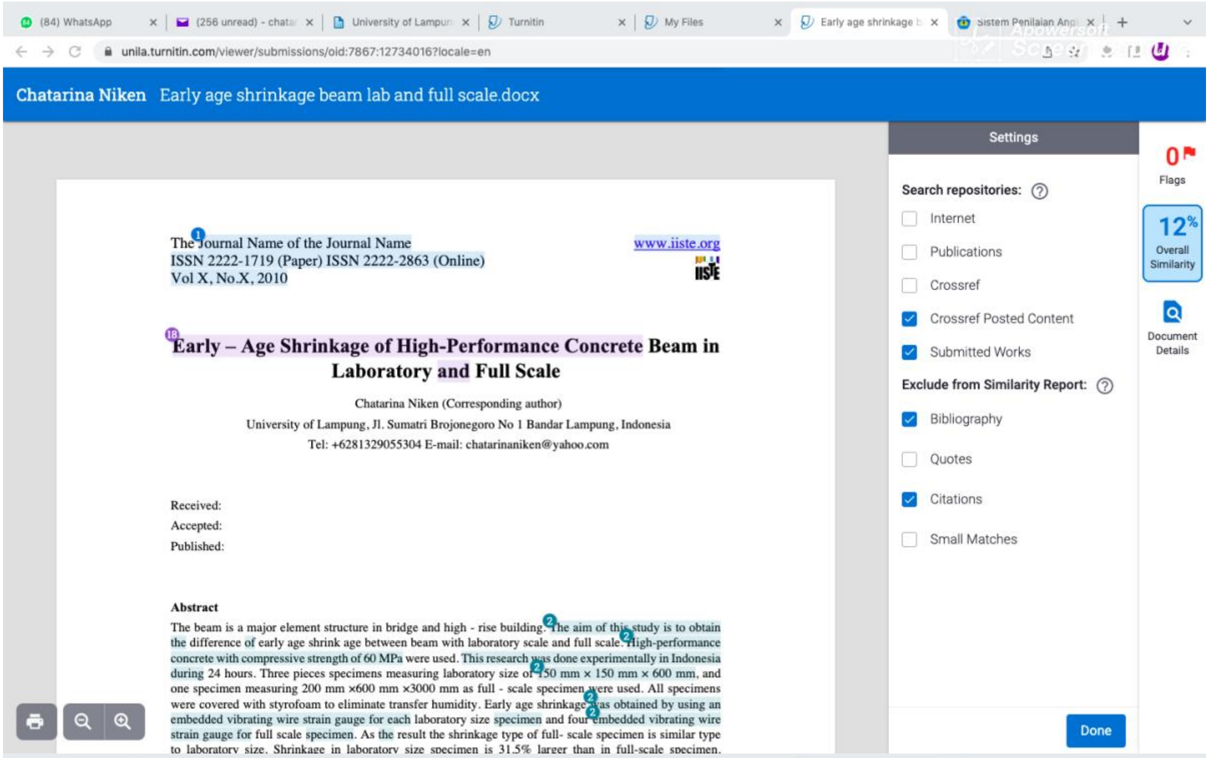

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Early – Age Shrinkage of High-Performance Concrete Beam in Laboratory and Full Scale

