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Prediction of "Concrete Compressive Strength" using SARIMA Method for Efficient Construction Planning

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Abstract. Over the past ten years, infrastructure development in Indonesia has undergone significant changes, particularly in terms of construction materials, one of which is concrete. Concrete is one of the most commonly used construction materials in the world, especially in building structures, bridges, roads, and other infrastructure. One of the main parameters that determine the quality and strength of concrete is compressive strength. Compressive strength describes the ability of concrete to withstand compressive forces and serves as a key indicator in determining concrete quality according to SNI classification. However, in practice, the compressive strength of concrete often does not meet the planned quality, mainly due to variations in constituent materials, mixing processes, casting execution, and suboptimal curing. In addition, external factors such as weather conditions, production equipment (batching plant), and technical errors in the field also affect the final quality of concrete. This study aims to develop a model for predicting concrete compressive strength using the Seasonal Autoregressive Integrated Moving Average (SARIMA) method with the assistance of SPSS software. The analysis was conducted using a factorial experimental design approach, with two factors including cylindrical sample shape as a fixed factor. A total of 30 samples were used. The compressive strength data were obtained from the Laboratory of Universitas Muhammadiyah Metro over a ten-year period (2015–2024), using samples that had been cured for 28 days.
Keywords: concrete compressive strength; prediction; SARIMA; time series

INTRODUCTION

Concrete is the most widely used construction material globally due to its reliability in various types of structures. Compressive strength is one of the main parameters indicating the quality and performance of concrete in resisting compressive loads, and has become a standard testing standard in quality classification based on SNI. Several previous studies have examined various factors affecting compressive strength, such as mixture proportions, cement type, aggregate, and curing process. Statistical methods and machine learning are also beginning to be used to model the prediction of concrete compressive strength. However, time series approaches such as SARIMA are still rarely applied in the context of long-term laboratory data.

Most previous research has focused on the influence of mixture composition or machine learning methods on compressive strength prediction. However, few studies have developed concrete compressive strength prediction models based on seasonal patterns

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and time trends using the SARIMA method, particularly with long-term historical data such as 10 years of laboratory data. Furthermore, the use of statistical software such as SPSS to apply the SARIMA model in civil engineering is still limited and is still used as a primary approach.

Developing a predictive model using the SARIMA method based on time series data to project concrete compressive strength. By utilizing historical laboratory data and applying statistical analysis using SPSS, it is hoped that an accurate and applicable model can be obtained for use as a decision-making tool in concrete quality control. This research aims to develop a concrete compressive strength prediction model using the SARIMA method. Furthermore, it analyzes the influence of seasonal patterns and trends in concrete compressive strength data over 10 years. It also provides an alternative statistical approach that can be used to evaluate concrete quality more accurately and efficiently, providing solutions to concrete quality discrepancies in the field through more precise predictions.

RESEARCH METHODS

This research is a quantitative study using a statistical experiment and time series forecasting approach. The objective is to develop a concrete compressive strength prediction model using the Seasonal Autoregressive Integrated Moving Average (SARIMA) method with the aid of SPSS software. The study employed a factorial design experimental approach, with two main factors: the fixed independent factor (the shape of the concrete sample (cylinder) and the time factor (the concrete compressive strength data by year (2015–2024). The data source used in this study was the Civil Engineering Laboratory of Muhammadiyah Metro University. The secondary data consisted of 28-day concrete compressive strength test results conducted over the past 10 years (2015–2024). The sample size was 30 concrete compressive strength test results, measured in MPa.

Data stationarity test using ACF and PACF graphs. Differentiation test if the data is not stationary. Identify model parameters (p, d, q) and (P, D, Q)s based on ACF, PACF graphs, and annual patterns. Parameter estimation using SPSS (SARIMA modeling). Model evaluation using AIC, BIC, and RMSE values. Model diagnostic test residual test to ensure there is no autocorrelation. Model validation by comparing predicted values to actual data. Software Used SPSS version 21 is used for SARIMA analysis and statistical data processing. Microsoft Excel for cleaning and initial data recapitulation.

RESULT AND DISCUSSIONS

The data used in this study are 28-day concrete compressive strength test results from the Civil Engineering Laboratory of Muhammadiyah Metro University, collected between 2015 and 2024. The total number of samples was 30, with cylindrical specimens used. Concrete compressive strength values varied between 18 MPa and 38 MPa, depending on the quality of the concrete tested and the mixing and curing conditions.

a. Data Collection

Table 1 presents concrete compressive strength data based on Civil Engineering Laboratory test results over a 10-year period (2015-2024).

