

OPTIMIZATION OF TUNED MASS DAMPER TO MINIMIZE THE DISPLACEMENT

Final Project Report
as a requirement to obtain Bachelor degree from
Universitas Atma Jaya Yogyakarta

by:
NATHAN YULEO FECAN
Student ID Number: 131315000



**INTERNATIONAL CIVIL ENGINEERING PROGRAM
DEPARTMENT OF CIVIL ENGINEERING
FACULTY OF ENGINEERING
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STATEMENT

I signed below stating that the final project with the title:

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Yogyakarta, March 27, 2017

Who made the remarks,

NATHAN YULEO FECAN

APPROVAL

Final Project Report

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has been approved by Supervisor

Yogyakarta, *27 March 2017*

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APPROVAL

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has been examined and approved by:

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PREFACE

First of all, I would like to thanks to God for His blessing that had been given to the author, so that the author could prepare and finish this final project report. This report was completed as a requirement to obtain Bachelor degree from Universitas Atma Jaya Yogyakarta.

I would like to express my gratitude towards:

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I realize this report has many mistakes. Therefore, I accept any form of suggestion for further improvement. Finally, I hope this report can be useful for the readers.

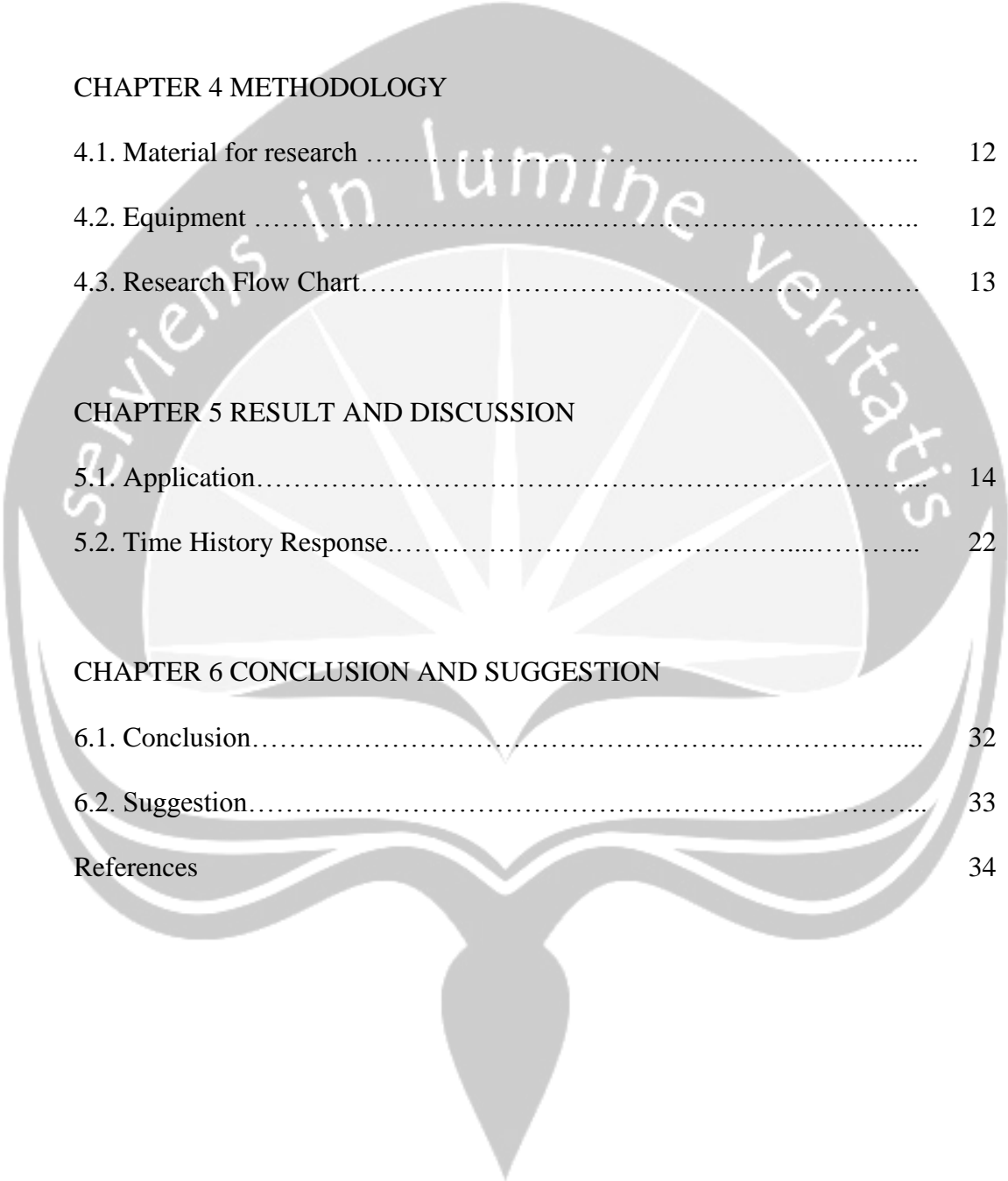
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NATHAN YULEO FECAN