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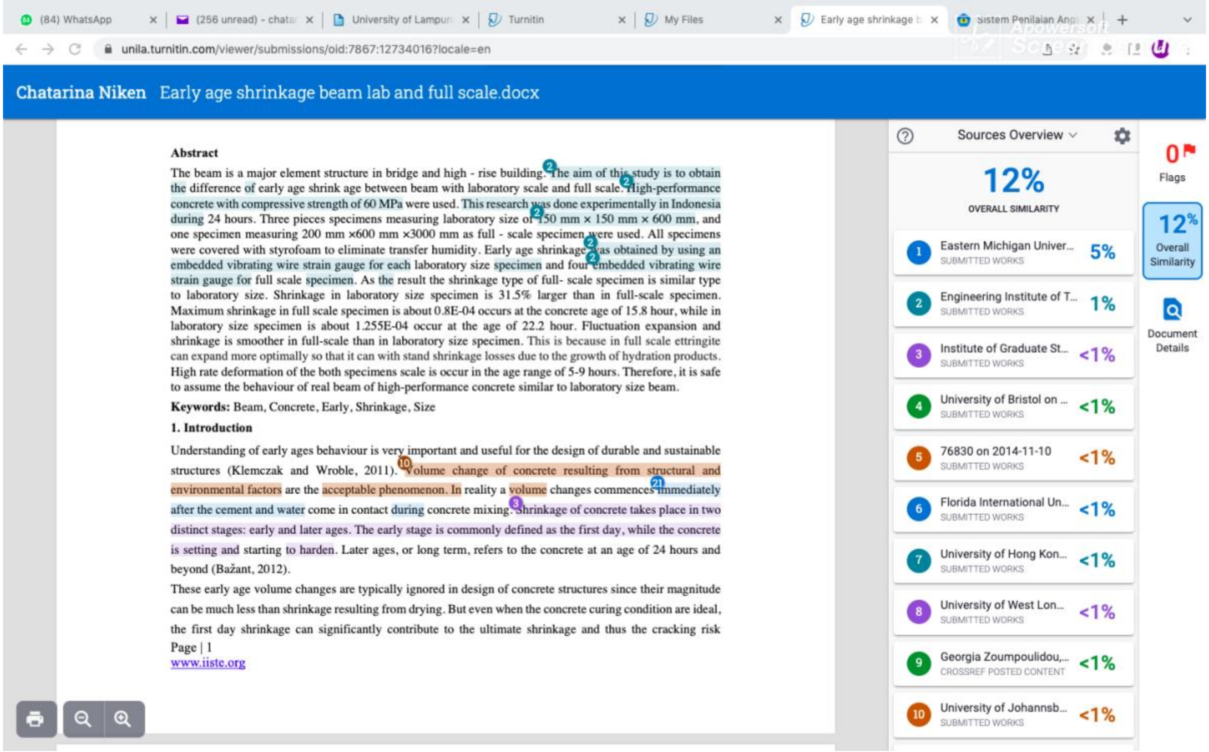
Abstract

The beam is a major element structure in bridge and high - rise building. The aim of this study is to obtain the difference of early age shrink age between beam with laboratory scale and full scale. High-performance concrete with compressive strength of 60 MPa were used. This research was done experimentally in Indonesia during 24 hours. Three pieces specimens measuring laboratory size of 150 mm × 150 mm × 600 mm, and one specimen measuring 200 mm ×600 mm ×3000 mm as full - scale specimen were used. All specimens were covered with styrofoam to eliminate transfer humidity. Early age shrinkage was obtained by using an embedded vibrating wire strain gauge for each laboratory size specimen and four embedded vibrating wire strain gauge for full scale specimen. As the result the shrinkage type of full- scale specimen is similar type to laboratory size. Shrinkage in laboratory size specimen is 31.5% larger than in full-scale specimen.



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Keywords: Beam, Concrete, Early, Shrinkage, Size

1. Introduction

Understanding of early ages behaviour is very important and useful for the design of durable and sustainable structures (Klemczak and Wroble, 2011). Volume change of concrete resulting from structural and environmental factors are the acceptable phenomenon. In reality a volume changes commences immediately after the cement and water come in contact during concrete mixing. Shrinkage of concrete takes place in two distinct stages: early and later ages. The early stage is commonly defined as the first day, while the concrete is setting and starting to harden. Later ages, or long term, refers to the concrete at an age of 24 hours and beyond (Bažant, 2012).

These early age volume changes are typically ignored in design of concrete structures since their magnitude can be much less than shrinkage resulting from drying. But even when the concrete curing condition are ideal, the first day shrinkage can significantly contribute to the ultimate shrinkage and thus the cracking risk