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Table 1. Concrete Compressive Strength Data (2015 – 2024)

Period	Concrete Compressive Strength Data	Period	Concrete Compressive Strength Data
JAN 2015	245,00	JAN 2020	272,00
FEB 2015	25,00	FEB 2020	277,00
MAR 2015	258,00	MAR 2020	283,00
APR 2015	261,00	APR 2020	286,00
MAY 2015	257,00	MAY 2020	282,00
JUN 2015	264,00	JUN 2020	29,00
JUL 2015	269,00	JUL 2020	296,00
AUG 2015	273,00	AUG 2020	30,00
SEP 2015	268,00	SEP 2020	293,00
OCT 2015	261,00	OCT 2020	287,00
NOV 2015	255,00	NOV 2020	279,00
DEC 2015	25,00	DEC 2020	273,00
JAN 2016	252,00	JAN 2021	278,00
FEB 2016	256,00	FEB 2021	283,00
MAR 2016	263,00	MAR 2021	289,00
APR 2016	267,00	APR 2021	292,00
MAY 2016	264,00	MAY 2021	288,00
JUN 2016	27,00	JUN 2021	295,00
JUL 2016	275,00	JUL 2021	301,00
AUG 2016	281,00	AUG 2021	305,00
SEP 2016	274,00	SEP 2021	298,00
OCT 2016	269,00	OCT 2021	292,00
NOV 2016	261,00	NOV 2021	284,00
DEC 2016	257,00	DEC 2021	278,00
JAN 2017	26,00	JAN 2022	283,00
FEB 2017	265,00	FEB 2022	287,00
MAR 2017	271,00	MAR 2022	294,00
APR 2017	275,00	APR 2022	297,00
MAY 2017	27,00	MAY 2022	293,00
JUN 2017	279,00	JUN 2022	30,00
JUL 2017	284,00	JUL 2022	306,00
AUG 2017	289,00	AUG 2022	31,00
SEP 2017	281,00	SEP 2022	303,00
OCT 2017	275,00	OCT 2022	297,00
NOV 2017	268,00	NOV 2022	29,00
DEC 2017	262,00	DEC 2022	285,00
JAN 2018	265,00	JAN 2023	288,00
FEB 2018	27,00	FEB 2023	292,00
MAR 2018	277,00	MAR 2023	298,00
APR 2018	28,00	APR 2023	301,00
MAY 2018	276,00	MAY 2023	297,00
JUN 2018	283,00	JUN 2023	303,00
JUL 2018	289,00	JUL 2023	309,00
AUG 2018	293,00	AUG 2023	314,00
SEP 2018	286,00	SEP 2023	307,00
OCT 2018	279,00	OCT 2023	30,00
NOV 2018	272,00	NOV 2023	293,00
DEC 2018	267,00	DEC 2023	287,00
JAN 2019	27,00	JAN 2024	291,00
FEB 2019	274,00	FEB 2024	295,00
MAR 2019	281,00	MAR 2024	301,00
APR 2019	284,00	APR 2024	305,00
MAY 2019	28,00	MAY 2024	30,00
JUN 2019	287,00	JUN 2024	306,00
JUL 2019	293,00	JUL 2024	312,00
AUG 2019	297,00	AUG 2024	317,00
SEP 2019	29,00	SEP 2024	31,00
OCT 2019	283,00	OCT 2024	303,00
NOV 2019	276,00	NOV 2024	296,00
DEC 2019	27,00	DEC 2024	29,00

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Based on Table 1, this data records the concrete compressive strength value every month from 2015 to 2024. Concrete compressive strength is an important indicator in construction planning because it shows the strength of concrete at a certain age. Throughout the observation period, the concrete compressive strength value showed significant fluctuations, with some months experiencing a drastic decrease, such as in FEB 2015, DEC 2015, JUN 2020, and several months in 2022-2024. This decrease may be influenced by factors such as material quality, concrete manufacturing methods, or environmental conditions during production. On the other hand, there are certain months such as JUL 2021, SEP 2022, and JUL 2024, where the concrete compressive strength showed an increase, which could indicate improvements in the techniques or quality of the materials used.

