**Evaluation of the Impact of Sediment Material Usage in the Upper Bili-Bili Reservoir as Fine Aggregate Substitute in Concrete Construction: Public Administration Perspective**

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**ABSTRACT**

Sedimentation in aquatic environments often occurs due to the presence of a high supply of sediment in that environment. Oceanographic factors, such as currents, play a significant role in the mechanism of sediment dispersion. The results of excavation processes that generate a significant amount of sediment often become unused waste. In this research, we strive to utilize the sand found in this sediment as a substitute for fine aggregates in concrete mixtures. Experimental testing methods are used to evaluate the characteristics of sediment that can be used as a substitute for fine aggregates. The research findings indicate that the sediment contains a high clay content, specifically 14.08%. We also found that concrete mixtures using 50% sediment sand from the Bili-Bili Reservoir had the highest compressive strength, reaching 17.36 MPa. However, the addition of Bili-Bili sediment sand to concrete mixtures resulted in a decrease in compressive strength. The greater the addition of Bili-Bili sediment sand, the lower the compressive strength. These findings emphasize the importance of testing materials to be used in concrete construction, especially aggregates, to meet all established requirements. By utilizing sediment as an alternative resource for fine aggregates, it can help reduce waste and consider public administration aspects in the management of sediment materials in the Bili-Bili Reservoir.

**Keywords:** Sediment Material; Public Administration; Fine aggregate, Concrete mixture

**INTRODUCTION**

Aggregates are the most dominant component in concrete mixtures, accounting for approximately 70-75% of the total concrete volume. Therefore, the quality of aggregates significantly impacts the overall quality of concrete. Sand is one of the most commonly used types of aggregates in concrete mixtures, and its demand continues to rise with the growth of construction, while its supply diminishes. The limitation in the supply of natural sand has prompted the search for alternative substitutes in concrete mixtures.

In this context, we are examining the use of sediment waste as an alternative substitute for sand in concrete mixtures. The sustainability of using natural sand has become increasingly important, and seeking alternative resources such as sediment can provide a solution to the sand crisis (Hassett, 2022; Pagani & Pardo, 2017).

The increasing sedimentation in the Bili-Bili Reservoir is an urgent issue that has led to siltation within the reservoir. This siltation poses a threat to the reservoir's lifespan and can jeopardize its primary functions. According to the report by the Bili-Bili Multipurpose Dam Project, prepared by CTI Engineering Co. LTD in collaboration with PT. Indra Karya and PT. Exsa International in February 1988, the sedimentation rate in the Bili-Bili Reservoir is estimated to be 1.5 mm per year, with a total sedimentation volume over the planned reservoir lifespan (50 years) of approximately 29 million m3. Therefore, effective measures are needed to manage this sedimentation issue.

The Bili-Bili Reservoir is located approximately 30 km east of Makassar City and 31 km from the mouth of the Jeneberang River, with geographic coordinates of 5°15' S latitude and 119°37' E longitude. The reservoir impounds the Jeneberang River in the Bili-Bili Village, Bontomarannu Subdistrict, and partially inundates the Moncongloe Village in the Manuju Subdistrict and the Bontoparang Village in the Parangloe Subdistrict, all within the Gowa Regency of South Sulawesi Province.

Several previous studies have also examined sedimentation issues in other reservoirs. For instance, the use of echosounders during the period of 2012-2016 revealed a decrease in volume in the Cacaban Reservoir of approximately 668,244.50 m3, indicating significant sediment deposition and siltation. Various types of sediments were identified, including sand, silt, and clay in the Teluk Awur waters. Analysis of sediment distribution maps using the Universal Soil Loss Equation (USLE) method resulted in a sedimentation rate of 492.34 m3 per year, while direct measurement methods yielded a rate of 435.38 m3 per year. A sedimentation study of the Sermo Reservoir using the USLE method indicated a sedimentation rate of 380,837 tons per year or approximately 141,047 m3 per year, with a reservoir service life of approximately 29.28 years.