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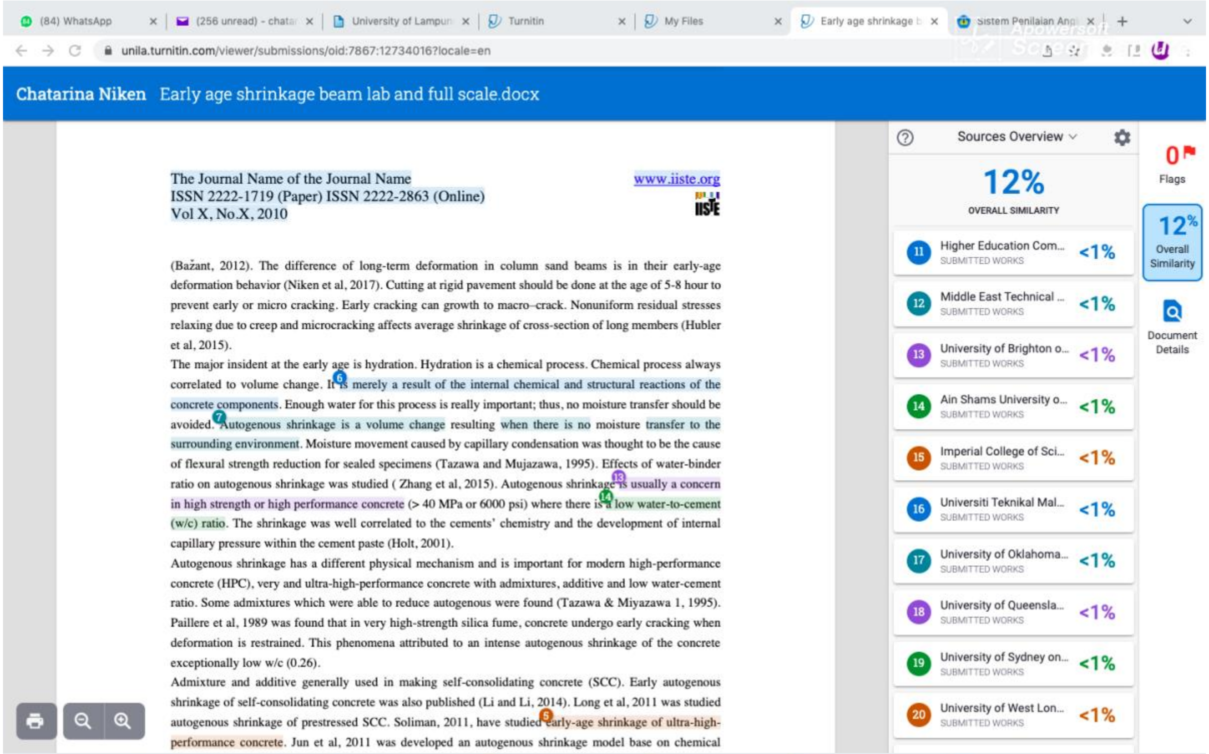

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(Bažant, 2012). The difference of long-term deformation in column sand beams is in their early-age deformation behavior (Niken et al, 2017). Cutting at rigid pavement should be done at the age of 5-8 hour to prevent early or micro cracking. Early cracking can growth to macro–crack. Nonuniform residual stresses relaxing due to creep and microcracking affects average shrinkage of cross-section of long members (Hubler et al, 2015).

The major insident at the early age is hydration. Hydration is a chemical process. Chemical process always correlated to volume change. It ⑥ is merely a result of the internal chemical and structural reactions of the concrete components. Enough water for this process is really important; thus, no moisture transfer should be avoided. ⑦ Autogenous shrinkage is a volume change resulting when there is no moisture transfer to the surrounding environment. Moisture movement caused by capillary condensation was thought to be the cause of flexural strength reduction for sealed specimens (Tazawa and Mujazawa, 1995). Effects of water-binder ratio on autogenous shrinkage was studied (Zhang et al, 2015). Autogenous shrinkage ⑬ is usually a concern in high strength or high performance concrete (> 40 MPa or 6000 psi) where there is ⑭ a low water-to-cement (w/c) ratio. The shrinkage was well correlated to the cements' chemistry and the development of internal capillary pressure within the cement paste (Holt, 2001).

Autogenous shrinkage has a different physical mechanism and is important for modern high-performance concrete (HPC), very and ultra-high-performance concrete with admixtures, additive and low water-cement ratio. Some admixtures which were able to reduce autogenous were found (Tazawa & Miyazawa 1, 1995). Paillere et al, 1989 was found that in very high-strength silica fume, concrete undergo early cracking when deformation is restrained. This phenomena attributed to an intense autogenous shrinkage of the concrete exceptionally low w/c (0.26).