Furthermore, this data also demonstrates the potential for seasonal patterns, with some months showing higher or lower concrete compressive strength values than others, likely influenced by weather factors or seasonal variations in the production process. Overall, there was a steady increase in 2021 and 2022, indicating efforts to improve concrete quality, while sharp declines, such as in June 2020 with a value of 29, indicate anomalies requiring special attention. This data provides a valuable basis for analyzing the relationship between the concrete production process, environmental conditions, and the resulting concrete strength, as well as providing a reference for improvements and quality control in future construction projects.

b. Plot Time Series Kuat Tekan Beton

Plot time series digunakan untuk melihat polak kuat tekan selama periode 2015 hingga 2024 follow Figure 1.

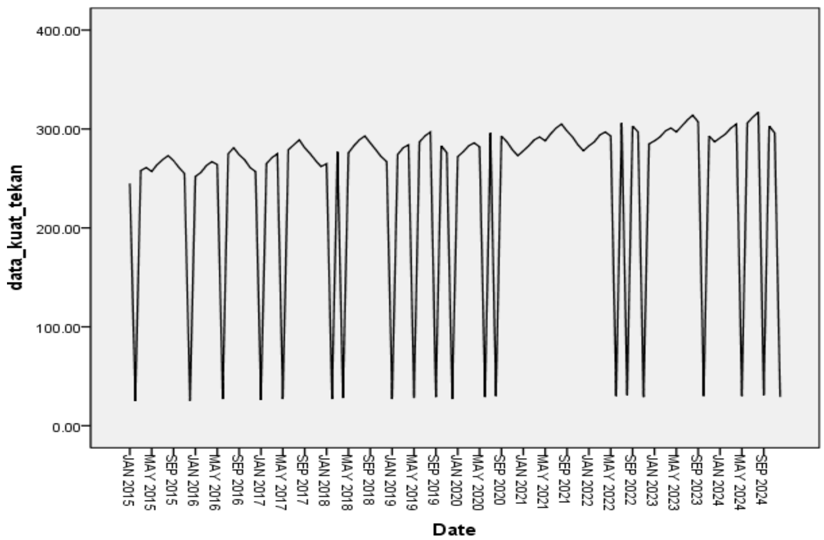

Figure 1. Time Series Plot of the Bandar Lampung area

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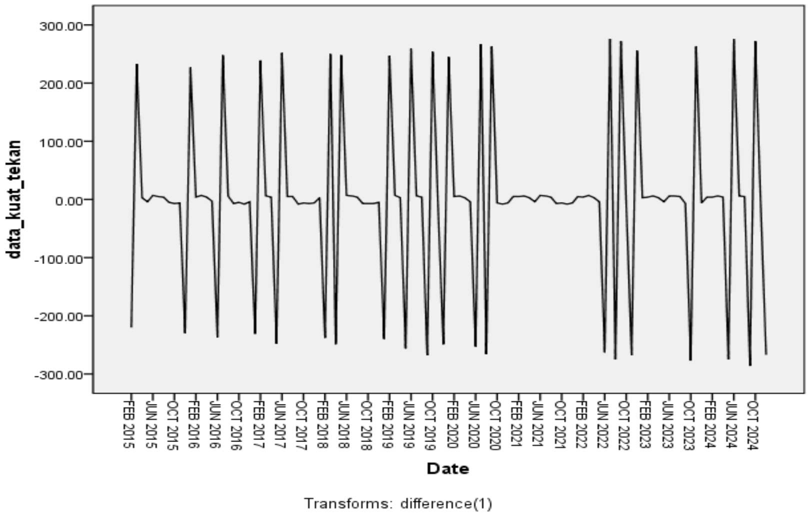

Figure 2. Time Series Plot of Concrete Compressive Strength After Stationary

Before SARIMA modeling, a stationariness test was first carried out on time series data. Based on the initial time series graph, the data shows an up-and-down trend and seasonal fluctuations. Therefore, a one-time differentiation is carried out. The ACF and PACF tests after the first differentiation showed that the data was stationary. No logarithmic transformation is required because the data does not contain extreme outliers.

1. Plotting Data (ACF and PACF)

Once the data reaches the stationary state, the next step is to set an order for SARIMA modeling. This stage is then followed by analysis to estimate the model and evaluation to select the most optimal model.

