CALIBRATING THE DENSITY OF CONCRETE FROM WASHED AND UNWASHED LOCALLY 3/8 GRAVEL MATERIAL AT VARIOUS CURING AGE

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Abstract: Concrete densities were calibrated at different water cement ratios and curing age, the study expressed the rate of fresh mix cement design with locally occurring 3/8 gravel to monitor its performance base on these conditions, the densities calibrated expresses model equations from washed and washed gravel as it characterized. The results express concrete densities at different water cement ratios and curing age, the variations are base on mix proportion thus variation on compactions, most results calibrated express variations base on the influences from mix proportion and compactions, other influence are impurities from unwashed 3/8 gravel, it express some variation of densities from graphical representation, these affect the densities of concrete as it express in various curing age, the developed model will be apply to predict the densities of concrete to determine variations of concrete performance.

Keywords: calibrating, density, concrete, washed and unwashed gravel

1. Introduction

Concrete is an tremendously multipurpose building material because, such type of material can be designed for compressive strengths ranging from M10 to 140MPa or higher (Caldarone, 2009). Concrete workability range from 0 mm slump to 150mm slump or more. Concrete mix design is known as technique of correct mix proportioning of ingredients of concrete base on the site requirements, in order to achieve required properties of concrete both is plastic and in hardened stage (Ode,2004). Concrete mix ratios are more of an art than a pure science thus methods for it are still evolving (Santhakumar, 2009, Eluozo and Ode 2015a, Eluozo and Ode 2015b, Eluozo and Ode 2015c). It is observed that there are four well conventional mix design procedures for designing normal strength concrete (NSC) mixes like Indian, American, US Bureau of Reclamation (USBR) and British Standard methods (Yaragal,2006). However, the application of DOE technique, including British method of concrete mix design, utilizes British test data and can be applied for concrete that contain fly ash or addictives (Shetty, 2008). None of these techniques supply the traditional curves showing the relationship between w/c ratio and the strength by testing concretes subjected to addictives (Ramarao G and Seshagiri Rao, 2005, Ephraim and Ode, 2006). On the contrary

HPC normally contains both pozzolanic and chemical admixtures. It has been a recognized fact that HPC mixes can be organized without the application of mineral admixtures but will never be without the chemical admixtures (Shridhar, 2002, Ode 2004). Concrete mix design of NSC is basically on the w/c ratio law first developed by Abrams in 1918 (Shah S. and Ahmad S., 1984) however, the procedures of present mix design techniques commonly known adopted for designing NSC mixes but cannot be directly applied for designing HPC mixes Gopalkrishnan et al., 2001**)**. The water content per m3 of concrete is recommended based on workability requirement given in terms of slump and Vee Bee time. The technique advocates different water contents for crushed and uncrushed aggregates. The DOE techniques can be applied for concrete that contain fly ash or ggbfs (Neville, 2008). The ACI method (as per ACI 211.1-1991) is based on determining the coarse aggregate content considering dry rodded coarse aggregate bulk density and fineness modulus of sand, which has been modified by P.C.Aitcin (Aitcin,1998).

2. Materials and method

Base on BS 1881 part114 of (1983) the cubes had been cured; they were dried under the laboratory temperature and weight using a weighing machine. The volume of the cube was found and the densities were obtained by dividing the mass by the volume, the generated results were subjected into calibration, these results generated expressed mathematical equation for different densities characterized 3/8 gravel on washed and washed at different curing age, .the expressed equations form calibrations will applied to predict the variation of densities from locally 3/8 gravel at different curing time.

3. Results and Discussion

Table: 1 Density of unwashed Mix at [0.45 at Different Curing Days

W/C Density Age of Days	TYPE Density kgM^3 U- MIX [0.45]
7	2.21E+03
14	2.22E+03
21	2.21E+03
28	2.26E+03
60	2.30E+03
90	2.25E+03

Table: 2 Density of unwashed Mix at [0.50] at Different Curing Days

W/C Density Age of Days	TYPE Density kgM^3 U- MIX [0.50]
7	2.20E+03
14	2.26E+03
21	2.17E+03
28	2.21E+03
60	2.24E+03
90	2.43E+03

Table: 3 Density of unwashed Mix at [0.55] at Different Curing Days

W/C Density Age of Days	TYPE Density kgM^3 U- MIX [0.55]
7	2.22E+03
14	2.23E+03
21	2.27E+03
28	2.24E+03
60	2.26E+03
90	2.22E+03

Table: 4 Density of unwashed Mix at [0.60] at Different Curing Days

W/C Density Age of Days	TYPE Density kgM^3 U- MIX [0.60]
7	2.25E+03
14	2.25E+03
21	2.29E+03
28	2.35E+03
60	2.25E+03
90	2.26E+03

Table: 5 Density of unwashed Mix at [0.65] at Different Curing Days

W/C Density Age of Days	TYPE Density kgM^3 U- MIX [0.65]
7	2.27E+03
14	2.23E+03
21	2.29E+03
28	2.30E+03
60	2.23E+03
90	2.19E+03

Table: 6 Density of unwashed Mix at [0.70] at Different Curing Days

W/C Density Age of Days	TYPE Density kgM^3 U- MIX [0.70]
7	2.22E+03
14	2.27E+03
21	2.27E+03
28	2.31E+03
60	2.10E+03
90	2.19E+03

Table: 7 Density of unwashed Mix at [0.75] at Different Curing Days

W/C Density Age of Days	TYPE Density kgM^3 U- MIX [0.75]
7	2.23E+03
14	2.23E+03
21	2.24E+03
28	2.24E+03
60	2.25E+03
90	2.25E+03

Table: 8 Density of unwashed Mix at [0.80] at Different Curing Days

W/C Density Age of Days	TYPE Density kgM^3 U- MIX [0.80]
7	2.27E+03
14	2.25E+03
21	2.25E+03
28	2.29E+03
60	2.26E+03
90	2.20E+03

Table: 9 Density of unwashed Mix at [0.85] at Different Curing Days

W/C Density Age of Days	TYPE Density kgM^3 U- MIX [0.85]
7	2.20E+03
14	2.27E+03
21	2.24E+03
28	2.24E+03
60	2.27E+03
90	2.26E+03

Table: 10 Density of unwashed Mix at [0.90] at Different Curing Days

W/C Density Age of Days	TYPE Density kgM^3 U- MIX [0.90]
7	2.27E+03
14	2.21E+03
21	2.23E+03
28	2.23E+03
60	2.26E+03
90	2.32E+03

Table: 11 Density of unwashed Mix at [0.95] at Different Curing Days

W/C Density Age of Days	TYPE Density kgM^3 U- MIX [0.95]
7	2.27E+03
14	2.21E+03
21	2.23E+03
28	2.23E+03
60	2.26E+03
90	2.32E+03

Table: 12 Density of unwashed Mix at [1.00] at Different Curing Days

W/C Density Age of Days	TYPE Density kgM^3 U- MIX [1.00]
7	2.22E+03
14	2.29E+03
21	2.25E+03
28	2.29E+03
60	2.26E+03
90	2.26E+03

Table: 13 Density of unwashed Mix at [1.05] at Different Curing Days

W/C Density Age of Days	TYPE Density kgM^3 U- MIX [1.05]
7	2.14E+03
14	2.16E+03
21	2.16E+03
28	2.36E+03
60	2.22E+03
90	2.13E+03

Table: 14 Density of Unwashed Mix at [1.10] at Different Curing Days

W/C Density Age of Days	TYPE Density kgM^3 U- MIX [1.10]
7	2.24E+03
14	2.28E+03
21	2.28E+03
28	2.41E+03
60	2.23E+03
90	2.23E+03

Table: 15 Density of washed Mix at [0.35] at Different Curing Days

W/C Density Age of Days	TYPE Density kgM^3 W-MIX [0.35]
7	2.13E+03
14	2.06E+03
21	2.20E+03
28	2.13E+03
60	2.10E+03
90	2.20E+03

Table: 15 Density of washed Mix at [0.45] at Different Curing Days

W/C Density Age of Days	TYPE Density kgM^3 W-MIX [0.45]
7	2.44E+03
14	2.47E+03
21	2.49E+03
28	2.52E+03
60	2.52E+03
90	2.53E+03

Table: 16 Density of washed Mix at [0.50] at Different Curing Days

W/C Density Age of Days	TYPE Density kgM^3 W-MIX [0.50]
7	2.49E+03
14	2.49E+03
21	2.50E+03
28	2.45E+03
60	2.49E+03
90	2.49E+03

Table: 17 Density of washed Mix at [0.55S] at Different Curing Days

W/C Density Age of Days	TYPE Density kgM^3 W-MIX [0.55]
7	2.59E+03
14	2.55E+03
21	2.51E+03
28	2.57E+03
60	2.48E+03
90	2.53E+03

Table: 18 Density of washed Mix at [0.60] at Different Curing Days

W/C Density Age of Days	TYPE Density kgM^3 W-MIX [0.60]
7	2.45E+03
14	2.48E+03
21	2.46E+03
28	2.47E+03
60	2.52E+03
90	2.54E+03

Table: 19 Density of washed Mix at [0.65 at Different Curing Days

W/C Density Age of Days	TYPE Density kgM^3 W- MIX [0.65]
7	2.44E+03
14	2.47E+03
21	2.42E+03
28	2.47E+03
60	2.44E+03
90	2.42E+03

Table: 20 Density of washed Mix at [0.70] at Different Curing Days

W/C Density Age of Days	TYPE Density kgM^3 W- MIX [0.70]
7	2.42E+03
14	2.40E+03
21	2.44E+03
28	2.46E+03
60	2.37E+03
90	2.43E+03

Table: 21 Density of washed Mix at [0.75] at Different Curing Days

W/C Density Age of Days	TYPE Density kgM^3 W- MIX [0.75]
7	2.48E+03
14	2.48E+03
21	2.52E+03
28	2.34E+03
60	2.55E+03
90	2.51E+03

Table: 22 Density of washed Mix at [0.80] at Different Curing Days

W/C Density Age of Days	TYPE Density kgM^3 W- MIX [0.80]
7	2.41E+03
14	2.45E+03
21	2.46E+03
28	2.26E+03
60	2.39E+03
90	2.49E+03

Table: 23 Density of washed Mix at [0.85] at Different Curing Days

W/C Density Age of Days	TYPE Density kgM^3 W- MIX [0.85]
7	2.47E+03
14	2.52E+03
21	2.51E+03
28	2.45E+03
60	2.43E+03
90	2.50E+03

