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Optimization Compresion Strength Of Concrete Using The Deterministic System With Simpleks Method

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ABSTRACT

Scientific computing is the field of science that studies mathematical models and quantitative analysis related to involving the use of computersto assist planners in making decisions. The purpose of this research is to determine the compressive strength of concrete with 2 samples of normal concrete specimens that have K200 and K-300 quality. This research method is carried out by conducting direct research in the laboratory and optimizing concrete compressive strength with the deterministic system of the simplex method. The Simplex method is used to find the optimal value of a linear program that involves many constraints and many variables (more than two variables). Based on the results of research in the laboratory, the K-200 quality concrete compressive strength of 167 kg / cm2 and K-300 quality concrete obtained 195 kg / cm2 compressive strength, while based on the data obtained through optimization with the simplex method it is known that for K-200 concrete quality a compressive strength of 116.5 kg / cm2 was obtained with material requirements of cement 10.56 kg, water 2.11 kg, fine aggregate 31.73 kg and coarse aggregates 13.05 kg. For K-300 quality concrete, compressive strength is 648.6 kg / cm2 with material requirements cement 2.4 kg, water 1.62 kg, fine aggregate 20.15 kg and crude aggregate 25.04 kg. The value of compressive strength in K-300 concrete is due to the amount of coarse aggregate material used which is much greater than the mix design, which is 25.04 kg. With the magnitude of the compressive strength value followed by the magnitude of material requirements reaching 2 times greater when compared with the results of mix design,

Keywords:
concrete, compressive strength, optimization, simplex

INTRODUCTION

Scientific computing is a field of science that studies mathematical models and quantitative analysis related to the use of computers. Scientific Computing in Science and Finance. The main topics covered include: Scientific Computing, probability theory, random walk and Brownian motion, stochastic differential equations (PDS), Euler-Maruyama (EM) method and Milstein method, convergence and stability properties of EM and Milstein methods, Monte Carlo simulation, PDS model stock price, PDS model in the field of science In this research, scientific computing is focused on how to process the experimental data on the compressive strength and flexural strength of concrete.

Mathematics cannot be separated from human life regardless of the field, in mathematics there are two classifications of formulas, namely static formulas and dynamic formulas. Static formulations involve algebraic equations or function optimization with one or more variables, in the form of scalars or vectors, having discrete or continuous values, can be limited or not. While the dynamic formulation involves two types of variables, namely the dependent variable and the independent variable.

A deterministic system is a system whose future behavior and dynamics are certain and can be predicted in precise detail, provided the initial conditions are known. From the system point of view, the initial conditions are the input/cause and the future dynamics of the system are the output/effect. The deterministic system is: "Two same inputs produce two equal outputs", and "Two slightly different inputs produce two slightly different outputs".

A stochastic system or random system is a system whose dynamics in the future are micro-changed so that they cannot be predicted, but are macro-predictable according to a certain probability distribution. From a systems point of view, a stochastic system is: "two equal inputs produce two different outputs".

The need for concrete in construction is very large, especially concrete that has high compressive strength and flexural strength. Before being used in construction, it must first be ensured that the concrete has the quality as planned by making samples in the laboratory with the start of making a mixture calculation (Mix Design). Sometimes there are conditions that cause compressive strength testing cannot be carried out due to equipment damage, while the results of the concrete compressive strength test are still needed, therefore this study was conducted to predict the compressive strength of concrete based on the planned strength of the concrete.

The high demand for concrete with several planned strengths requires an effective way to determine the proportion of the needs of each concrete constituent material with a previously planned strength, for example concrete with a strength strength of K-200, and K-300. An effective increase in production is needed, so that modeling is needed in calculating the material requirements for making concrete, and the method used in this study is a deterministic system using the simplex method.