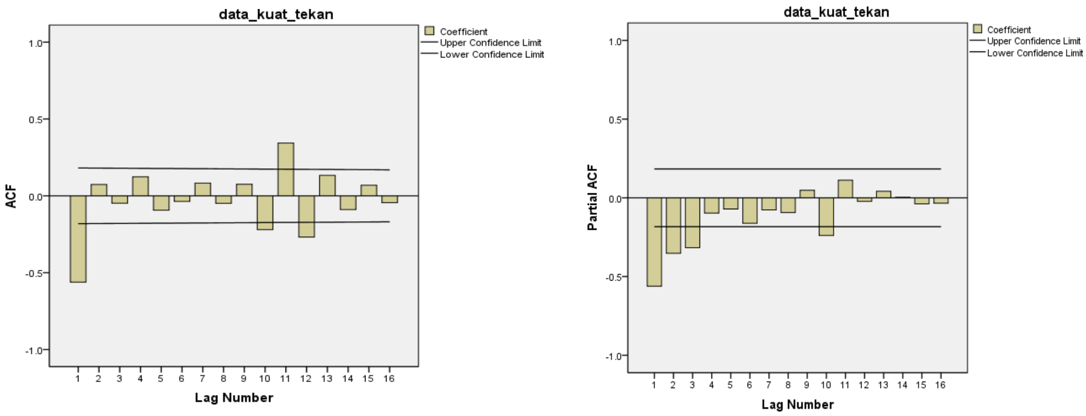

Figure 3. ACF and PACF plots

Through the analysis of the ACF and PACF graphs and the iteration process of the model in SPSS, the best model was obtained:

a) p,d,q (3,1,1) Non-seasonal SARIMA parameters
b) P,D,Q (1,1,1) Seasonal parameters with seasonal periods indicate the model has a fairly good match.

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2. SPSS Forecast Results for 2025

After conducting data analysis, stationary test, ARIMA model identification, model estimation, model evaluation, then the next are the results of forecasting concrete compressive strength data for the next 12 months in 2025 using the SARIMA model (p,d,q) (3, 1, 1).

Table 2. Statistical models obtained

Model	Number of Predictors	Model Fit statistics								Ljung-Box Q(18)			Number of Outliers
		Stationary R-squared	R-squared	RMSE	MAPE	MAE	MaxAPE	MaxAE	Normalized BIC	Statistics	DF	Sig.	
data_kuat_tekan-Model_1	0	.774	-.319	114.186	142.906	82.512	1105.109	298.380	9.694	14.143	14	.439	0

Based on Table 2. It can be seen that the RMSE and MAPE values of 114,186 and 142,906 were obtained using the SARIMA model of order (p,d,q) (3, 1, 1).

