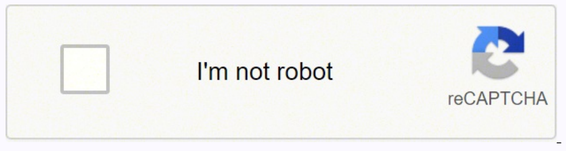

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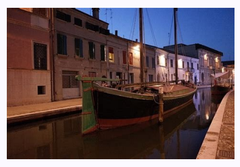

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Upon testing of all programs, they were published as standalone programs using MATLAB’s compiler for use by the community.The programs take into consideration all the aspects of concrete mix design; for example, in the ACI method, the program considers the absorption and moisture content of aggregate and the different methods for calculation of sand content. Converting empirical tables to matrices. Limitations of This StudyEvery mix design method suggests conducting trail mixes and testing the resulting hardened concrete samples to ensure that the designed mix can produce the required compressive strength. A comprehensive comparison of mix design methods would require comparing other parameters such as the cost of a concrete mix normalized by its experimentally found strength. Moreover, Wang Jizong Liang et al [11] used MATLAB to develop a mix optimization design for high-performance concrete.In addition to using hard-coded programs to solve engineering problems, a substantial attention nowadays is directed to machine learning and deep learning techniques since they proved to be capable of solving complicated problems. Methods2.1. Mix Design Computer ProgramsThe process of creating programs that replace manual calculations of a concrete mix design involves many steps starting from understanding the mix design method to converting empirical graphs and tables to computer-accessible format and finally meticulously comparing results of the program to manual calculations. All tables of numerical values from each mix design method were loaded to the MATLAB program as matrices of rows i and columns j. When the strength is increased by 5 MPa, the cost trend becomes more evident as the ACI suggests mixes that cost more than the other methods (see Figure 7(b)).As cement is the main influencers on cost, in Figure 8, we compare the cement content calculated by the three methods for normal strength mixes as the 28-day compressive strength increases from 20 to 40 MPa, with varying MNS and when the required slump is 50 mm (Figure 8(a)) and 100 mm (Figure 8(b)). This was performed using MATLAB fitting app, which can fit data points using a variety of functions such as polynomial fit and exponential fit, among others. Furthermore, most of the available Microsoft Excel sheets are unprotected and can be overwritten [1]. Abdul Qader, Ibrahim, Al Aidaros, Abdulkareem, and Alwuayl created and tested the programs. Chemical and/or mineral admixtures can be sometimes added to normal strength concrete mixes and are always added to high strength, high-performance concretes. It should be noted that when these comparisons were made, only superplasticizers were used in the mixes as an admixture. (a)(b)(a)(b)(a)(b)(a)(b)(a)(b)(a)(b)4. The programs successfully designed concrete mixes ranging from 10 to 160 MPa 28-day compressive strengths with minimal errors and provided estimates of the cost of each mix. Engineers usually perform concrete mix design calculations by hand, which can be prone to errors. It is worth mentioning that the range of values for each input is hinted to the user, and that if provided input data by the user is outside the limits, an error is shown. It is beneficial to compare different mixes and examine their performances and the associated costs. Developing an algorithm for each method. Representative comparisons are shown in Tables 3–7. It is a part of the ACI 211 [32] method, and it assumes that the absolute volume of concrete is the sum of the absolute volumes of its constituents. Prior to commencing the process of coding, authors spent sufficient time understanding each method and how it can be best programmed and presented to users. Step 2. The method uses many empirical charts rather than tables and has the advantage of choosing the type of aggregates that are being used, i.e., crushed or uncrushed as well as providing designers with the option to choose from two types of cements.1.2. Popular Mix Design Methods for High Strength ConcreteIn the last few decades, mega projects such as skyscrapers and bridges necessitated the need for high strength concrete (HSC). The use of ANN in predicting the strength of concrete continued as machine learning and deep learning methods improved, solving problems related to strength prediction of normal and high strength concrete [13–18], high strength and high-performance concrete [19–21] and ultra-high-performance concrete [22], recycled aggregate concrete [23], structural lightweight concrete [24], and self-consolidating concrete [25]. File description (Excel .exl file)The document is practical use of concrete mix design for professionals. Also, using the developed programs, methods were compared regarding their suggested concrete ingredients’ quantities, associated cost, and general trends. A flowchart of the program created in this work according to modified DOE is shown in Figure 3.2.2.6. ACI 211.4R-8Input: the input is required strength, materials properties (specific gravities, bulk densities, and moisture content), maximum nominal size of coarse aggregates, required workability (slump), whether fly ash and/or admixtures are used, cost of concrete constituents, casting quantity, and whether previous test records are available.Output: the output is weights (per cubic meter and per provided casting quantity) of cement, water, fine, and coarse aggregates as well as fly ash and admixtures and the associated