Admixture and additive generally used in making self-consolidating concrete (SCC). Early autogenous shrinkage of self-consolidating concrete was also published (Li and Li, 2014). Long et al, 2011 was studied autogenous shrinkage of prestressed SCC. Soliman, 2011, have studied ⑤ early-age shrinkage of ultra-high-performance concrete. Jun et al, 2011 was developed an autogenous shrinkage model base on chemical

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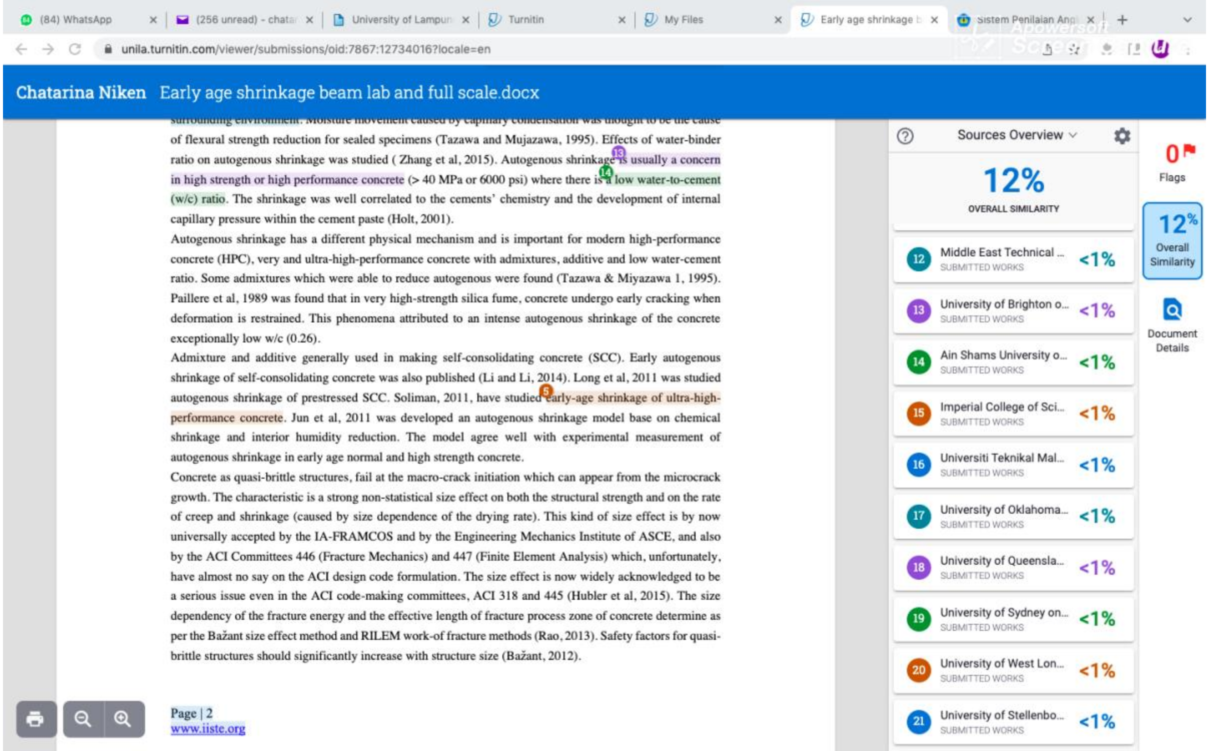

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shrinkage and interior humidity reduction. The model agree well with experimental measurement of autogenous shrinkage in early age normal and high strength concrete.

Concrete as quasi-brittle structures, fail at the macro-crack initiation which can appear from the microcrack growth. The characteristic is a strong non-statistical size effect on both the structural strength and on the rate of creep and shrinkage (caused by size dependence of the drying rate). This kind of size effect is by now universally accepted by the IA-FRAMCOS and by the Engineering Mechanics Institute of ASCE, and also by the ACI Committees 446 (Fracture Mechanics) and 447 (Finite Element Analysis) which, unfortunately, have almost no say on the ACI design code formulation. The size effect is now widely acknowledged to be a serious issue even in the ACI code-making committees, ACI 318 and 445 (Hubler et al, 2015). The size dependency of the fracture energy and the effective length of fracture process zone of concrete determine as per the Bažant size effect method and RILEM work-of fracture methods (Rao, 2013). Safety factors for quasi-brittle structures should significantly increase with structure size (Bažant, 2012).

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