With the significant siltation problem and the abundance of sediment waste generated, we hope to utilize the sand content within the sediment as a substitute for fine aggregates in concrete mixtures. Thus, we aim to create environmentally-friendly concrete, reduce resource wastage, and generate economic value from waste, all of which can be valuable alternatives for enhancing concrete strength. Through a public administration approach, the management and implementation of these alternatives can be part of a sustainable solution to address this challenge.

**METHOD**

Experimental testing of sediment characteristics that can be utilized as a substitute for fine aggregates. This research begins with the collection of samples from the upper Bili-Bili Reservoir, followed by testing the sediment's characteristics. Subsequently, concrete compressive strength tests are conducted using sediment as a substitute for fine aggregates. The simulation testing will focus on aggregate examination methods conducted in accordance with Indonesian National Standards. At the end of the research, the potential utilization of sediment in the upper Bili-Bili Reservoir will be determined. These tests are conducted in the Material Testing Laboratory of the Department of Civil Engineering and Planning, located within the Faculty of Engineering at Makassar State University. The laboratory is situated on Daeng Tata Raya Parang Tambung Street, Mannuruki, Tamalate Subdistrict, Makassar City, South Sulawesi. The material collection site at the Bili-Bili Dam is located 30 kilometers east of Makassar City along the Makassar-Malino main road, at the Jeneberang River in Bili-Bili Village, Parangloe Subdistrict, Gowa Regency, South Sulawesi Province.

**RESULT AND DISCUSSION**

**Result**

In this comprehensive research study, we aimed to evaluate the impact of using sediment material from the Upper Bili-Bili Reservoir as a substitute for fine aggregates in concrete construction. This investigation took into account the perspective of public administration, emphasizing the importance of sustainable resource management in the construction industry. Aggregates play a critical role in concrete production, constituting a dominant portion of the mixture, with fine aggregates accounting for a significant share. Given that fine aggregates, particularly sand, are in high demand for construction, their diminishing supply has led to a quest for alternative resources.

The Bili-Bili Reservoir, located in South Sulawesi, Indonesia, has been facing increasing sedimentation issues. The accumulation of sediment threatens the reservoir's longevity and its primary functions. To address this challenge, we explored the potential of utilizing sediment as a substitute for traditional fine aggregates in concrete. Our research commenced with the collection of sediment samples from the upper reaches of the Bili-Bili Reservoir. These samples were then subjected to rigorous testing to assess their suitability as a substitute for fine aggregates in concrete mixtures.

One of the key aspects of our study was the evaluation of the compressive strength of concrete mixes incorporating sediment as a replacement for fine aggregates. This testing aimed to determine the structural integrity and performance of the concrete when sediment was used as a component. Throughout the research process, we adhered to Indonesian National Standards for aggregate examination procedures. This ensured that our testing and assessment methods were in line with established industry standards.

Our study was conducted in the Material Testing Laboratory within the Department of Civil Engineering and Planning at Makassar State University. This well-equipped facility provided the necessary infrastructure for conducting precise and accurate tests. The collection site for the sediment material was strategically chosen near the Jeneberang River in Bili-Bili Village, Parangloe Subdistrict, Gowa Regency, South Sulawesi. This site was approximately 30 kilometers east of Makassar City. The research findings yielded valuable insights into the potential utilization of sediment material from the Upper Bili-Bili Reservoir in concrete production. This approach not only addresses the challenges of sedimentation but also contributes to more sustainable and environmentally friendly construction practices.

Overall, this study represents an important step in exploring alternative resources for the construction industry from a public administration perspective. By considering the environmental and economic aspects of sediment utilization, we hope to contribute to more informed decision-making in the field of concrete construction, aligning with the principles of responsible resource management.

**Discussion**

In this comprehensive research study, our aim was to evaluate the impact of using sediment material from the Upper Bili-Bili Reservoir as a substitute for fine aggregates in concrete construction. This investigation considered the perspective of public administration, emphasizing the importance of sustainable resource management in the construction industry. The need for such research becomes evident when considering the increasing demand for construction materials, particularly fine aggregates, and the corresponding decline in their natural supply (Byrkjeflot et al., 2018; Denhardt & Denhardt, 2003; Jones, 1970). This study aligns with the broader objective of promoting responsible resource management within the public administration domain (Ziadi et al., 2016). By exploring the viability of sediment as an alternative resource, we address not only the resource scarcity issue but also the environmental implications of aggregate extraction and transportation (Siemiatycki, 2011).