cost. For this case, data points in the table were fitted and replaced with a polynomial modal equation. More importantly, the comparisons presented in this work are only a few of the unlimited comparisons that can be easily made between normal and high strength mix design methods, which will unravel other key differences between mix design methods. Additionally, this work emphasizes the necessity and the effectiveness of using simple programs to solve fundamental civil engineering problems. It is developed by the American Concrete Institute. The comparisons presented in this work are only a few of the unlimited comparisons that can be easily made between normal and high strength mix design methods. Preliminary comparisons between mix design methods showed that design methods suggest similar mix proportions for a given compressive strength. Calculations from the developed programs were compared with manual calculations for verification purposes, and results from manual calculations and programs agree very well. Creating a GUI for each program. Similar findings were reported in [5–7]. Experimental results showed that the concrete proportioned by this method can achieve a compressive strength of up to 120 MPa at the age of 28 days [37].2. Such comparisons are vital to engineers to be able to make informed decisions regarding which mix to use from strength, workability, durability, and cost point of views.1. IntroductionThere are numerous methods for designing concrete mixes, including the American Concrete Institute (ACI) method, the absolute volume method (AVM), and the Department of Environment (DOE) method. However, ever since the advent of computers, solving engineering problems have become easier, faster, and in most cases more accurate [1]. Authors decided to use MATLAB (MathWorks, Inc, MA, USA) coding environment because it provides tools for terminal coding as well as applications for the creation of graphical user interfaces. Besides MS Excel, standalone programs and MATLAB scripts have been used to design concrete mixes. For instance, Gupta, Mittal, and Saini developed a normal strength concrete mix designer using MATLAB. Further, researchers [8] created MATLAB programs to design high strength concrete mixes. A total of 60 comparisons were made, and it was found that manual calculations and programs calculations agree very well. It is important to note that while ACI mixes cost more, experimentally, they are found to be more cost effective and efficient than DOE [18, 31].(a)(b)(a)(b)3.4.2. High Strength ConcreteIn the comparison between the high strength methods, namely, the modified DOE, the ACI, and the Aïtcin method, we can see that methods provide similar estimates of the quantities of water, cement, aggregates, and HRWRA (superplasticizer) for 60 and 70 MPa 28-day compressive strengths (see Figure 9). The method uses predefined ratios for fine/coarse aggregate and gives the designer the freedom of choosing the water/cement ratio based on the required compressive strength of the hardened concrete. A flowchart of the program created in this work according to Aïtcin is shown in Figure 3.2.2.5. Modified DOEInput: the input is required strength, materials properties, maximum cement content, types of course and fine aggregates, type of cement, cost of concrete constituents, casting quantity, and whether previous test records are available.Output: the output is weights (per cubic meter and per provided casting quantity) of cement, water, fine, and coarse aggregates as well as superplasticizers, suggested ratios for coarse aggregate, and the associated cost. Understanding each mix design method. Abdullahi and Al-Mattarneh and Mohammed and Sadiku developed a MATLAB script to output the ingredients of light weight structural concrete [10]. In both cases, 50 mm and 100 mm concrete consistency requirements, and for all MNS, it is clear that in most of the cases, ACI suggests higher amounts of cement as strength increases than other methods. The main considerations and factors involved in this method are presented in Table 1.Key considerationsAVMACIDOEFresh concrete consistencyNoYesYesAverage required strength based on previous testsNoYesYesAir-entrainmentNoYesNoSize of aggregatesNoYesYesCrushed-uncrushed aggregatesNoNoYesRapid hardening portland cementNoNoYesPercentage of fines passing 600 μ sieveNoNoYes1.1.2. American Concrete Institute (ACI 211) MethodThe ACI 211 [32] method for designing concrete mixes is widely used. These findings and others would have been difficult to be revealed using traditional methods of mix design. A comprehensive checking and debugging of each program were conducted to ensure that programs run properly and error-free. Step 8. Similarly, Makenya and John [1] reported a MATLAB program that is capable of designing concrete mixes of high strength using Erntroy and Shacklock method [9]. The method can be used to design concrete mixes having either rounded or angular aggregates, regular or light weight aggregates, and air-entrained or non-air-entrained mixes.1.1.3. Department of Environment (DOE) MethodDOE is the United Kingdom’s Department of Environment method [33] which is also known as the British Standard method. The amount of cement calculated by the ACI method is higher than that calculated from the other methods. A mix design using this method follows many simple steps that result in final design values. Results and Discussion3.1. Created ProgramsA representative program of the created GUI-aided programs developed in this work is shown in Figure 4.3.2. Example of Designing a Concrete Mix Using the