METHOD

The research was carried out by making specimens in the form of cubes of 15 cm x 15 x m x 15 cm with concrete quality K-200 and K-300. Concrete compressive strength tests were carried out on day 21 with concrete specimens. and using the optimization of concrete strength using the simplex method. The research procedure carried out is as follows:

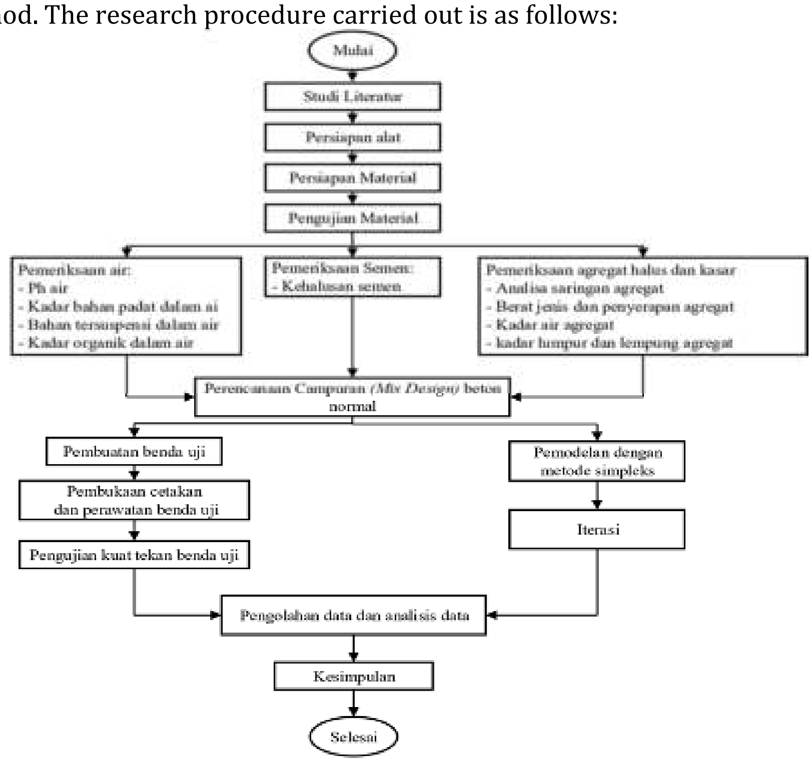

Figure 1. Flowchart of research stages

RESULTS AND DISCUSSION

In this study using scientific computing with a deterministic model that uses the general form of linear programming, namely nThe problem of linear programming with conditional optimization is finding the maximum value or finding the minimum value of an objective function with respect to limitations or constraints that must be met. The maximizing objective function is denoted by Z and the relation in the constraint is of the form.

Prior to optimizing the determination of the compressive strength of concrete, previously carried out activities carried out in the concrete laboratory, namely the preparation of tools and materials as well as material testing whose test results were used for the concrete mix design stage (mix design) in this case using the ACI method. The results of the mix design are shown in Table 1 below.

Table 1. Mix Design (Mix Design) for normal concrete

NO	DESCRIPTION		Sample 1	Sample 2
1	Quality	:	K 200	K 300
	f'c	:	16,600	25,000
	K	:	200	300
2	Standard deviation (N/mm2)	:	12	12
3	Margins (N/mm2)	:	12	12
4	Target mean Strength (cylinder) (N/mm2)	:	28,600	37,000
	Target mean Strength (cube) (kg/cm^2)	:	344.578	445,783
5	Cement type (kg/cm^2)	:	Type 1	Type 1
6	Fine aggregate	:	crushed	crushed
	Coarse aggregate	:	crushed	crushed
7	Water Cement Factor (free water cement ratio)			
	FAS (cylinder) (N/mm2)	:	0.585	0.500
	FAS (cube) (kg/cm^2)	:	0.595	0.510
	FAS	:	0.590	0.505
8	Maximum FAS	:	0.600	0.600
9	Slumps (mm)	:	120±20	120±20
10	Maximum aggregate size (mm)	:	20	20
11	Free water content			
	Slumps (mm)	:	120±20	120±20
	Maximum site of aggregates (mm)	:	20	20
	Wf(kg/cm^3)	:	225	225
	Wc (kg/cm^3)	:	225	225
	Free water content (kg/cm^3)	:	225	225
12	Cement content (kg/cm^3)	:	381,356	445.545
14	Minimum Cement Content (kg/cm^3)	:	325,000	325,000
15	Adjusted FAS (kg/cm^3)	:	0.590	0.505
16	Gradation Zone	:	III	II
17	Aggregate proportion percentage			
	Proportion of fine aggregate (%)	:	35	42
	Proportion of course aggregate (%)	:	65	58
18	Combined aggregate relative density			
	Specific gravity of fine aggregate	:	2,611	2,626
	Specific gravity of coarse aggregate	:	2,422	2,466
	Gs (kg/cm^3)	:	2,501	2,533