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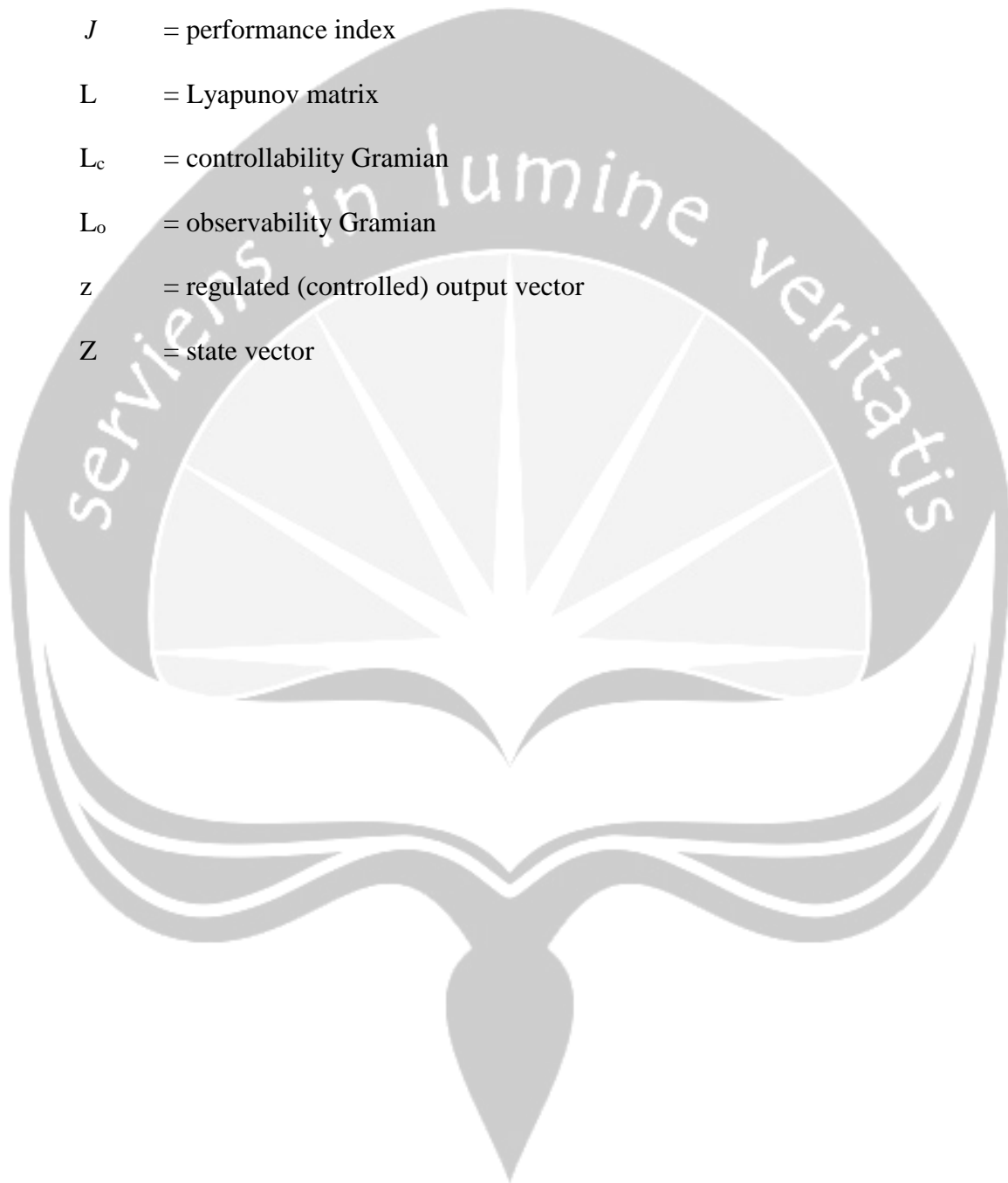
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NOTATIONS



