STABILIZATION OF CLAY
BY FLY ASH AND CEMENT

Final Project

By:
PERDANA KUSUMAH GONDO WIJAYA
Student Number: 00 13 10252

ATMA JAYA YOGYAKARTA UNIVERSITY
Faculty of Engineering
Department of Civil Engineering
International S1 Program
2010
APPROVAL

Final Project

STABILIZATION OF CLAY
BY FLY ASH AND CEMENT

By:

PERDANA KUSUMAH GONDO WIJAYA
Student Number: 00 13 10252

has been approved

Yogyakarta, .....................

International Program of Civil Engineering
Head

Ir. Y. Lulie, M.T.

Advisor

Ir. John Tri Hatmoko, M.Sc.

Department of Civil Engineering
Head

Junaedi Utomo, M.Eng.
APPROVAL

Final Project

STABILIZATION OF CLAY
BY FLY ASH AND CEMENT

By:
PERDANA KUSUMAH GONDO WIJAYA
Student Number: 00 13 10252

has been examined and approved by the examination committee

Signature  Date


Member  :  Ir. Junaedi Utomo, M.Eng.  August 3, 2010

Member  :  Ir. Ch. Arief Sudibyo  03/08 2010
ACKNOWLEDGEMENT

The writer would like to express thank to Jesus Christ for grant and blessing so that the final project with the title STABILIZATION OF CLAY BY FLY ASH AND CEMENT has completed as a prerequisite for finishing the study at International S1 Program, Civil Engineering Department, Faculty of Engineering, University of Atma Jaya Yogyakarta.

During the process of writing, the writer has received many supports, both directly and indirectly which are consisting of suggestions and instructions. Be aware of supports from many people, the writing process of this final project will not be realized.

At this good opportunity, the writer would like to express thank to:

1. Ir. John Tri Hatmoko, M.Sc., as the advisor of this final project, thanks for everything.
2. Ir. Y. Lulie, M.T., as the Head of International S1 Program Civil Engineering of Atma Jaya Yogyakarta University.
3. Sumiyati Gunawan, ST., MT., as the Head of Soil Mechanics Laboratory of Atma Jaya Yogyakarta University.
4. Mr. Harto as the laborant of Soil Mechanics Laboratory of Atma Jaya Yogyakarta University, thanks for helping.
5. Mas Wiko as the officer of International S1 Program Civil Engineering of Atma Jaya University, thanks for helping.
6. Father, Mother, my brother and sister, thanks for keep supporting me.
7. All International Civil Engineering students, especially for Class of 2000 (Cahyo, Budi, Chris, Febry, Arnold, Diwan, Sandy, Riris, Ita, and Tulodho). Thanks for accompanying me in class.
8. All of friends and relatives for supporting.
Finally, the writer realizes that this project is far infallible, whereas the writer has limited and unperfected abilities. Hopefully this final project has benefit for require circles.

Yogyakarta, ……………., 2010

Perdana Kusumah Gondo Wijaya
SN: 00 13 10252
CONTENTS

Title ................................................................................................................. i
Approval I ...................................................................................................... ii
Approval II .................................................................................................... iii
Acknowledgement ..........................................................................................iv
Contents..........................................................................................................vi
List of tables ................................................................................................... ix
List of figures .................................................................................................. x
List of appendix .............................................................................................. xi
Abstract ........................................................................................................ xii

CHAPTER I. INTRODUCTION ................................................................. 1
  I.1. Background ................................................................................................ 1
  I.2. Problem Statement ................................................................................. 2
  I.3. Problem Limitation ............................................................................... 2
  I.4. Research Objectives ............................................................................. 2
  I.5. Research Originality ........................................................................... 3