19	Density of concrete (kg/cm^3)	:	2255,000	2275,000 20
20	Total aggregate content (kg/cm^3)	:	1648,644	1604.455
21	Fine aggregate content (kg/cm^3)	:	577,025	673,871
22	Coarse aggregate content (kg/cm^3)	:	1071,619	930,584
23	Adjustment to aggregate moisture content			
	Water (kg/cm^3)	:	234,685	225,975
	Ag. Fine (kg/cm^3)	:	575,630	674,075
	Ag. Coarse (kg/cm^3)	:	1063,960	929,406
24	Mixed quantity			
	Volume of cylinder mold (cm^3)	:	5301.438	5301.438
	Volume of cube mold (cm^3)	:	3375,000	3375,000
	Casting volume (m^3)	:	0.010	0.010
	Cement (kg)	:	3,971	4,639
	Water (liters)	:	2,443	2,353
	Fine aggregate (kg)	:	5,995	7,018
	Coarse aggregate (kg)	:	11,070	9,677

The manufacture of test objects in this study refers to SNI 2493:2011 (Procedures for making and maintaining concrete specimens in the laboratory). The mold used is square with the condition that the mold must be smooth and free from protrusions. The sides, base and ends must be perpendicular and free from indentations. The mold used is a cube with a size of 15 cm x 15 cm. The material requirements for each sample are listed in table 2.

Table 2. Requirements for normal concrete constituents

Information	Sample 1 K-200 . Concrete			Sample 2 K-300 . Concrete			Total needs
	1	**0.003375**	**Percentage**	**1**	**0.003375**	**Percentage**	**Materials (kg)**
Cement (kg)	3.97	0.0134	17	4.64	0.0157	20	29
Water liters)	2.44	0.0082	10	2.35	0.0079	10	16
Fine aggregate (kg)	6.00	0.0202	26	7.02	0.0237	30	44
Coarse Aggregate (kg)	11.0 7	0.0374	47	9.68	0.0327	41	70
Total materials	23.4 8	0.0792	100	23.6 9	0.0799	100	237

Discussion

The results of the weighting of technical factors show that among the three existing technical factors, the factor that is considered the most dominant to measure the feasibility of asphalt roads and concrete roads is the power factor against the weather (0.491). The second factor is resistance to ground movement (0.347) and the last is resistance to traffic changes (0.162). These results indicate that respondents view weather resistance as being very important to the feasibility of a road, especially because changes in weather generally often trigger damage to a construction (eg due to rain, puddles, etc.) more than other factors.

Table 3. Results of weights for technical factors

No.	Factor	Weight
1.	Weather resistance	0.491
2.	Resistance to ground movement	0.347
3.	Resistance to traffic changes	0.162

Meanwhile, a minor factor is the factor of resistance to changes in traffic. For the most influential non-technical factors to assess the feasibility of a road is occupied by the factor of maintenance period and availability of resources (0.328). The maintenance period relates to the speed with which a construction requires repair. Meanwhile, the availability of resources is mainly related to the availability of funds. These two factors dominantly indicate that 1) as little maintenance and repair as possible means that road construction is considered better, and 2) availability of resources, especially funds, is a factor that will determine whether a construction is chosen to be built or not. Because basically funds are always an obstacle, especially in the midst of the limited road construction budget in Indonesia.

Table 4. Weighting results for non-technical factors

No.	Factor	Weight
1.	Road surface comfort	0.221
2.	Ease of implementation of development	0.123
3.	Road maintenance period	0.328
4.	Availability of resources and technology	0.328

Meanwhile, another important factor to consider is the problem of road construction surface comfort (0.221). This factor is important because it relates to user comfort after construction is completed. In this study, the convenience factor is also superior to the ease of construction factor (0.123). From the table, it can be seen that the overall concrete construction is better than asphalt construction as indicated by the eigenvalue of concrete construction (0.580) which is higher than the eigenvalue for asphalt construction (0.420). In conclusion, concrete construction is more suitable for the construction of the Demak – Godong road.