Developed ProgramsAn example showcasing how data are inputted into the program and how results are shown is illustrated in Figure 5.3.3. Manual vs. Such comparisons are vital to engineers to be able to make informed decisions regarding which mix to use from strength, workability, durability, and cost point of views. Output of the programs was used to draw conclusions regarding the differences in concrete ingredients quantities, associated cost, and general trends of all methods. MATLAB Guide was used to create all GUI’s. The method of fitting is regression methods [38]. This method takes into consideration many factors, including aggregate shape.1.2.3. Modified DOE MethodModified DOE [37] is based on the design of normal concrete mixes published by the Department of Environment (DOE) of United Kingdom. Further, available comparisons between mix design methods are limited with regard to the studied range of strengths and parameters. Description of the three methods used in this work is given below.1.2.1. ACI 211.4R-08 MethodACI 211.4R-08, Guide for Selecting Proportions for High Strength Concrete Using Portland Cement and Other Cementitious Materials [35], is a detailed guide for designing high strength concrete using different types of the cementitious materials such as cement, fly ash, cement slag, and silica fume. In this table, only a few values of w/c ratio corresponding to concrete compressive strength are provided, and other values can be interpolated. Concrete mixes can be designed using many methods such as the British method (DOE) and the American method (ACI). free to use or share modify, even commercially; Sharing this file online not prohibited.Contributor: “Anonymous”Country: “all countries”Agreement: by downloading this document and using this site you agreed to terms and conditions of this website. It is also worth mentioning that the difference between quantities of materials using the ACI method is very similar for both air-entrained and non air-entrained, however, with higher air content in the mix designed by the former.(a)(b)(a)(b)By comparing the mixes designed by the three methods when the strength is increased to 40 MPa and 40 mm MNS is used, we observe that the AVM suggests lowering the amount of coarse aggregates by 14%, roughly, while both ACI and DOE suggest increasing the amount of CA by approximately 50%. Hence, in this work, algorithms were developed and implemented for six mix design methods, which replaced the time-consuming hand calculations with error-free and fast ones, in a user-friendly fashion. This was achieved by digitizing the curves by carefully tracing the curves in the source image and then converting them to x-y data points. Graphs of the mix design methods were first converted from mere images to x-y graphs whose data points were later fitted and converted into their respective modal equations using the procedure outlined in Step 3. All authors discussed the results and wrote the manuscript.AcknowledgmentsThis research was funded by Taif University Researchers Supporting Project (number TURSP-2020/204), Taif University, Taif, Saudi Arabia.Copyright © 2022 Mohammed Abdul Qader et al. The developed programs were used to design concrete mixes of normal strength and high strength mixes ranging from 10 to 160 MPa 28-day compressive strengths. In addition, when the used coarse aggregates are uncrushed, the DOE method reduces the amount of fine aggregates by approximately half (see Figure 6(b)).In Figure 7(a), it can be seen that when comparing the cost associated with designing a concrete mix for a 28-day strength of 30 MPa using AVM, DOE, and ACI and varying MNS, type of aggregates, and for air-entrainment and non air-entrainment, we notice that the AVM method provides the cheapest mix while DOE and ACI provide mixes with comparable costs. Hence, all values in the table can be accessed by providing the coordinates i and j. Comparing programs to manual calculations. Besides neural networks, decision trees have also been used to predict compressive strength of different types of concrete such as high strength and high-performance concrete [26, 27], FRP-confined concrete [28], as well as recycled aggregate concrete [29, 30].Comparisons between ACI and DOE methods regarding their mix designs and associated cost have been investigated and reported in literatures [18, 31]. The main considerations and factors involved in this method are presented in Table 2.Key considerationsACI 211.4R-08AïtcinModified DOERange47–83 MPa40–160 MPa60–100 MPaSuperplasticizerYesYesYesCementitious materialsYesYesYesAggregate shapeNoYesNo1.2.2. Aïtcin MethodAïtcin [36] introduced a method for designing a high strength/performance concrete based on the ACI 211–1. Additionally, while the use of machine learning and artificial intelligence models proved to be very effective in solving problems of varying nature and difficulty, they are associated with prediction/classification errors. HSC can also be used in smaller structures to reduce the size of the structural members hence maximizing the utilization of floor areas. An algorithm for each mix design method was created and programmed following the procedure reported in each method’s source documents. Step 6. Each mix design method’s program was converted into a GUI-assisted program by using MATLAB’s tool guide. Step 7. A flowchart of the program created in this work according to ACI 211.4R-8 is shown in Figure 3.2.3. Comparisons of Mix Design MethodsConcrete mix design methods were compared in three main areas:(i)Quantities of concrete constituents suggested by each method for