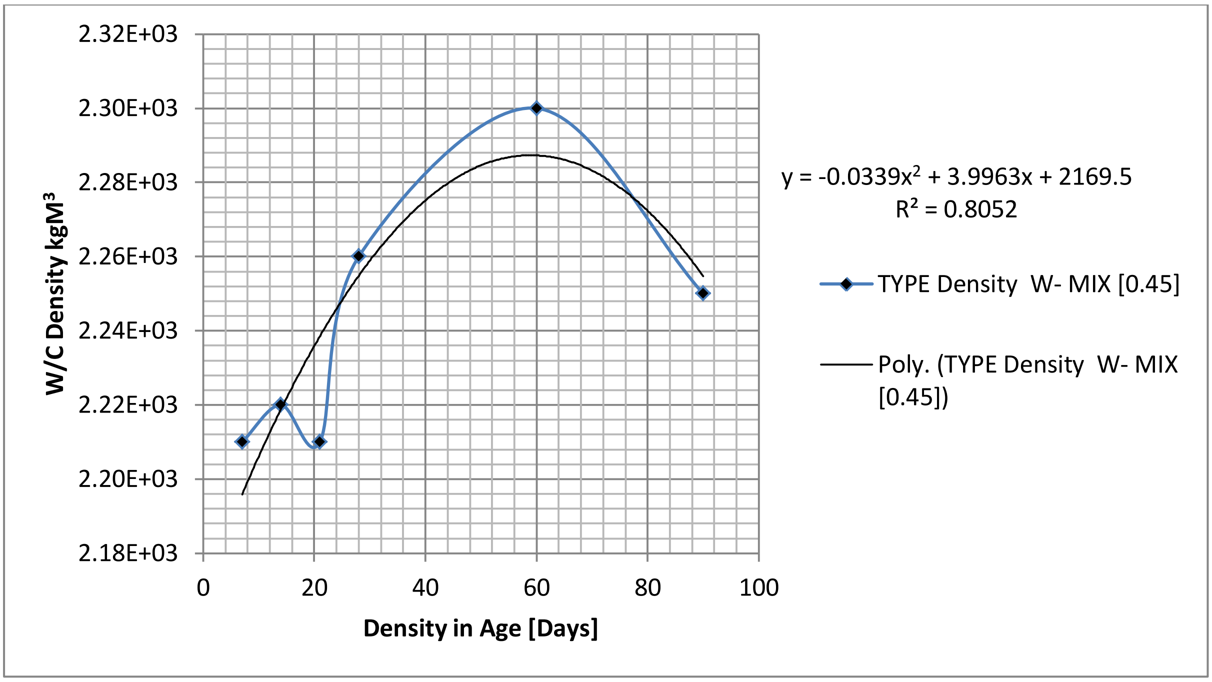

Figure: 1 Density of unwashed Mix at [0.45 at Different Curing Days

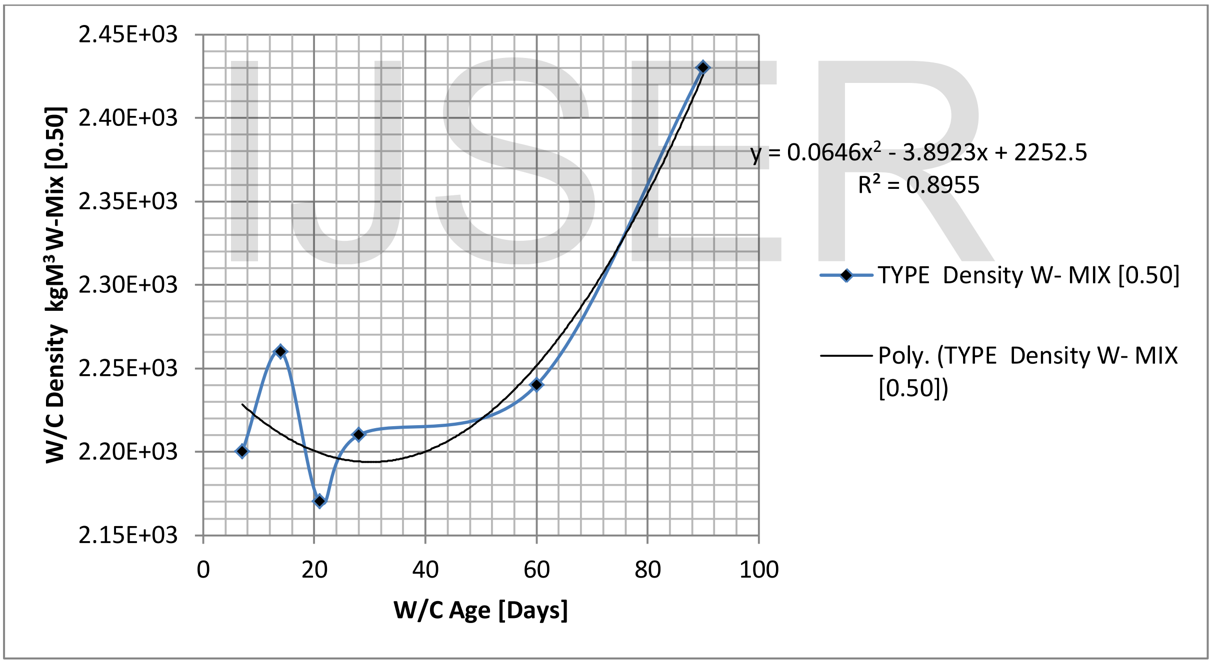

Figure: 2 Density of unwashed Mix at [0.50] at Different Curing Days

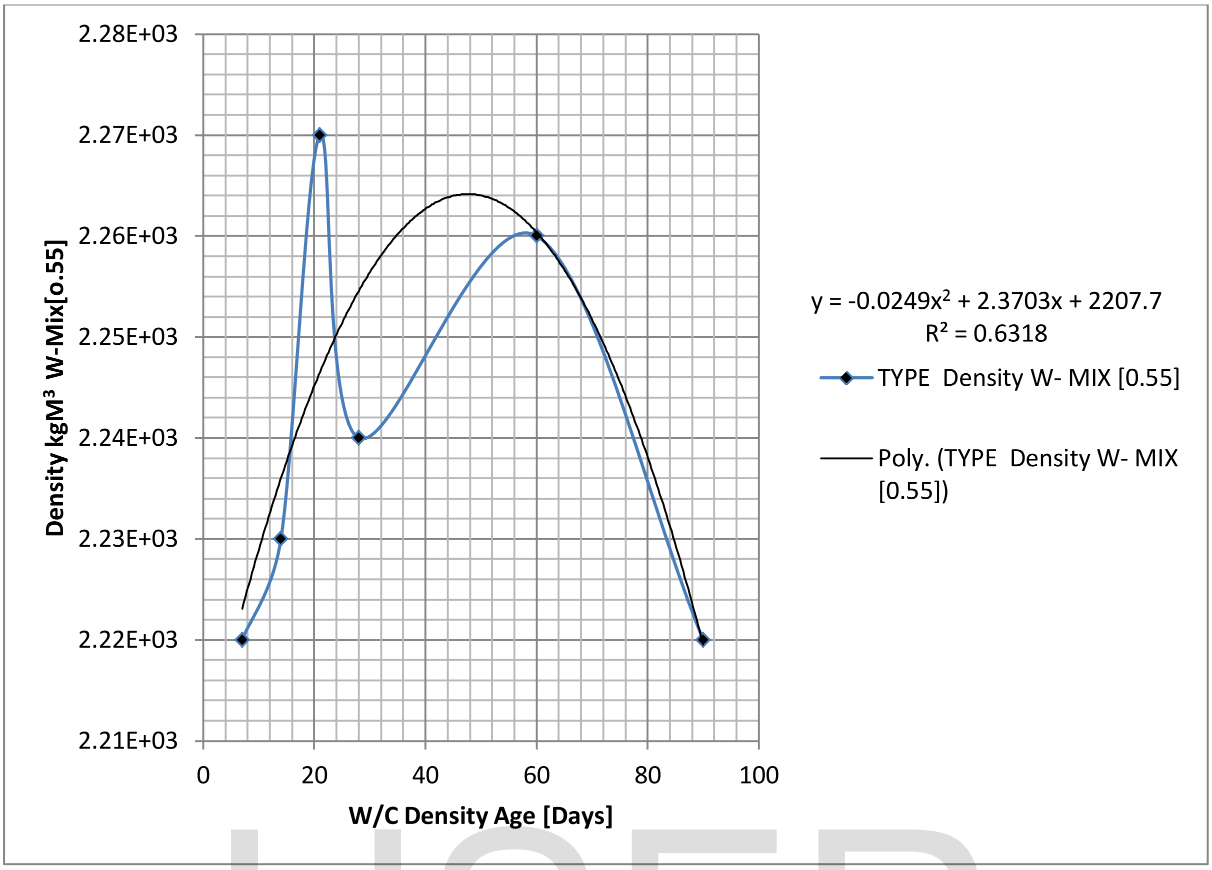

Figure: 3 Density of unwashed Mix at [0.55] at Different Curing Days

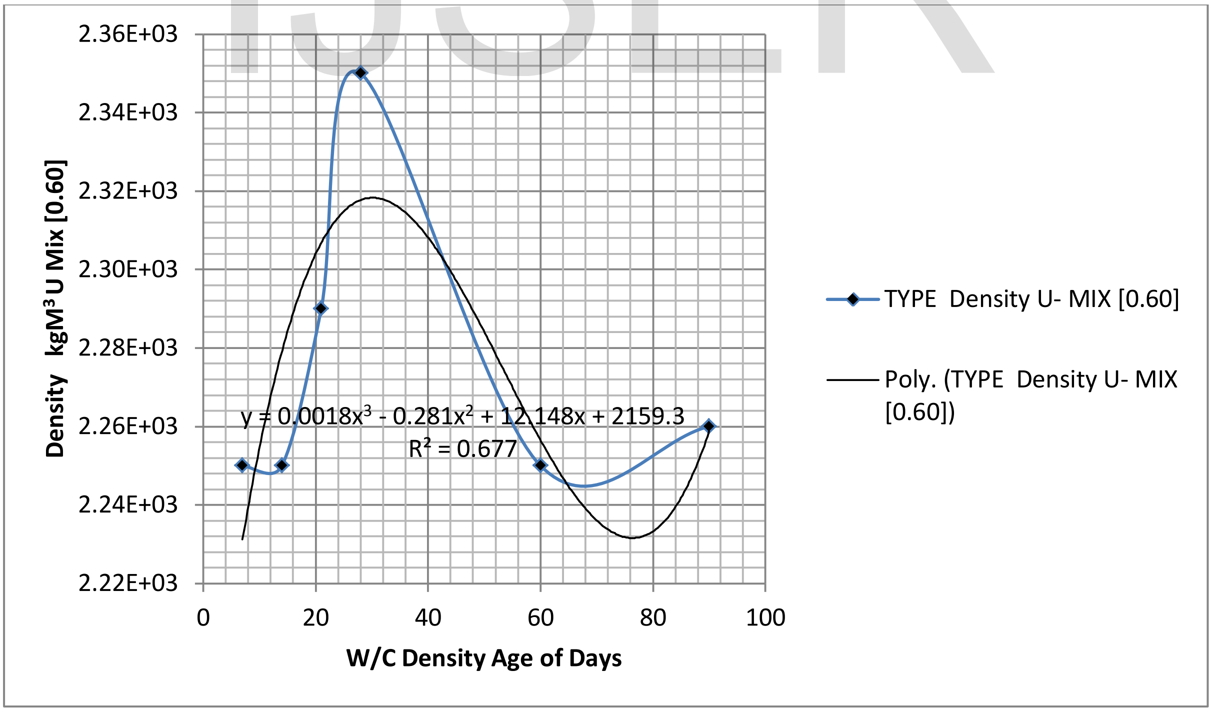

Figure: 4 Density of unwashed Mix at [0.45 at Different Curing Days

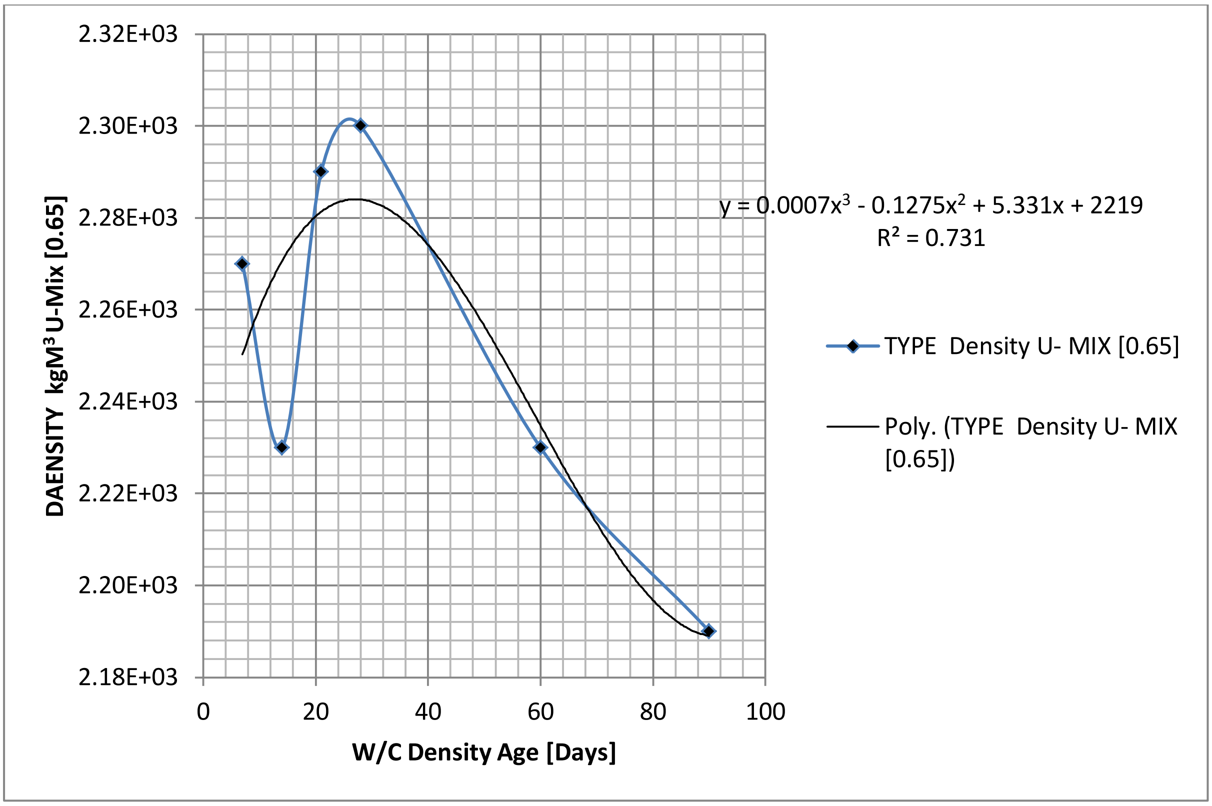

Figure: 5 Density of unwashed Mix at [0.65 at Different Curing Days

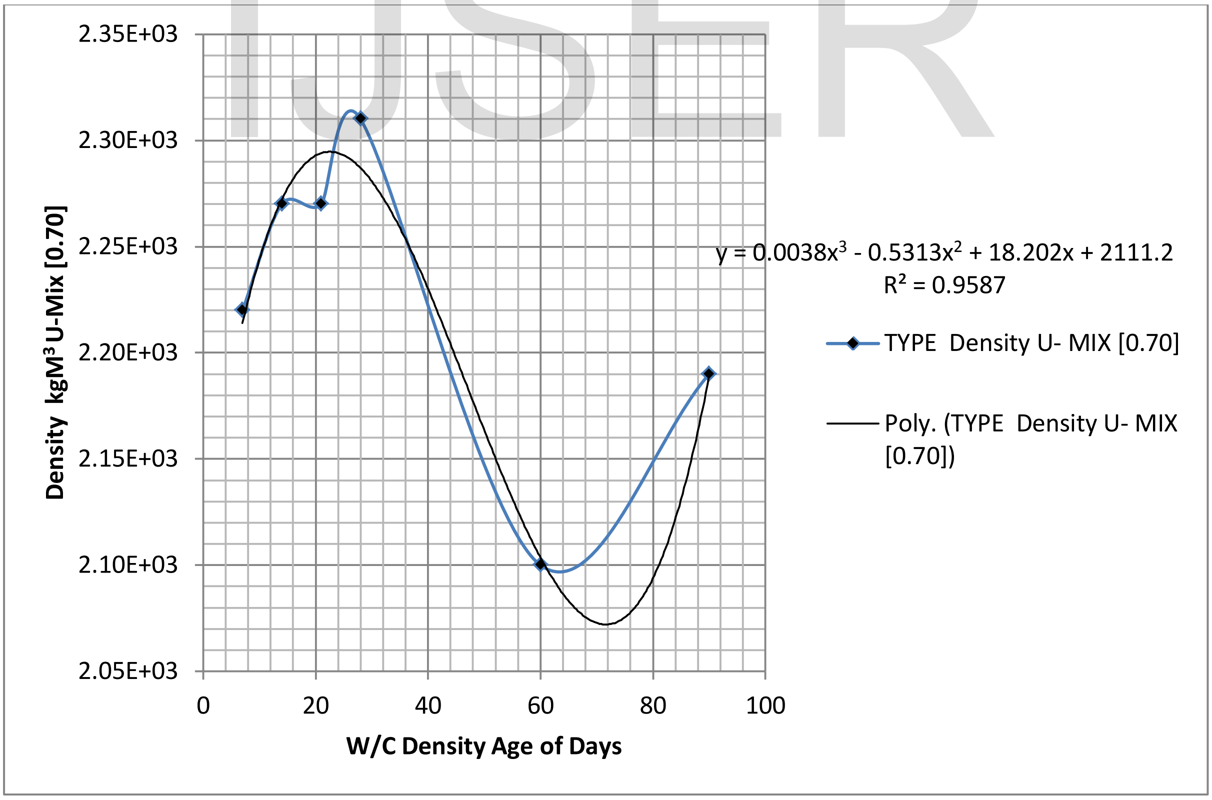

Figure: 6 Density of unwashed Mix at [0.70] at Different Curing Days

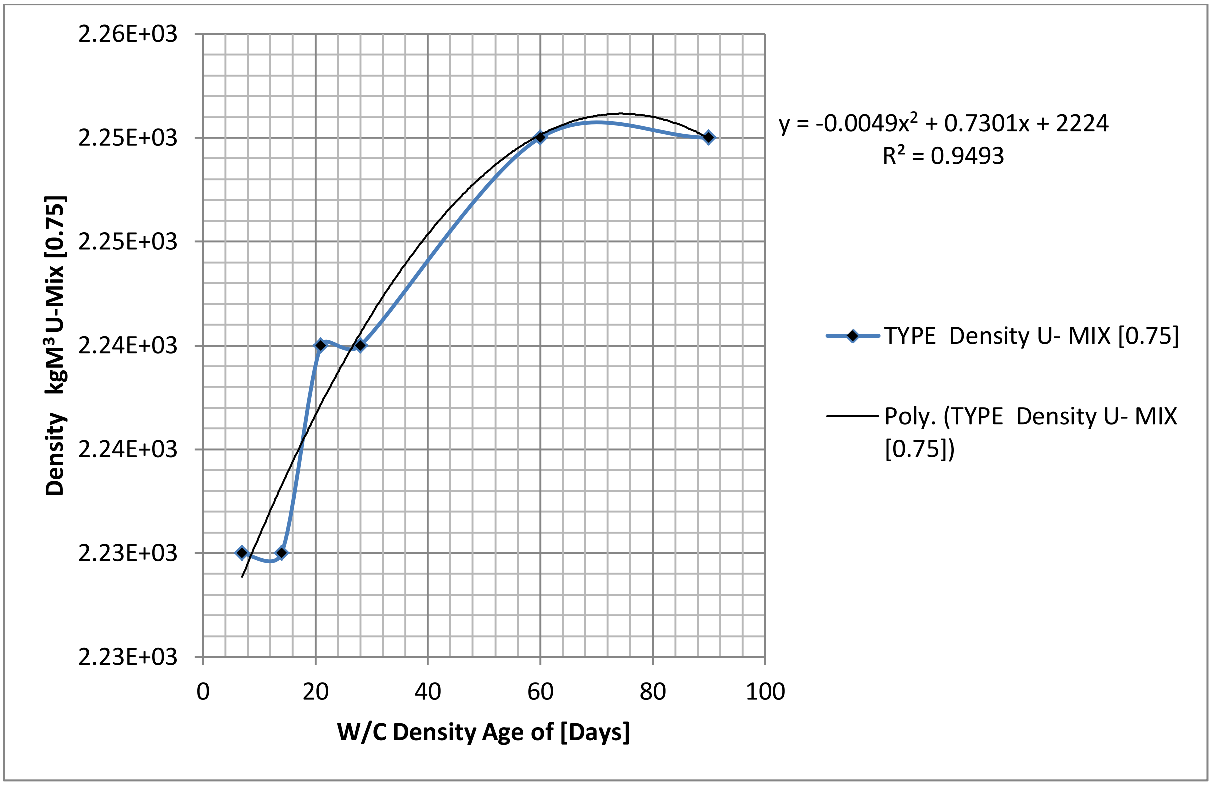

Figure: 7 Density of unwashed Mix at [0.75 at Different Curing Days

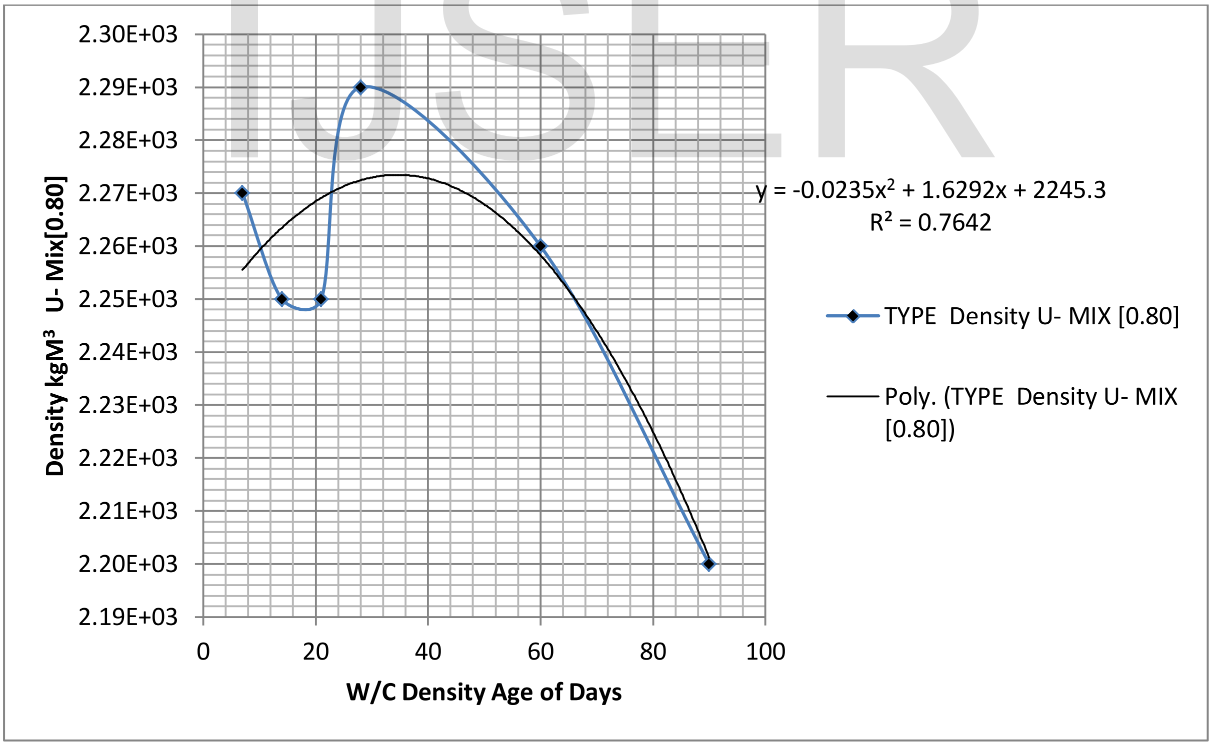

Figure: 8 Density of unwashed Mix at [0.80] at Different Curing Days

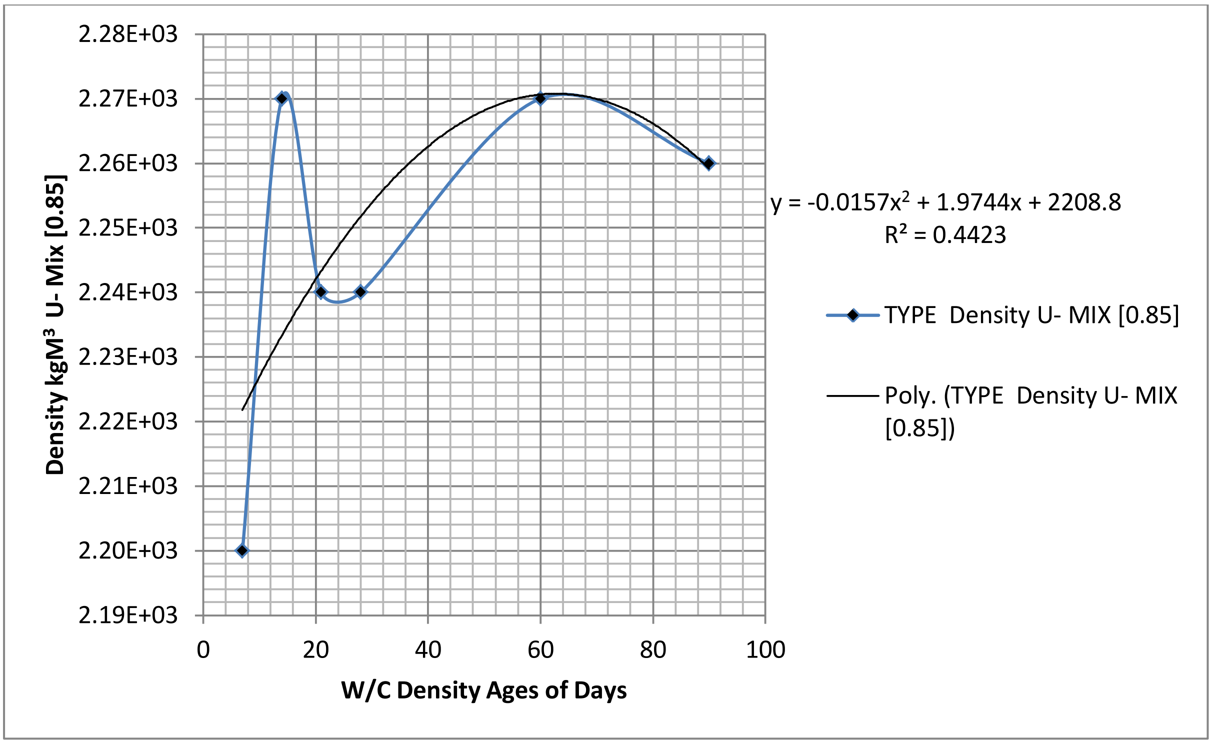

Figure: 9 Density of unwashed Mix at [0.85 at Different Curing Days

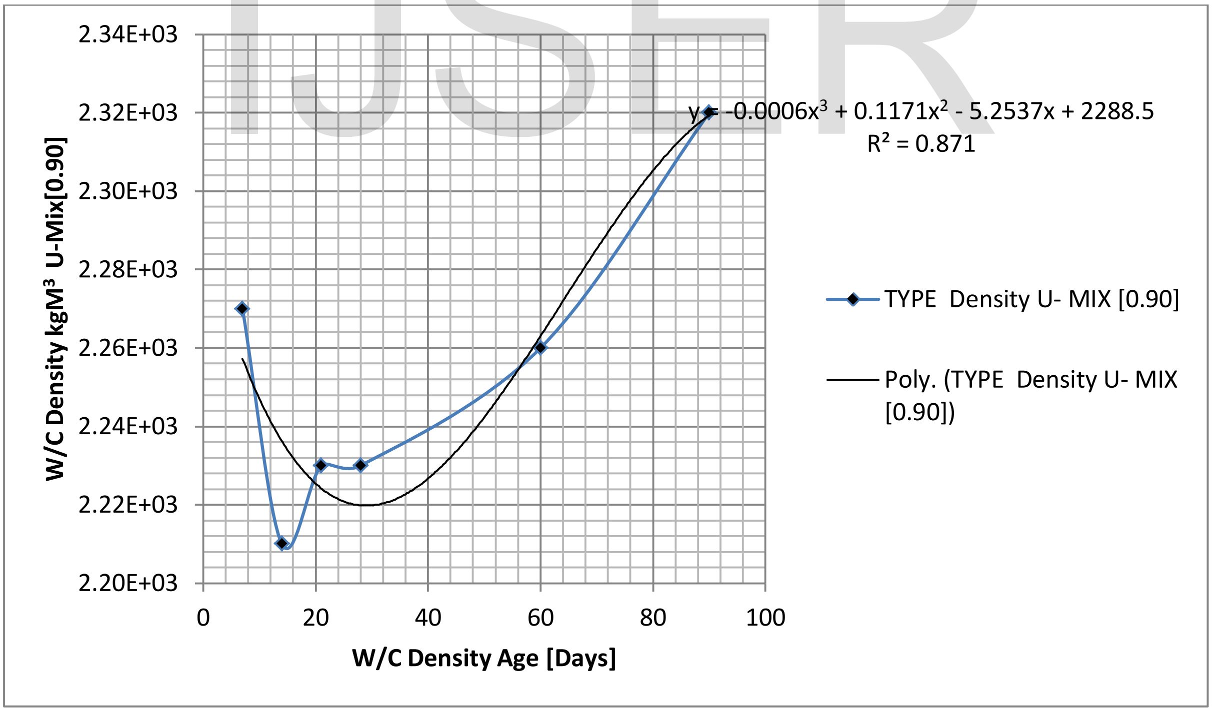

Figure: 10 Density of unwashed Mix at [0.90] at Different Curing Days

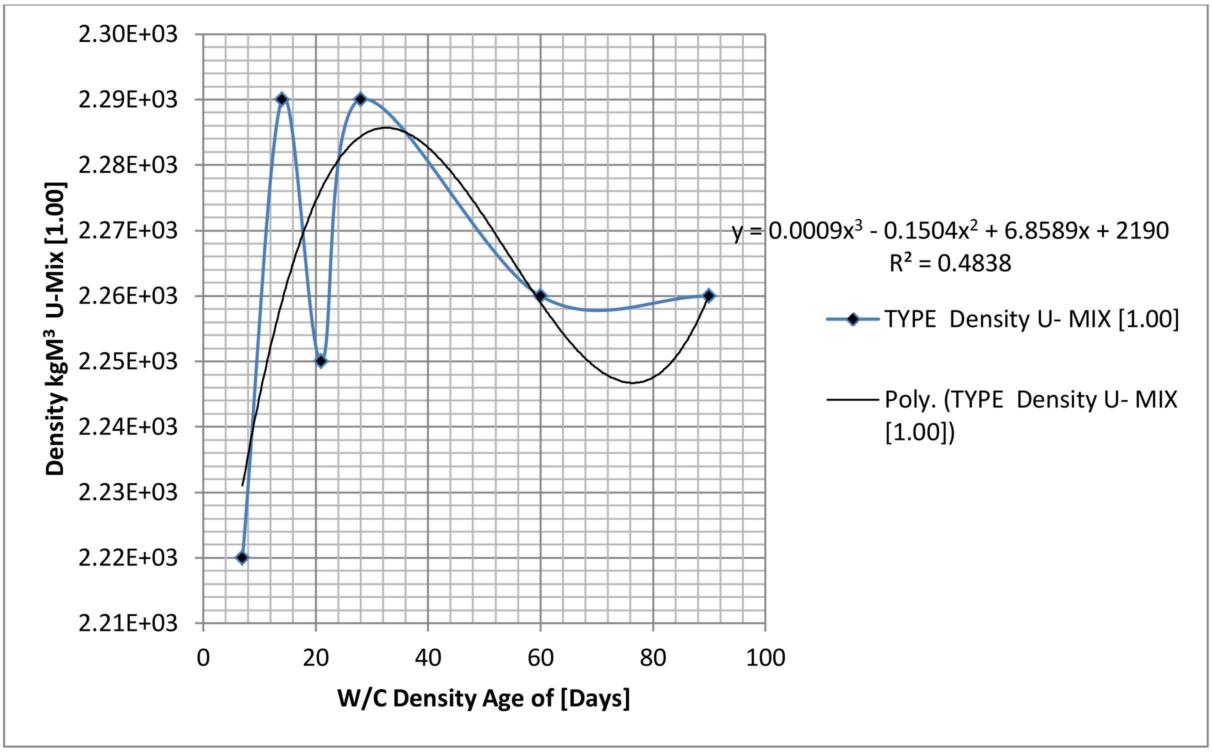

Figure: 11 Density of unwashed Mix at [1.00] at Different Curing Days

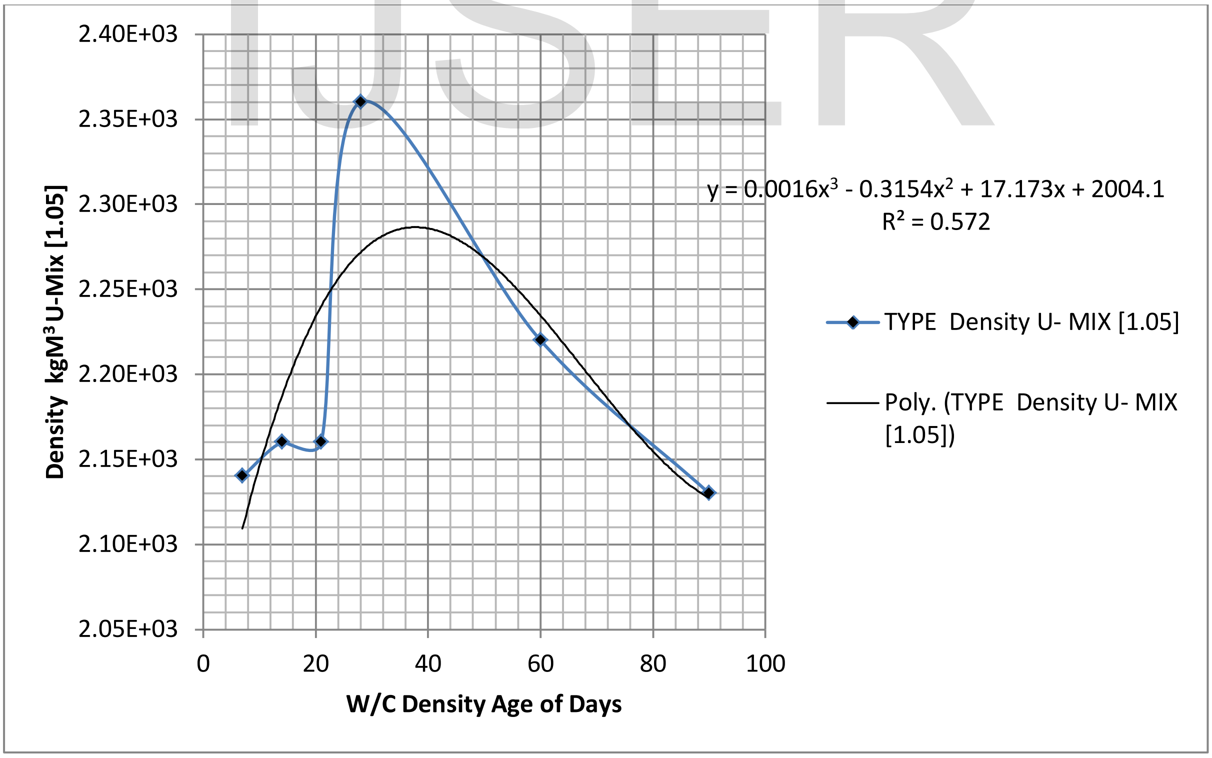