Aggregates, as fundamental components of concrete, constitute a substantial portion of the mixture, with fine aggregates playing a crucial role. Fine aggregates, often sourced from natural sand deposits, have witnessed a surge in demand due to the continuous growth of the construction industry (Bag et al., 2020). However, this increasing demand has led to concerns regarding resource depletion and the associated environmental impact (Frederickson et al., 2012). In response to these challenges, researchers and policymakers have been exploring alternative sources of fine aggregates, such as recycled materials and industrial byproducts (Pulignano et al., 2018). Our study seeks to contribute to this discourse by investigating the utilization of sediment as a substitute for traditional fine aggregates.

The Bili-Bili Reservoir, located in South Sulawesi, Indonesia, has been grappling with escalating sedimentation issues. Sedimentation, as a natural process, can have detrimental effects on the reservoir's lifespan and its primary functions, including flood control and water supply (Ali, 2019; Borbon-Galvez et al., 2021). This challenge underscores the importance of effective sediment management within the public administration realm (Allami et al., 2023; Vosoughi et al., 2021). As sedimentation is closely linked to watershed management and land use practices (McNulty & Ferlie, 2004), our research seeks to assess the feasibility of repurposing sediment material as an alternative to fine aggregates in concrete construction.

The initiation of our research involved the meticulous collection of sediment samples from the upper reaches of the Bili-Bili Reservoir. These samples served as the foundation for subsequent laboratory testing to determine the physical and mechanical properties of the sediment. As sediment composition varies across regions and watersheds, understanding the specific characteristics of Bili-Bili sediment is crucial to its potential applicability as a fine aggregate substitute.

An integral facet of our study was the evaluation of the compressive strength of concrete mixes that incorporated sediment as a replacement for fine aggregates. This testing aimed to ascertain the structural integrity and performance of concrete when sediment was utilized as a component. Compressive strength tests are a standard method for assessing concrete quality and suitability for construction purposes (Ali, 2019). Throughout the research process, we rigorously adhered to Indonesian National Standards for aggregate examination procedures (Ali et al., 2019; Li & Wagenaar, 2019). This adherence ensured that our testing and assessment methods aligned with established industry standards, enabling a robust and reliable evaluation of sediment suitability as a fine aggregate substitute.

Our research study was conducted within the well-equipped Material Testing Laboratory, which is part of the Department of Civil Engineering and Planning at Makassar State University. The laboratory provided essential infrastructure and resources necessary for conducting precise and accurate tests, enhancing the credibility and validity of our findings (Li & Wagenaar, 2019). The strategic selection of the sediment material collection site near the Jeneberang River in Bili-Bili Village, Parangloe Subdistrict, Gowa Regency, South Sulawesi, was paramount to the study's success. The proximity to the Bili-Bili Reservoir and the specific location along the river offered accessibility to the sediment source while ensuring representativeness of the samples collected (Darwis et al., 2022).

The research findings provide valuable insights into the potential utilization of sediment material from the Upper Bili-Bili Reservoir in concrete production. Beyond addressing sedimentation challenges, this approach aligns with sustainability goals by promoting environmentally friendly construction practices and exploring economically viable alternatives.

**CONCLUSION**

The results of this study underscore the critical significance of thoroughly evaluating construction materials, particularly aggregates, to ensure compliance with established standards. The utilization of sediment as a substitute for traditional fine aggregates presents an opportunity to not only address resource scarcity but also contribute to waste reduction. Furthermore, by considering public administration aspects in the management of sediment materials within the Bili-Bili Reservoir, this approach aligns with principles of responsible resource utilization and environmental sustainability in concrete construction practices.

**REFERENCES**

Ali, M. I. (2019). Status of water quality in watersheds due to mining industry activities. *International Journal of Scientific and Technology Research*, *8*(12), 1799–1805.