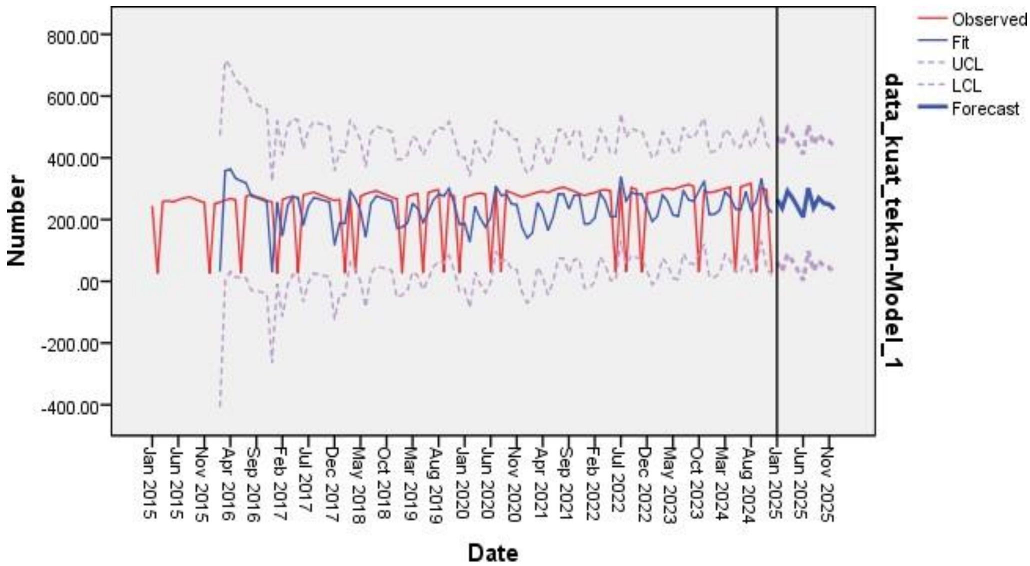

Figure 4. Predicted Results of Concrete Compressive Strength

Table 3. Concrete Compressive Strength Prediction Results

Period	Prediction Concrete Compressive Strength
JAN 2025	265,38
FEB 2025	230,54
MAR 2025	287,68
APR 2025	268,93
MAY 2025	236,74
JUN 2025	207,49
JUL 2025	301,19
AUG 2025	238,28
SEP 2025	269,18

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OCT 2025	253,40
NOV 2025	249,45
DEC 2025	230,48

Table 3 shows that the rainfall period differs only a few numbers so that it is estimated that the strength of concrete is from January 2025 to December 2025.

CONCLUSION AND SUGGESTIONS

This study aims to predict the prediction model of compressive strength of concrete using the SARIMA method with a time series approach. Through the stages of historical data analysis of compressive strength of concrete for the period 2015–2024, a differentencing process was carried out to ensure stationary properties, identification of model parameters through ACF and PACF, and testing of several combinations of SARIMA orders. The best results were obtained on the SARIMA model (3,1,1) with an RMSE value of 114,186 and a MAPE of 142,906. This model is able to produce a prediction of the compressive strength of concrete for the next 12 months in 2025, with a relatively stable predictive value between months. These findings show that the SARIMA method can be used as a tool to forecast the compressive strength of non-seasonal concrete, so that it can support infrastructure planning and development management in Indonesia.

This study only uses one variable, namely the compressive strength value of concrete based on historical data. For more accurate predictions in the future, it is recommended that the SARIMA model be combined with other methods such as ARIMAX or machine learning, by adding external variables such as cement type, temperature at casting, water-cement ratio, and curing method. It is suggested that there be closer cooperation between academics and concrete testing laboratories so that the process of documenting compressive data is carried out systematically and continuously, in order to support time series data research in the future. For students or civil engineering practitioners who want to use the SARIMA method, it is recommended to improve their understanding of time series analysis and the ability to use SPSS software, in order to be able to make predictions and analyses independently and precisely.

DAFTAR PUSTAKA

Al'afi, M. R., Nurhidayat, A., & Sugiarto. (2020). Pemodelan data deret waktu menggunakan metode ARIMA dan SARIMA. *Jurnal Sains dan Informatika, 6*(1), 10–18.

Badruzzaman, M., Islam, M. S., & Hossain, M. M. (2019). Prediction of compressive strength of concrete using time series model. *Journal of Civil Engineering Research, 9*(2), 45–52.

Box, G. E. P., Jenkins, G. M., Reinsel, G. C., & Ljung, G. M. (2015). *Time series analysis: Forecasting and control* (5th ed.). Wiley.

Gujarati, D. N., & Porter, D. C. (2010). *Dasar-dasar ekonometrika* (5th ed.). Salemba Empat.

Makridakis, S., Wheelwright, S. C., & Hyndman, R. J. (1998). *Forecasting: Methods and applications* (3rd ed.). John Wiley & Sons.

Montgomery, D. C., Jennings, C. L., & Kulahci, M. (2015). *Introduction to time series analysis and forecasting* (2nd ed.). Wiley.

Nainggolan, P. (2017). Pemanfaatan ARIMA untuk peramalan mutu beton berdasarkan data uji laboratorium. *Jurnal Teknik Sipil, 8*(1), 21–29.

Pusat Penelitian dan Pengembangan Permukiman. (2019). *Petunjuk teknis mutu beton dalam bangunan gedung dan perumahan*. PUPR.

Volume 3, No. 2, 2025, 70-77
ISSN 2963-9875 (Online)
ISSN 2964-2884 (Print)

SNI 03-2834-2000. (2000). *Tata cara pembuatan rencana campuran beton normal*. Badan Standardisasi Nasional.
Shumway, R. H., & Stoffer, D. S. (2017). *Time series analysis and its applications: With R examples* (4th ed.). Springer. https://doi.org/10.1007/978-3-319-52452-8
Sugiyono. (2018). *Metode penelitian kuantitatif, kualitatif, dan R&D*. Alfabeta.