Figure: 12 Density of unwashed Mix at [1.05 at Different Curing Days

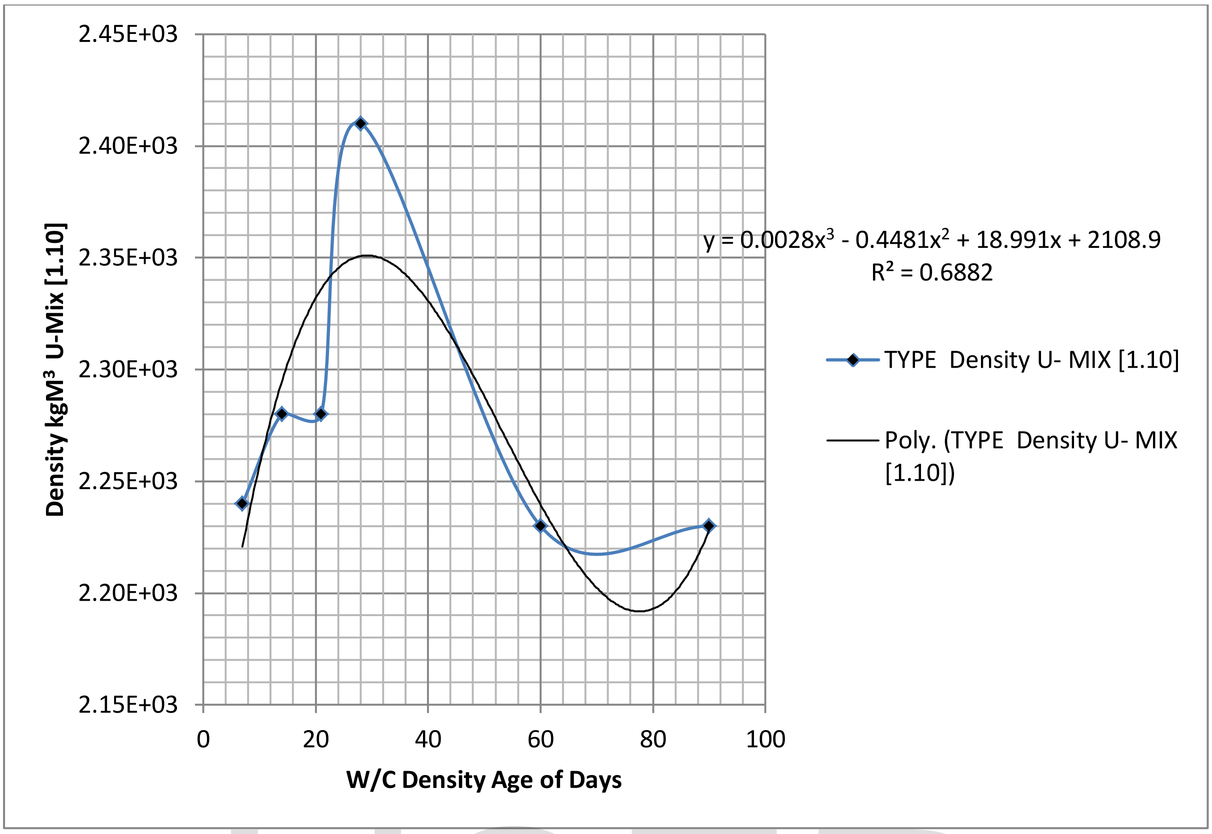

Figure: 13 Density of unwashed Mix at [0.10] at Different Curing Days

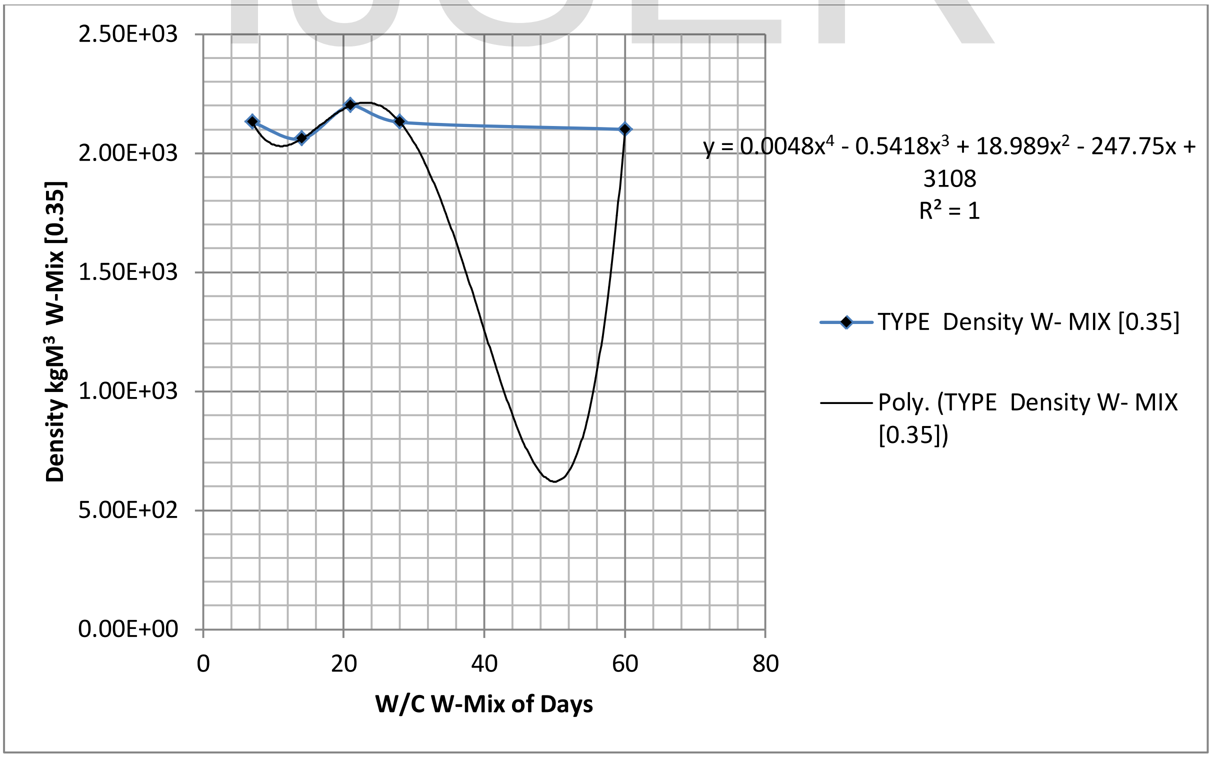

Figure: 14 Density of washed Mix at [0.35] at Different Curing Days

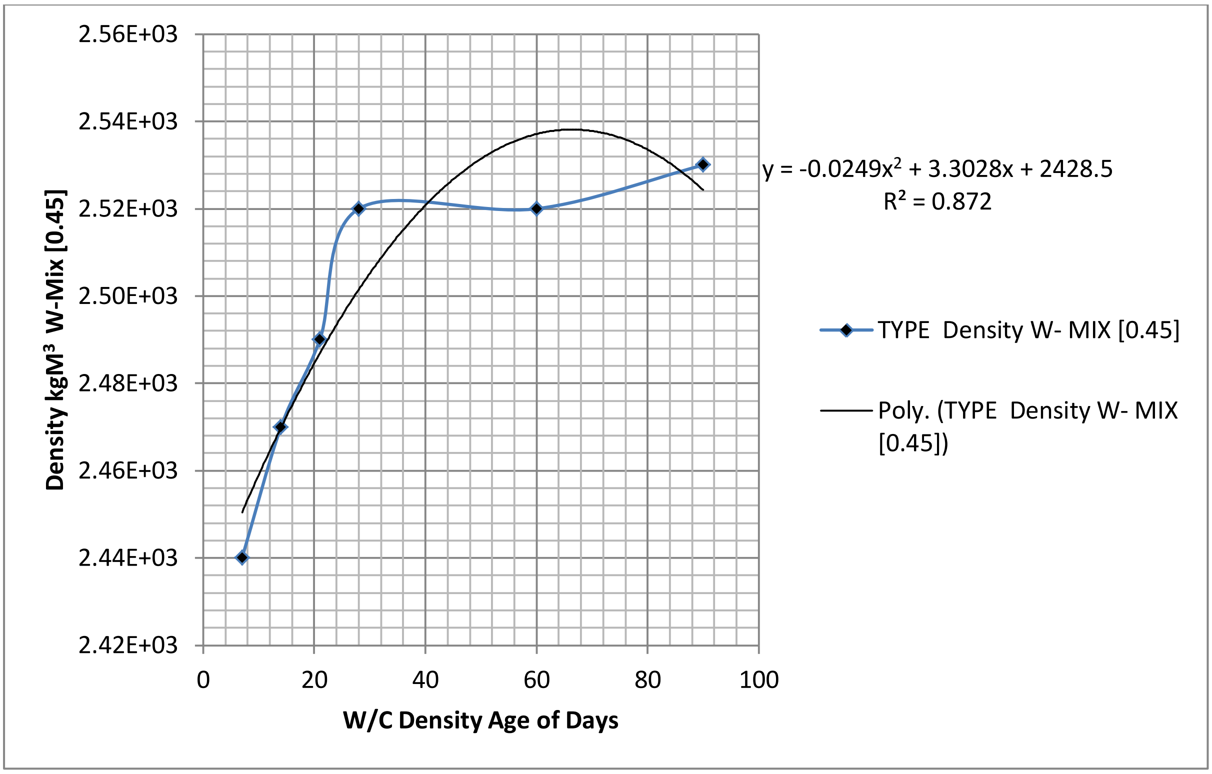

Figure: 15 Density of washed Mix at [0.45 at Different Curing Days

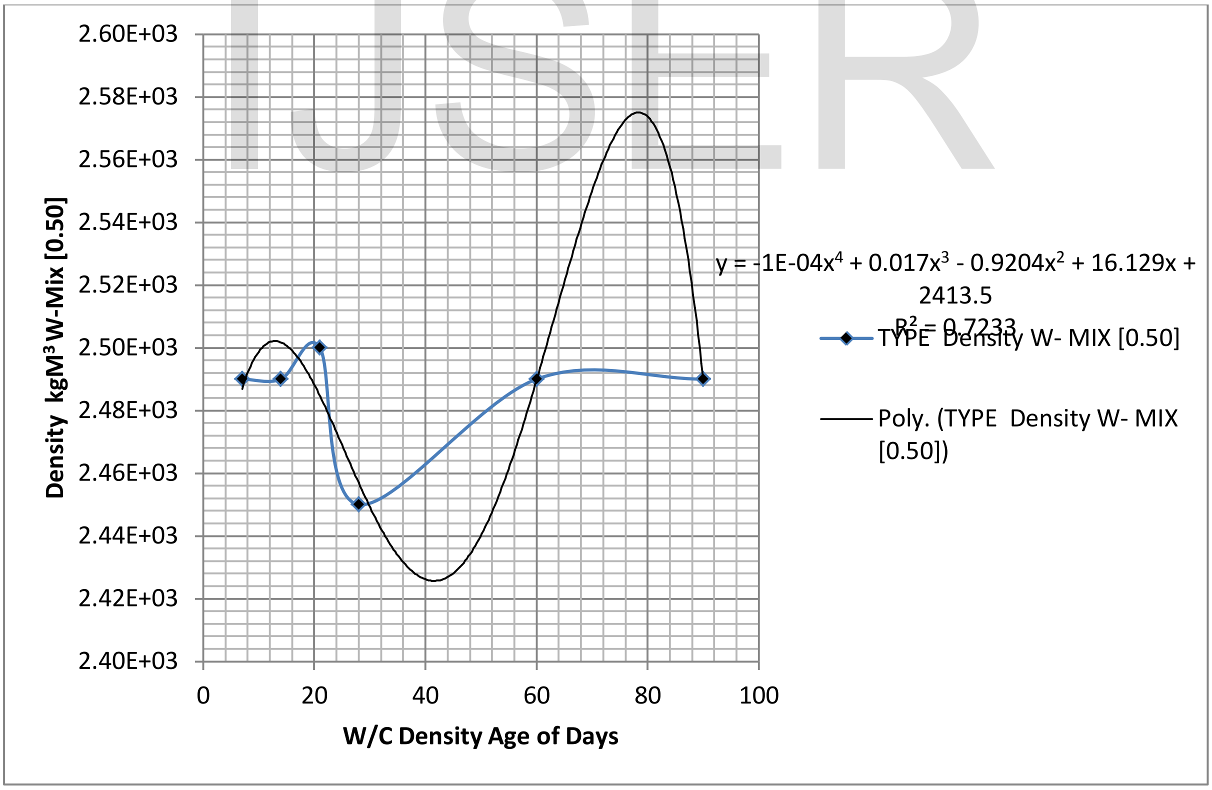

Figure: 16 Density of washed Mix at [0.50] at Different Curing Days

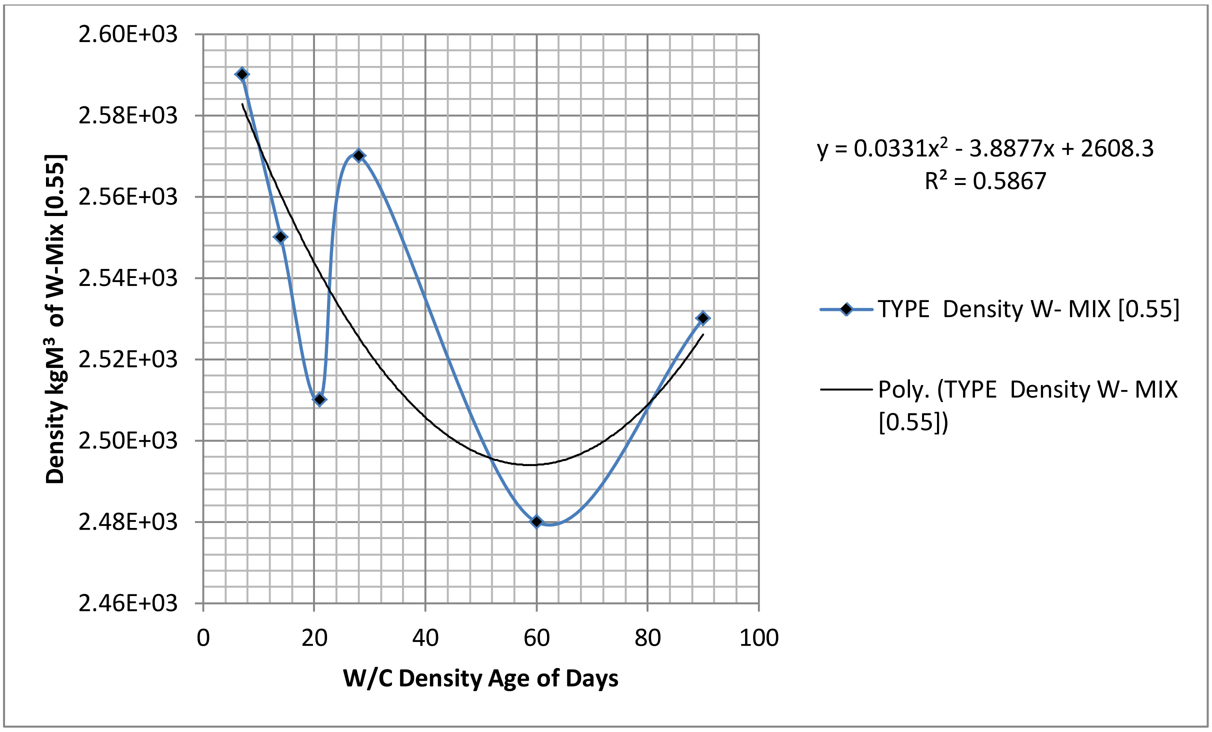

Figure: 17 Density of washed Mix at [0.55] at Different Curing Days

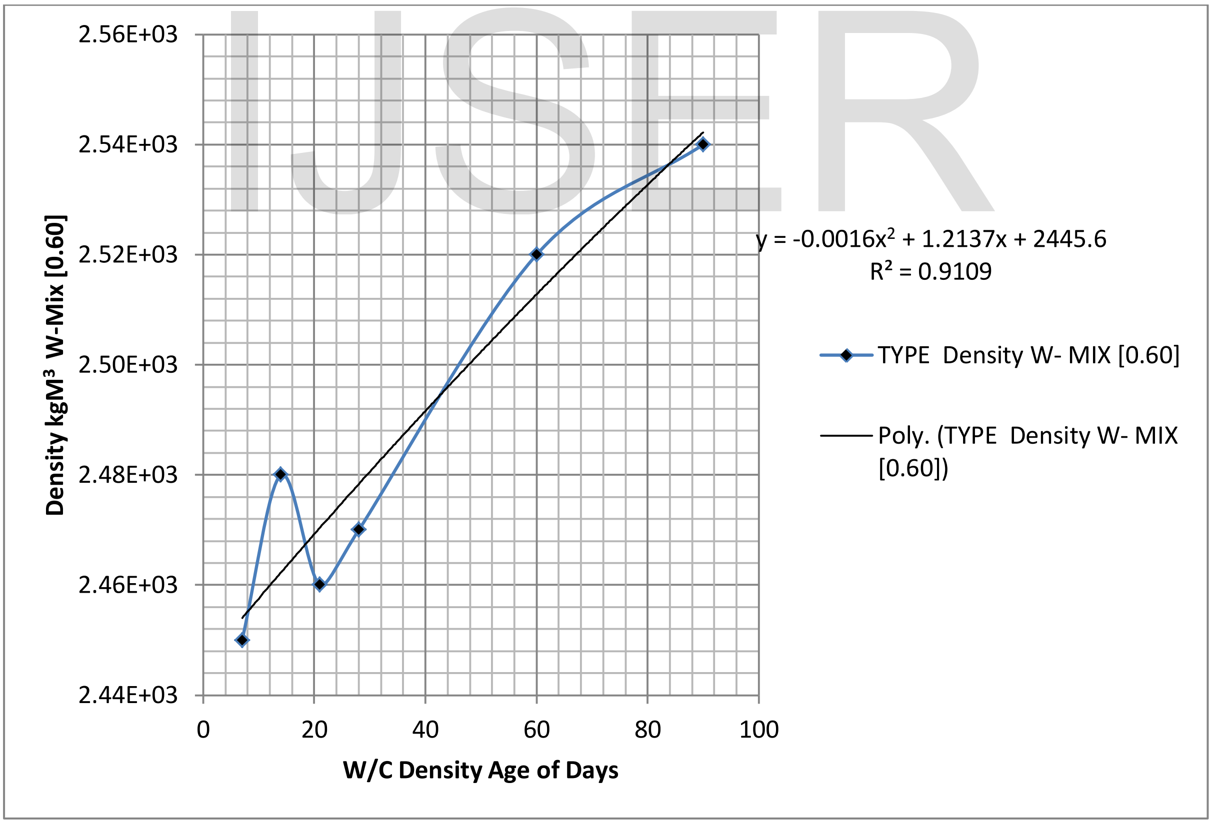

Figure: 18 Density of washed Mix at [0.60] at Different Curing Days

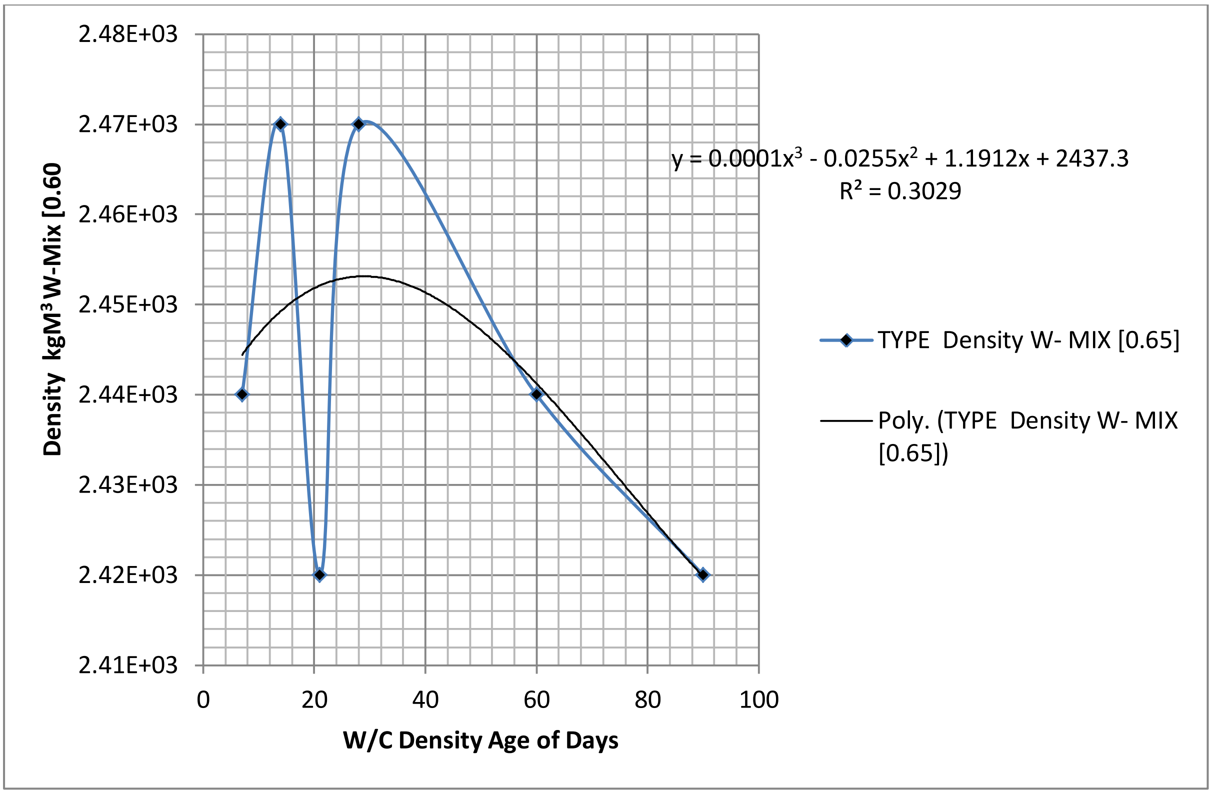

Figure: 19 Density of washed Mix at [0.65] at Different Curing Days

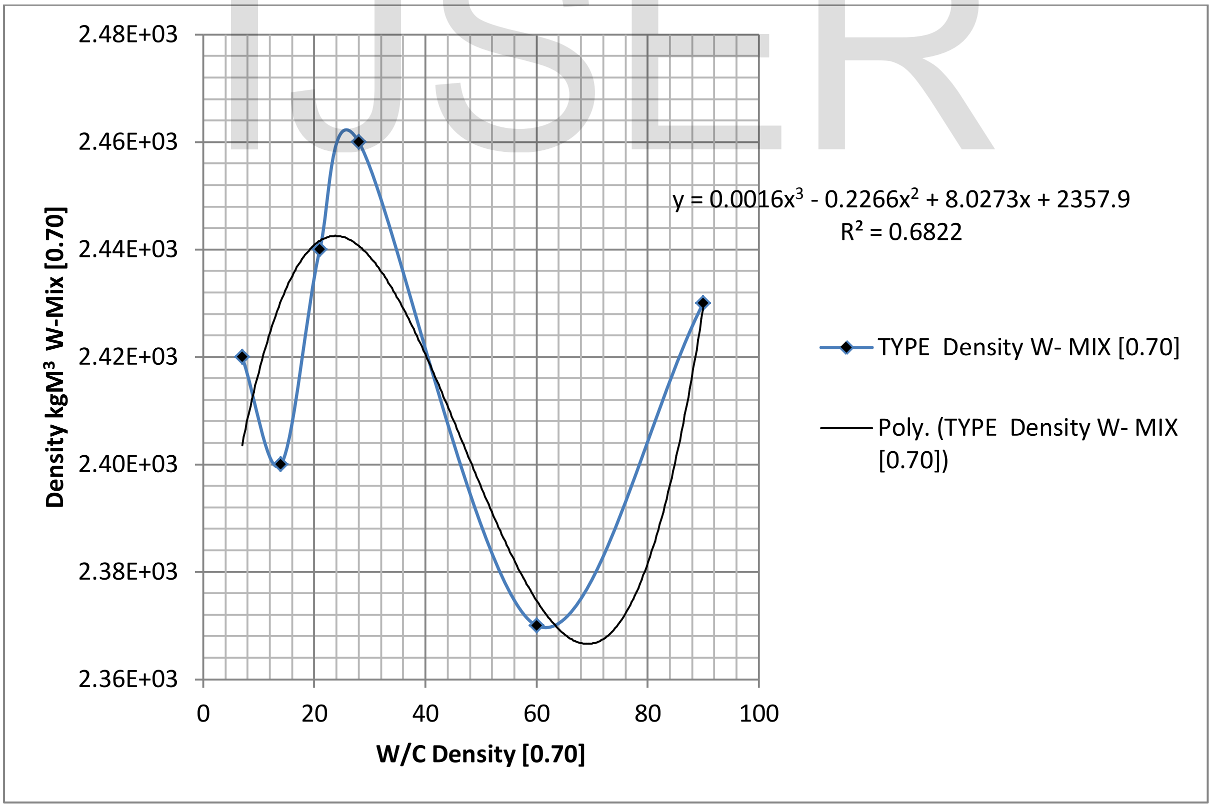

Figure: 20 Density of washed Mix at [0.70] at Different Curing Days

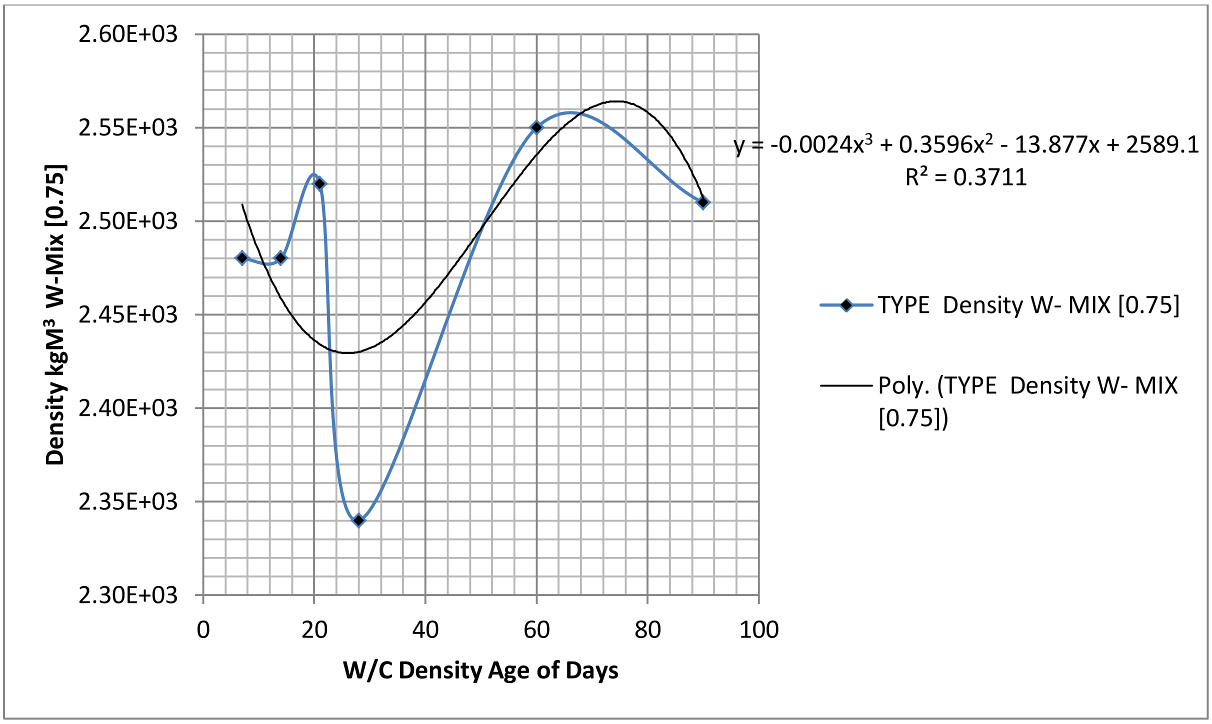

Figure: 21 Density of washed Mix at [0.75] at Different Curing Days

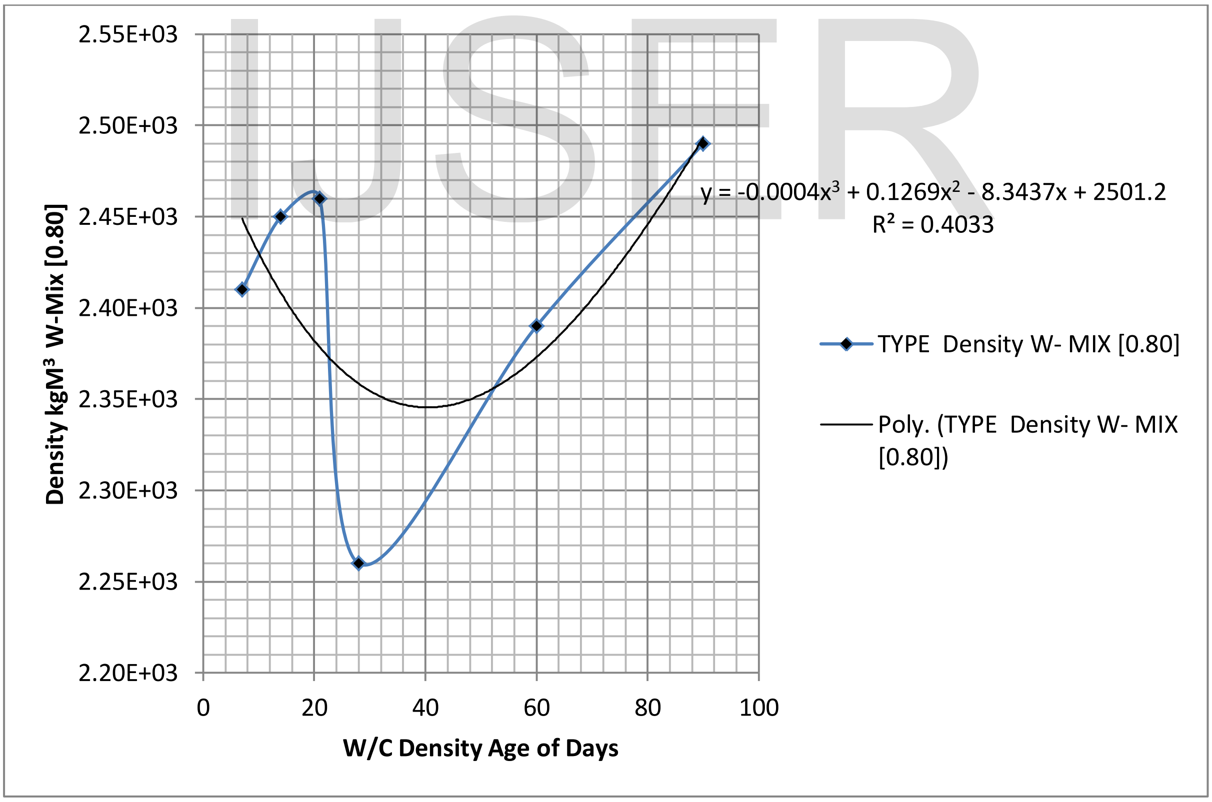

Figure: 22 Density of washed Mix at [0.80] at Different Curing Days

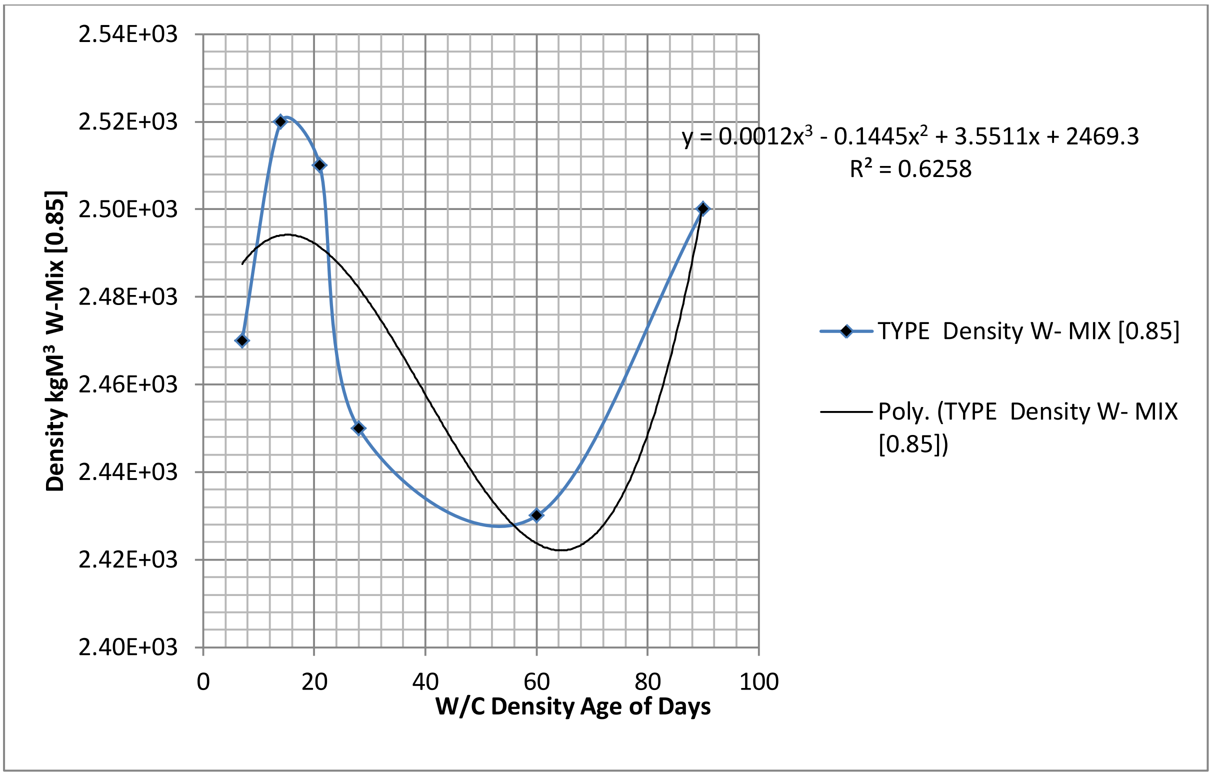

