

**UNIVERSITAS ATMA JAYA YOGYAKARTA LIBRARY'S  
STRUCTURAL RESPONSE TO EXTERNAL BLAST LOADING**

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

by:

**EDGART PRAHARJA MASGAWAN PONGSITANAN**  
Student ID Number: 121314320



**INTERNATIONAL CIVIL ENGINEERING PROGRAM  
DEPARTMENT OF CIVIL ENGINEERING  
UNIVERSITAS ATMA JAYA YOGYAKARTA  
YOGYAKARTA  
DECEMBER 2016**

## STATEMENT

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### UNIVERSITAS ATMA JAYA YOGYAKARTA LIBRARY'S STRUCTURAL RESPONSE TO EXTERNAL BLAST LOADING

by:

EDGART PRAHARJA MASGAWAN PONGSITANAN

Student ID Number: 121314320

Has been approved by Supervisor

Yogyakarta, December 15<sup>th</sup>, 2016

Supervisor,



(Prof. Ir. Yoyong Arfiadi, M.Eng., Ph.D)

Department of Civil Engineering  
Chairman,



(Jalannat Sudjari, S.T., M.T)

## APPROVAL

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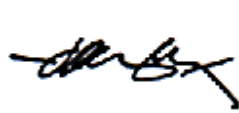

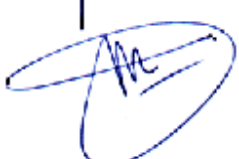


by:

EDGART PRAHARJA MASGAWAN PONGSITANAN

Student ID Number: 121314320

Has been examined and approved by the examination committee:

	Name	Signature	Date
Chairman	: Prof. Ir. Yoyong Arfiadi, M.Eng., Ph.D		15/12/16
Secretary	: Dr. Ir. AM. Ade Lisantono, M.Eng		16/12/2016
Member	: Dinar Gumilang Jati, S.T., M.Eng		16/12 2016

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I realize, this report may be flawed. Therefore, I accept any form of suggestion for further improvement. Thank you.

Yogyakarta, November 2015

Author

Edgart P.M. Pongsitanan

121314320

**“AND THE LORD SHALL GUIDE YOU  
CONTINUALLY, AND SATISFY YOUR SOUL IN  
DROUGHT, AND MAKE FAT YOUR BONES: AND YOU  
SHALL BE LIKE A WATERED GARDEN, AND LIKE A  
SPRING OF WATER, WHOSE WATERS FAIL NOT.”**

ISAIAH 58:11 (UKJV)



*However difficult life may seem, there is always  
something you can do and succeed at.*

STEPHEN HAWKING

For Jesus Christ, my father in heaven, my beloved mother,  
my brothers & sisters and all of comrades.

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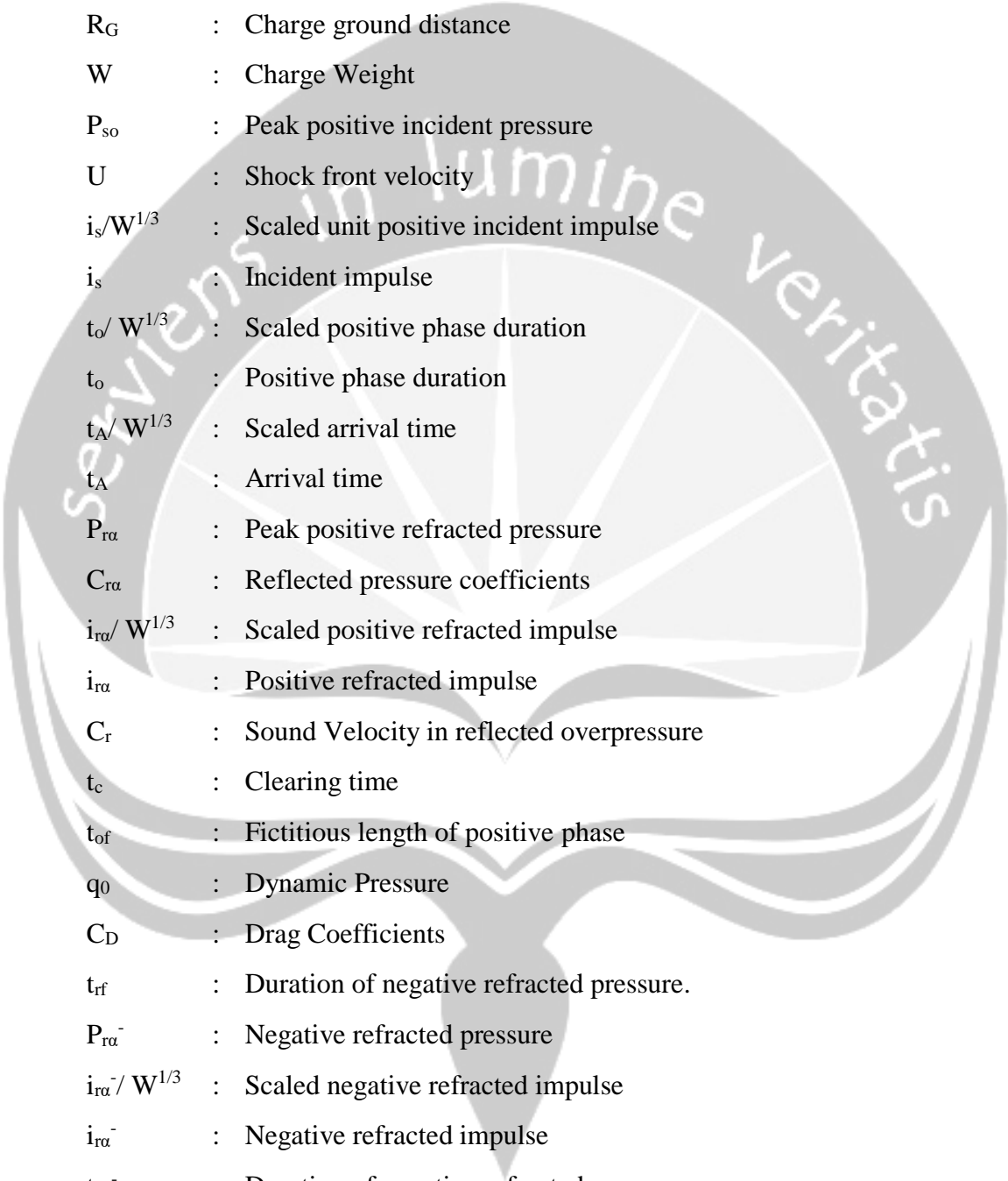
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## LIST OF SYMBOLS