m	= mass of the main system
m_d	= mass of the damper
μ	= mass ratios between structure and damper
c	= damping of the main system
c_d	= damping of the damper
k	= stiffness of the main system
k_d	= stiffness of the damper
u	= displacement
\dot{u}	= velocity
\ddot{u}	= acceleration
a_g	= ground acceleration
y	= relative displacement
\dot{y}	= relative velocity
\ddot{y}	= relative acceleration
P	= external force of the main system
P_d	= external force of the damper
ω	= natural frequency of the main system
ω_d	= natural frequency of the damper
t	= time
ξ	= damping ratio of the main system
ξ_d	= damping ratio of the damper
α	= frequency ratio

- C_z = regulation matrix
- E = modulus of elasticity
- J = performance index
- L = Lyapunov matrix
- L_c = controllability Gramian
- L_o = observability Gramian
- z = regulated (controlled) output vector
- Z = state vector



ABSTRACT

“OPTIMIZATION OF TUNED MASS DAMPER TO MINIMIZE THE DISPLACEMENT” prepared by Nathan Yuleo Fecan, Stu. ID Number 131315000, 2017, Structural Engineering, International Civil Engineering Program Department, Faculty of Engineering, Universitas Atma Jaya Yogyakarta.

Tuned mass dampers (TMDs) systems are one of the vibration controlled devices used to reduce the response of buildings subjected to lateral loadings such as wind and earthquake loadings. There has been many research of TMDs due to their simplicity. The optimization of properties of TMDs become one topic that will become the main topic in this research. The numerical optimization technique is used to compute the optimum values of TMD parameters that will minimize the maximum displacement of the structure. The concept of genetic algorithms is based on Charles Darwin's theory of survival of the fittest. Genetic algorithm simulates the survival of the fittest among individuals over consecutive generation for solving a problem.

The purpose of this research is to optimize the tuned mass damper parameter that are damping (k_d) and damping system (c_d). In this research a simple 20 stories building will be used for the simulations. The building is modeled as shear building. The TMDs will be added to the building in the top floor. In order to optimize the parameters of TMDs, Genetic algorithms (GAs) were used to help the optimization problems. For the comparison, different mass ratio with the range between 1% to 10% were used.

The result of simulation shows that when mass ratio increased, frequency ratio will be decreased. When mass ratio increased, damping ratio of TMD will be increased. Then the building will be simulating subject earthquake ground accelerations such as El Centro 1940, Kobe 1995, Hachinohe 1968 and Northridge 1994 ground accelerations. The displacement of the structure without TMD in El Centro 1940, Kobe 1995, Hachinohe 1968 and Northridge 1994 ground accelerations are 0.244 m, 0.317 m, 0.312 m and 0.693 m, respectively. The acceleration of the structure without TMD are 6.545 m, 1.567 m, 4.31 m and 1.59 m, respectively. When applied with the 10% TMD, the displacement reduced by 18.95% to 0.198 m, 7.6 % to 0.293 m, 31.75% to 0.213 m and 20.10% to 0.554 m. For the acceleration reduced by 90% to 0.655 m, 90% to 0.157 m, 90% to 0.431 m, 90% to 0.159 m. The simulation of the optimized TMDs subject to earthquake ground accelerations show that the TMDs can reduce the displacement and acceleration of the building effectively.

Keywords: *tuned mass dampers, genetic algorithm, optimization, earthquake.*