Figure: 23 Density of washed Mix at [0.85] at Different Curing Days

Concrete densities were observed to be heterogeneous in behaviour base on the investigations expressed from the results. In figure one there is an increase in density of concrete base on the curing age to the optimum values recorded at sixty days, slight decrease of density were observed above sixty to ninety days dropping within the rate of twenty eight days while figure two experienced different rate of density in the concrete formation, rapid increase were observed depositing the optimum level at ninety days , figure three observed fluctuation in density of the concrete at unwashed conditions, slight increase were observed to a certain point within the ninety curing days fluctuation pressure the concrete formation at the point at ninety days, rapid decrease of density were experienced. Thus maximum density were noted at twenty one curing days, similar fluctuation were found in figure four where maximum density were experienced at twenty one curing days, decrease predominate to sixty days with slight increase above. Figure five experienced an average increase in density within seven and fourteen curing days, sudden decrease were observed fluctuating to the optimum density at twenty eight days thus decreasing rapidly to the lowest at ninety curing days, figure six expressed similar condition, fluctuation were expressed in figure six where the optimum values were obtained in twenty eight curing days, thus the lowest deposited at sixty days developing slight increase at ninety curing days figure seven expressed different conditions, an increase in density of concrete were observed to the maximum at ninety days, figure eight experienced vacillations that manifest within the curing days, the maximum values were obtained at twenty eight curing days thus sudden decrease were found developing the minimum density at ninety days gradually increase were seen in figure nine, the optimum were experienced at twenty one curing days, sudden decrease were observed at twenty eight curing days thus express rapid increase from twenty eight to sixty days with slight decrease at ninety days. Figure ten express slight vacillation between seven and twenty eight curing days thus gradual increase were express at the optimum in ninety days. Figure eleven express similar condition were slight fluctuation was observed between seven and sixty curing days thus the optimum values were recorded at twenty eight days, but rapid fluctuations of