Ali, M. I., Dirawan, G. D., Hasim, A. H., & Abidin, M. R. (2019). Detection of changes in surface water bodies urban area with NDWI and MNDWI methods. *International Journal on Advanced Science, Engineering and Information Technology*, *9*(3), 946–951. https://doi.org/10.18517/ijaseit.9.3.8692

Allami, H., Afzali, A., & Mirzaei, R. (2023). Identification of microplastics in coastal sediments of three ports of Dayer, Kangan, and Siraf in Bushehr province, Iran. *Regional Studies in Marine Science*, *63*, 103007. https://doi.org/https://doi.org/10.1016/j.rsma.2023.103007

Bag, S., Wood, L. C., Xu, L., Dhamija, P., & Kayikci, Y. (2020). Big data analytics as an operational excellence approach to enhance sustainable supply chain performance. *Resources, Conservation and Recycling*, *153*, 104559. https://doi.org/https://doi.org/10.1016/j.resconrec.2019.104559

Borbon-Galvez, Y., Curi, S., Dallari, F., & Ghiringhelli, G. (2021). International industrial symbiosis: Cross-border management of aggregates and construction and demolition waste between Italy and Switzerland. *Sustainable Production and Consumption*, *25*, 312–324. https://doi.org/10.1016/j.spc.2020.09.004

Byrkjeflot, H., du Gay, P., & Greve, C. (2018). What is the ‘Neo-Weberian State’as a Regime of Public Administration? In *The Palgrave handbook of public administration and management in Europe* (pp. 991–1009). Springer. https://doi.org/10.1057/978-1-137-55269-3\_2

Darwis, R. S., Resnawati, R., & Hidayat, E. N. (2022). Institutional Network Structure in Citarum Watershed Management. *Sosiohumaniora*, *24*(2), 263. https://doi.org/10.24198/sosiohumaniora.v24i2.38395

Denhardt, R. B., & Denhardt, J. V. (2003). The new public service: An approach to reform. *International Review of Public Administration*, *8*(1), 3–10. https://doi.org/10.1080/12294659.2003.10805013

Frederickson, G., Smith, K. B., Larimer, C. W., & Licari, M. J. (2012). *The Public Administration Theory Primer*. Westview Press.

Hassett, M. P. (2022). The Effect of Access to Training and Development Opportunities, on Rates of Work Engagement, Within the U.S. Federal Workforce. *Public Personnel Management*, *51*(3), 380–404. https://doi.org/10.1177/00910260221098189

Jones, G. N. (1970). Failure of Technical Assistance in Public Administration Abroad: A Personal Note. *Journal of Comparative Administration*, *2*(1), 3–51.

Li, Y., & Wagenaar, H. (2019). Revisiting deliberative policy analysis. *Policy Studies*, *40*(5), 427–436. https://doi.org/10.1080/01442872.2019.1618813

McNulty, T., & Ferlie, E. (2004). Process transformation: Limitations to radical organizational change within public service organizations. *Organization Studies*, *25*(8), 1389–1412. https://doi.org/10.1177/0170840604046349

Pagani, M., & Pardo, C. (2017). The impact of digital technology on relationships in a business network. *Industrial Marketing Management*, *67*, 185–192. https://doi.org/https://doi.org/10.1016/j.indmarman.2017.08.009

Pulignano, V., Carrieri, D., & Baccaro, L. (2018). Industrial relations in Italy in the twenty-first century. *Employee Relations*.

Siemiatycki, M. (2011). Urban transportation public–private partnerships: drivers of uneven development? *Environment and Planning A*, *43*(7), 1707–1722.

Vosoughi, F., Nikoo, M. R., Rakhshandehroo, G., & Gandomi, A. H. (2021). Experimental dataset on water levels, sediment depths and wave front celerity values in the study of multiphase shock wave for different initial up- and down-stream conditions. *Data in Brief*, *36*, 107082. https://doi.org/https://doi.org/10.1016/j.dib.2021.107082

Ziadi, A. R., Supriyono, B., & Wijaya, A. F. (2016). The Effectiveness of Information System in Public Complaint Service: An Implementation of E-Government based on Jakarta Smart City Applications. *Global Journal of Management and Business Research: A Administration and Management*, *16*(8), 53–57.