the same required compressive strength(ii)Cost associated with each design mix produced by each method for the same required compressive strength(iii)General trends3. To illustrate this idea, consider the table that correlates w/c ratio to compressive strength in the ACI method [32], shown in Figure 2. In the field of concrete technology, researchers have used computers to design concrete mixes. Ingredients costs were reported to us by local vendors at the date of writing this paper. The reason behind AVM costing less than ACI and DOE is that it suggests low amounts of cement (see Figure 6(a)). In addition, comparing different mixes within the same method and mixes designed by different methods and evaluating the associated cost of each mix can be time consuming, much like other engineering design problems. All fit equations were polynomials of R2 exceeding 0.99 (see Figure 2). Step 4. In the case of normal strength concrete, the ACI 211 method suggests higher amounts of cement than both Absolute Volume method and Department of Environment method. The design of high strength concrete is far more complex than a normal strength concrete mix as it requires judicious selection of mix quantities and admixtures [9]. Further, it was found that designing a mix using ACI method can be costly compared with the other methods. For high strength concrete, the American Concrete Institute for high strength concrete mix design (ACI 211.4R), the modified DOE method for high strength concrete mixes, and the Aïtcin method were used.1.1. Popular Mix Design Methods for Normal Strength Concrete1.1.1. Absolute Volume Method (AVM)The absolute volume mix design method is used by engineers as a fast method for designing concrete mixes. Setting up the coding environment. Some tables, however, have only several values that have been extracted from experiments; hence, required values that lie in between of the existing values in the table can be interpolated. The guide provides a procedure for the design of HSC. It was first published in 1975 and then revised in 1988. Additionally, most of the available software in the literature do not offer a graphical user interface for the process of input and output of the data, which can be problematic and may further complicate the process of concrete mix design. The copy of the terms of use can be found at can click below to download editable fileDownload Excel FilesJust one click to enjoy this design all free we don’t need anyone to hassle easily download, without Signup or Sign in.NOTE: As soon as you click to download bottom, it will automatically download the file to your location, please check your folder before you click it again. Extra calculations are provided by the programs such as ingredients quantities for a specific casting quantity and the cost of the required concrete quantity in Saudi Riyals (SR). MathWorks-published tool GRABIT [39] was used for this job. Step 5. However, when the used aggregates are uncrushed, the DOE method suggests higher quantities of coarse aggregates and fine aggregates than the other methods. The following steps are followed in the implementation of all programs. Publishing the created programs. While this study provides engineers and scholars with tools to easily design and compare normal and high strength mixes, it is vital that results presented in this work are compared with results of experimental tests; therefore, it is the intent of the authors to perform experimental studies to complement the results presented herein. Future work shall extend the current to include experimental validation and computer simulation.Data AvailabilityAll data, models, or codes that support the findings of this study are available from the corresponding author upon reasonable request.Conflicts of InterestThe authors declare that they have no conflicts of interest.Alghamdi, Alsaluli, Alwetaishi, and Alsehli conceptualized the idea and methodology. Additionally, default input values are pre-entered for the ease of use, such as cost of concrete constituents.2.2. Inputs and Output of Programs2.2.1. AVMInput: the input is required strength, materials properties (w/c ratio, specific gravities, and bulk densities), cost of concrete constituents, casting quantity, and state of control on placing and mixing concrete.Output: the output is weights (per cubic meter and per provided casting quantity) of cement, water, fine, and coarse aggregates and the associated cost. Santoso described concrete mix designs using British DOE and American ACI methods according to compressive strength and cost using local materials. Concrete is mix of cement, fine aggregate, course aggregate, water and sometime admixture, to achieve different compressive strength you need different proportion among the constituents.This file contains practical calculations Considering one cube meter of concrete the ingredients are calculated on absolute volume basisThe design includes This file contains the following items;C-30 Concrete Mix designC-10 Concrete Mix designDetermination of Aggregate Loose Unit Weight, Determination of Aggregate Rodded Unit Weight, Determination of Fine Aggregate Rodded Unit Weight, and Determination of Aggregate Impact Value Test BS812 PART 3-1975File format: .xls compatible with Ms offece 2007 and aboveDownload Excel FilesUser purpose of file: this mix design represent a C-30 and C-10 in ACISince this is excel file you can just edit the values to get the final result for your projectCan be use, edited and use for more purpose.Sample view:Size of the file:

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