density were observed from twenty eight to the optimum level at sixty days thus decrease were experiences at ninety day. Figure twelve maintain these fluctuation found to predominant in unwashed 3/8 gravel, the maximum values found at sixty day and minimum at ninety days. Figure thirteen definitely express vacillation gradual increase were expressed from seven days to point were slight increase was observe between fourteen and twenty one curing days, sudden increase were obtained at the maximum of twenty eight days thus sudden decrease was experienced at sixty and finally express slight increase at ninety days. Figure fourteen in the same vein maintain fluctuation between seven and twenty eight curing days were the optimum where recorded and linear increase were expressed between sixty and ninety curing days. Figure fifteen express gradual increase from seven to twenty eight days, thus slight increase to the optimum were expressed at ninety days. Figure sixteen maintain the predominant fluctuation between seven and sixty days where the lowest density was recorded at twenty eight days with slight increase at ninety days. Figure seventeen, fluctuation deposited experienced optimum level at seven days while the lowest density at sixty days, thus express slight increase at ninety days. Figure eighteen expressed slight fluctuation between seven and twenty one curing days, rapid increase were expressed from twenty eight to the optimum days at ninety days, figure twenty developed oscillation between seven to the optimum at twenty eight days thus experienced sudden decrease from twenty eight to the lowest at sixty expressing slight increase at ninety days. Figure twenty one maintained these oscillations between seven and sixty days were the optimum was recorded at sixty days expressing slight decrease at ninety days. Figure twenty two, developed similarity with twenty one gradual increase was observed between seven and twenty one where the lowest density was recorded at twenty eight day, sudden increase were experienced from twenty eight to sixty days with slight decrease recorded at ninety curing days, twenty three expressed vacillation between seven and twenty eight days, rapid increase were observed to the optimum at ninety days.

4. Conclusion

Calibrating the densities of concrete at different water cement ratios has express its level of signification at different curing age on high concrete strength. The relationship between compaction and porosity has express its role in various densities generated with different water cement ratios at different curing time. The densities that generated mass over volume express at different mix designed detailed the impact of porosity influenced by compaction, these are through washed and unwashed locally occurring 3[8 gravel at various water cement ratios. The results calibrated generated different derived models equations that will predict the densities of concreted of 3/8 unwashed and washed occurring gravel at different water cement ratios and age. Densities from calibrating values through graphical representations express the rate of densities at different curing time. These are influenced by the variations of deposited impurities and compaction rate that determined porosities variations in concrete formations. Different express models equations generated from results calibration of concrete densities were generated to be derived, this will produce predictive values that will be compared with other measured values for locally washed and unwashed occurring 3/8 gravel for higher concrete strength. The measured results fails in line with normal concrete densities and such it is acceptable base on its densities.

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