumulative % retained) / 100 = (717/100) = **7.17**

**TABLE 2 .** Fineness modulus of fine aggregate test

|  |  |  |  |
| --- | --- | --- | --- |
| **Sieve size** | **Weight retained (g)** | **Cumulative weight retained(g)** | **Cumulative percentage weight Retained (%)** |
| 4.75mm | 0 | 0 | 0 |
| 2.36mm | 100 | 100 | 10 |
| 1.18mm | 250 | 350 | 35 |
| 0.6mm | 350 | 700 | 70 |
| 0.3mm | 200 | 900 | 90 |
| 0.15mm | 100 | 1000 | 100 |
| **Total** |  |  | **275** |

Therefore, fineness modulus of aggregate = (cumulative % retained) / 100 = (275/100) = **2.75**

# ANNEXURE 1.2: Concrete Mix proportions for Trial Mix 1

Cement = 350 kg/m3

Water = 140 kg/m3

Fine aggregates = 773 kg/m3

Coarse aggregate = 1262 kg/m3

w/c = 0.4

For casting trial mass of ingredients required will be calculate ed for 9 no’s cube

Volume of concrete required for 9 cubes = 9 x (0.153x1.25) = 0.0379687 m3

Cement = (383.2 x0.0379687) kg/m3 = 13.28kg

Water = (140 x0.0379687) kg/m3 =5.31 kg

Coarse aggregate = (773 x 0.0379687) kg/m3 =29.29 kg

Fine aggregates = (1262 x 0.0379687) kg/m3  = 47.28 kg

Chemical admixture = 7 ml

Mix ratio obtained = 1 :2.2: 3.6 with a water cement ratio of 0.40

**ANNEXURE 1.3 :** m-file of the mix design

clc

%Script File for Mix Design of Concrete Based on IS 10262:2009

description = ['This is a software that performs mix design of concrete.'];

disp (description);

grade\_designation = ['select type of grade designation M20 , M30 , M40'];

disp (grade\_designation) %Tell the user

grade\_designation = input('Enter grade designation: ', 's' );

maximum\_nominal\_size\_of\_aggregate = ['select maximum nominal size of aggregate: 10, 20,40'];

disp (maximum\_nominal\_size\_of\_aggregate)

maximum\_nominal\_size\_of\_aggregate = input('Enter maximum nominal size of aggregate');

disp(maximum\_nominal\_size\_of\_aggregate)

'\n';

slump = input('enter the slump value');

fprintf('slump :%3.0f .\n',slump);

'\n';

specific\_gravity\_of\_cement = input('enter the specific gravity of cement');

disp(specific\_gravity\_of\_cement)

'\n';

specific\_gravity\_of\_water = input('enter the specific gravity of water');

disp(specific\_gravity\_of\_water)

'\n';

chemical\_admixture = input('enter the admixture') ;

disp(chemical\_admixture)

'\n';

specific\_gravity\_of\_admixture = input('enter the specific ADMIXTURE');

disp(specific\_gravity\_of\_admixture)

'\n';

specific\_gravity\_of\_coarse\_aggregate = input('enter the specific gravity of coarse aggregate');

disp(specific\_gravity\_of\_coarse\_aggregate)

'\n';

specific\_gravity\_of\_fine\_aggregate = input('enter the specific gravity of fine agggregate');

disp(specific\_gravity\_of\_fine\_aggregate)

'\n';

description = ['TARGET STRENGTH FOR MIX PROPORTIONIG'];

disp(description)

%calculation of TARGET STRENGTH %Tell the user

if grade\_designation == 'M20'

characteristic\_compressive\_strength\_at\_28\_days= 20;

elseif grade\_designation == 'M30'

characteristic\_compressive\_strength\_at\_28\_days= 30;

elseif grade\_designation == 'M40'

characteristic\_compressive\_strength\_at\_28\_days= 40;

end

fprintf('characteristic\_compressive\_strength\_at\_28\_days :%1.0f N/mm2.\n',characteristic\_compressive\_strength\_at\_28\_days);