Table 5. Final eigenvector results for the feasibility assessment of asphalt and concrete roads

No.	Type of road construction	Weight
1.	Concrete	0.580
2.	Asphalt	0.420

CONCLUSION

That based on the AHP analysis, it is known that the technical factor that has the highest weight is the weather resistance factor (0.491). This indicates that the weather resistance factor is considered the most important technical factor to assess the feasibility of a road based on the respondent's assessment. Whereas based on the AHP analysis, it is known that the non-technical factor that has the highest weight is the resource availability factor (0.667). This indicates that the resource availability factor is the most considered non-technical factor in the selection of roadworthiness based on the respondent's assessment. Of the 8 assessment factors, concrete construction excels on 4 factors, namely weather resistance, soil movement resistance, traffic resistance and maintenance period with an average superiority level of 6 times compared to asphalt construction. While asphalt construction excels in the factors of road surface comfort, ease of implementation of development, availability of resources and technology and costs with an average level of advantage of 4 times compared to concrete construction. From a comparative analysis involving all the factors reviewed, it is known that on average concrete roads are superior to asphalt roads. This is shown from the results of the weighting for concrete construction reaching 0.580, while the weight for asphalt construction is only 0.420.

REFERENCE

A. G. Lake, L. Djakfar, Y. Zaika, J. T. Sipil, F. Teknik, and U. B. Malang, "KINERJA CAMPURAN SPLIT MASTIC ASPHALT DENGAN BEBERAPA MATERIAL DARI KALIMANTAN," *J. Rekayasa Sipil*, vol. 4, no. 3, 2010.

Limbong, T., Simarmata, J., Rofendi Manalu, M., Rikki, A., & Rajagukguk, D. M. (2020, July). Implementation Of Multi Factor Evaluation Process (MFEP) In Assessment Of Employee Performance Achievement. In *Journal of Physics Conference Series* (Vol. 1573, No. 1, p. 012022).

A. G. Lake, L. Djakfar, Y. Zaika, J. T. Sipil, F. Teknik, and U. B. Malang, "KINERJA CAMPURAN SPLIT MASTIC ASPHALT DENGAN," *J. Rekayasa Sipil*, vol. 4, no. 3, 2010.

K. Y. Prahastyo, N. Sebayang, and L. K. Wulandari, "Penentuan Skala Prioritas Pemilihan Jenis Perkerasan jalan dengan Metode Analitycal Hierarchy Process pada proyek Preservasi Rekonstruksi Jalan Sidoarjo …," *INFOMANPRO*, 2019.

A. Sandhyavitri and N. Saputra, "Analisis Risiko Jalan Tol Tahap Pra Konstruksi (Studi Kasus Jalan Tol Pekan Baru-Dumai)," *J. Tek. Sipil*, vol. 9, no. 1, 2019, doi: 10.28932/jts.v9i1.1366.

T. L. Ing and S. Riana, "Analisis Kondisi Permukaan Perkerasan Jalan pada Jalan Lemahneundeut dengan Metode PCI dan RCI," *J. Tek. Sipil*, vol. 15, no. 1, 2019, doi: 10.28932/jts.v15i1.1854.

P. S. Sukanto and R. T. Subagio, "Sistem Pendukung Keputusan Penilaian Kinerja Dosen Menggunakan Metode AHP," *JUMANJI (Jurnal Masy. Inform. Unjani)*, vol. 3, no. 01, 2019, doi: 10.26874/jumanji.v3i01.48.

Rajagukguk, D. M., & Ritonga, I. S. (2020). Sistem Pendukung Keputusan Pemilihan Kepala Sekolah Berprestasi Menggunakan Metode SAW (Simple Additive Weighting). *Jurnal Teknik Informatika UNIKA Santo Thomas*, *5*(2), 202-210.

B. Ali, "Analisis Sistem Pendukung Keputusan Pemilihan Bibit Kakao Menggunakan Metode AHP," *J. Ilm. d'Computare*, vol. 9, 2019.

T. A. Nugroho, R. N. S. Fathonah, and Noviana Riza, *Implementasi Metode Analytical Hierarchy Process Pada Aplikasi E-Planning*. 2020.

A. Qiyamullailiy, S. Nandasari, and Y. Amrozi, "PERBANDINGAN PENGGUNAAN METODE SAW DAN AHP UNTUK SISTEM PENDUKUNG KEPUTUSAN PENERIMAAN KARYAWAN BARU," *Tek. Eng. Sains J.*, vol. 4, no. 1, 2020, doi: 10.51804/tesj.v4i1.487.7-12.