$Z_G$	: Scaled charge distance
$R_G$	: Charge ground distance
$W$	: Charge Weight
$P_{so}$	: Peak positive incident pressure
$U$	: Shock front velocity
$i_s/W^{1/3}$	: Scaled unit positive incident impulse
$i_s$	: Incident impulse
$t_o/W^{1/3}$	: Scaled positive phase duration
$t_o$	: Positive phase duration
$t_A/W^{1/3}$	: Scaled arrival time
$t_A$	: Arrival time
$P_{ra}$	: Peak positive refracted pressure
$C_{ra}$	: Reflected pressure coefficients
$i_{ra}/W^{1/3}$	: Scaled positive refracted impulse
$i_{ra}$	: Positive refracted impulse
$C_r$	: Sound Velocity in reflected overpressure
$t_c$	: Clearing time
$t_{of}$	: Fictitious length of positive phase
$q_0$	: Dynamic Pressure
$C_D$	: Drag Coefficients
$t_{rf}$	: Duration of negative refracted pressure.
$P_{ra}^-$	: Negative refracted pressure
$i_{ra}^-/W^{1/3}$	: Scaled negative refracted impulse
$i_{ra}^-$	: Negative refracted impulse
$t_{rf}^-$	: Duration of negative refracted pressure.

## ABSTRACT

**UNIVERSITAS ATMA JAYA YOGYAKARTA LIBRARY'S STRUCTURAL RESPONSE TO EXTERNAL BLAST LOADING**, Edgart Praharja Masgawan Pongsitanan, Student Number 121314320, year of 2016, Structural Engineering, International Civil Engineering Program, Department of Civil Engineering, Universitas Atma Jaya Yogyakarta.

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Over 10 years the terrorist activities and threats have become the growing problem in Indonesia. Following the September 9<sup>th</sup>, 2004, vehicle bombing of the Australian Embassy in Kuningan, Jakarta, July 17<sup>th</sup>, 2009, bombing at the JW Marriott hotel and Ritz-Carlton hotel, Jakarta, until the most recent terrorist activities January 14<sup>th</sup>, 2016, explosions and gun fire near Plaza Sarinah, Jl. MH Thamrin, Jakarta Pusat. As we already aware that terrorists were targeting the government buildings, embassies, hotels, but after a decade and a half of rolling waves of terrorist act across the world, these buildings are now harder to hit, so they've changed their target, over the last 13 months there has been a series of extremely bloody attacks on school, colleges and universities.

This final project attempts to analyze the UAJY's library structure subjected to the blast loading especially from vehicle bombing. The blast loading obtains by using software called AT Blast and compared with the procedure proposed by UFC 3-340-02. The blast load was analytically determined as a pressure-time history and numerical model of the structure was created using ETABS 2015 (v.15.2.0), the conventional software for the static/dynamic analysis of structures, as a full 3D model with Beam elements for girders and columns and Shell elements for slabs. The blast pressure is depending on the stand-off distance. Peak refracted overpressure  $P_r$  was increasing when the stand-off distance decreasing. Resulted in the reflected overpressure is more at the bottom floors and low at the top floors. Blast has a characteristic of high amplitude, the explosion near the structure can cause catastrophic damage to the structure, from the story drift ratio result it was observed that the story drift exceeds the story drift limitation as per SNI 1726: 2012 Section 7.12.1 the story drift ratio shall not exceed 0.015. From the graphical representation of joint displacement and maximum story displacement the maximum response on the concrete frame structure under the action of blast loading is occur at the top. From the maximum story drift ratio figure, the maximum ratio was occurred at the first level of the building in the y direction is about 0.055. Therefore, the Universitas Atma Jaya Yogyakarta's Library current design cannot resist blast loading come from vehicle with 227 kg charge weight.

**Key Words:** ETABS, Blast Loading, Vehicle Bomb, Pressure-Time History, Story Drift, Peak Refracted Overpressure.