%standard deviation %Tell the user

if grade\_designation == 'M20'

standard\_deviation= 4;

elseif grade\_designation == 'M30'

standard\_deviation= 5;

elseif grade\_designation == 'M40'

standard\_deviation= 5;

end

fprintf('standard deviation: %2.0f \n', standard\_deviation);

target\_strength = characteristic\_compressive\_strength\_at\_28\_days + (1.65\*standard\_deviation);

fprintf('target strength :%3.0f N/mm2.\n',target\_strength);

if maximum\_nominal\_size\_of\_aggregate==10

maximum\_water\_content =208;

elseif maximum\_nominal\_size\_of\_aggregate==20

maximum\_water\_content =186;

elseif maximum\_nominal\_size\_of\_aggregate==40

maximum\_water\_content =165;

end

if slump>=25 & slump<=50

Maximum\_water\_content = maximum\_water\_content ;

elseif slump>=50 & slump<=75

Maximum\_water\_content = maximum\_water\_content + (0.03 \* maximum\_water\_content)

elseif slump>=75 & slump<=100

Maximum\_water\_content = maximum\_water\_content + (0.06 \* maximum\_water\_content)

elseif slump>=100 & slump<=125

Maximum\_water\_content = maximum\_water\_content + (0.09\* maximum\_water\_content)

end

fprintf('Maximum water content:%2.2f Kg/m3 \n',Maximum\_water\_content);

description1 = ['Based on trials with superplasticizer water content reduction of 29 percent has been achieved.'];

description = [' Hence, the arrived water content '];

disp(description1)

disp(description)

water\_content = Maximum\_water\_content\*0.71 ;

x = Maximum\_water\_content\*0.71;

fprintf('water content: %4.0f Kg/m3 \n', water\_content);

water\_cement\_ratio = 0.40;

fprintf('water cement ratio: %1.2f \n',water\_cement\_ratio);

cement\_content= water\_content/water\_cement\_ratio;

fprintf('cement content: %4.0f Kg/m3 \n', cement\_content);

description = ['PROPORTION OF VOLUME OF COARSE AGGREGATE AND FINE AGGREGATE CONTENT'];

disp(description)

description2 = ['for zone1'];

disp(description2)

if maximum\_nominal\_size\_of\_aggregate == 10

volume\_of\_coarse\_aggregate= 0.44 ;

elseif maximum\_nominal\_size\_of\_aggregate == 20

volume\_of\_coarse\_aggregate= 0.56 ;

elseif maximum\_nominal\_size\_of\_aggregate == 40

volume\_of\_coarse\_aggregate= 0.69 ;

end

fprintf('volume of coarse\_aggregate: %1.2f \n' ,volume\_of\_coarse\_aggregate);

volume\_of\_fine\_aggregate = 1 - volume\_of\_coarse\_aggregate ;

fprintf(' volume of fine aggregate: %1.2f \n' , volume\_of\_fine\_aggregate);

'\n';

description= ['mix calculations'];

disp(description)

'\n';

volume\_of\_concrete = 1 ;

fprintf(' volume of concrete: %1.2f m3\n' , volume\_of\_concrete)

volume\_of\_cement = (cement\_content)/(1000 \* specific\_gravity\_of\_cement);

fprintf('volume of cement: %2.6f m3 \n',volume\_of\_cement)

volume\_of\_water = x /(1000\*specific\_gravity\_of\_water) ;

fprintf(' volume of water: %1.6f m3 \n' , volume\_of\_water);

Mass\_of\_chemical\_admixture = 0.02\*cement\_content ;

fprintf('mass of chemical admixture: %.5f kg \n', Mass\_of\_chemical\_admixture)

'\n';

y = Mass\_of\_chemical\_admixture;

volume\_of\_chemical\_admixture = y /(1000\*specific\_gravity\_of\_admixture) ;

fprintf(' volume of admixture: %1.11f m3 \n' , volume\_of\_chemical\_admixture);

Volume\_of\_all\_in\_aggregate = volume\_of\_concrete-(volume\_of\_cement + volume\_of\_water +volume\_of\_chemical\_admixture) ;

fprintf('Volume of all in aggregate:%1.3f m3 \n', Volume\_of\_all\_in\_aggregate);

e = Volume\_of\_all\_in\_aggregate

Mass\_of\_coarse\_aggregate =e\* volume\_of\_coarse\_aggregate \* specific\_gravity\_of\_coarse\_aggregate \* 1000 ;

fprintf('Mass of coarse aggregate:%1.4f m3 \n', Mass\_of\_coarse\_aggregate);

Mass\_of\_fine\_aggregate = e\* volume\_of\_fine\_aggregate \* specific\_gravity\_of\_fine\_aggregate \* 1000 ;

fprintf('Mass of fine aggregate:%1.4f m3 \n', Mass\_of\_fine\_aggregate);