CHAPTER II. LITERATURE REVIEWS AND BASIC THEORIES .......... 4
  II.1. Literature reviews ............................................................................... 4
  II.2. Basic Theories ...................................................................................... 9
    II.2.1. Fly Ash .......................................................................................... 9
      II.2.1.1. Definition of Fly Ash ............................................................... 9
      II.2.1.2. Fly Ash Chemical Element Analysis ..................................... 10
      II.2.1.3. Physical Attribute And Characteristics ............................... 11
II.2.1.4. Fly Ash Influence To Soil......................... 11
II.2.2. Clay Soil .......................................................... 12
   II.2.2.1. Clay Soil Definition.......................... 12
   II.2.2.2. Soil Properties............................................. 12
   II.2.2.3. Clay Soil Characteristics....................... 14
II.2.3. Cement ............................................................ 16
II.2.4. Soil Stabilization............................................ 16

CHAPTER III. RESEARCH METHODOLOGY ....................... 17
    III.1. Materials And Instruments.......................... 17
       III.1.1. Materials......................................................... 17
       III.1.2. Instruments..................................................... 17
    III.2. Research Procedure ........................................... 21
       III.2.1. Materials Test ........................................... 21
           III.2.1.1. Clay ....................................................... 21
           III.2.1.1.1. Clay Characteristics Test (Water Content)...... 21
           III.2.1.1.1. Compaction (Standard Proctor Test)........... 22
           III.2.1.2. Fly Ash ...................................................... 25
           III.2.2. Sample Preparation And Production.................. 25
               III.2.2.1. Sample Preparation .................................. 25
               III.2.2.2. Sample Production .................................. 26
           III.2.3. Curing Time ............................................. 28
           III.2.4. Unconfined Compression (UCS) Test ................ 28
    III.3. Research Flow Chart ......................................... 31
CHAPTER IV. RESULT AND ANALYSIS ............................................... 32

IV.1 Material Test Result ................................................................. 32
    IV.1.1. Clay Characteristics Test Result .................................... 32
    IV.1.2. Standard Proctor Test Result ........................................ 33

IV.2 Unconfined Compression Test (UCS) Result .................... 38
    IV.2.1. Clay Soil + Cement ................................................... 38
    IV.2.2. Clay Soil + Cement + Fly Ash ................................. 41

CHAPTER V. CONCLUSION AND SUGGESTION .............................. 44

V.1. Conclusion ............................................................................ 44
    V.2. Suggestion ....................................................................... 45

REFERENCES

APPENDICES
# LIST OF TABLES

<table>
<thead>
<tr>
<th>Table No.</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Fly ash Chemistry Element</td>
<td>10</td>
</tr>
<tr>
<td>2.2</td>
<td>Type of Cement</td>
<td>16</td>
</tr>
<tr>
<td>3.1</td>
<td>Total sample for UCS test</td>
<td>28</td>
</tr>
<tr>
<td>4.1</td>
<td>Water content test</td>
<td>33</td>
</tr>
<tr>
<td>4.2</td>
<td>Unit weight</td>
<td>34</td>
</tr>
<tr>
<td>4.3</td>
<td>Data for OMC calculation</td>
<td>36</td>
</tr>
<tr>
<td>4.4</td>
<td>UCS Test of Clay-Cement Result conclusion</td>
<td>38</td>
</tr>
<tr>
<td>4.5</td>
<td>UCS Test of Clay-Cement-Fly Ash Result conclusion</td>
<td>41</td>
</tr>
<tr>
<td>Figure No.</td>
<td>Description</td>
<td>Page</td>
</tr>
<tr>
<td>-----------</td>
<td>--------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>3.1</td>
<td>Oven</td>
<td>18</td>
</tr>
<tr>
<td>3.2</td>
<td>Weight scales</td>
<td>18</td>
</tr>
<tr>
<td>3.3</td>
<td>Mold</td>
<td>18</td>
</tr>
<tr>
<td>3.4</td>
<td>Split Mold Cylinder</td>
<td>19</td>
</tr>
<tr>
<td>3.5</td>
<td>Hammer</td>
<td>19</td>
</tr>
<tr>
<td>3.6</td>
<td>Extruder</td>
<td>19</td>
</tr>
<tr>
<td>3.7</td>
<td>Caliper</td>
<td>20</td>
</tr>
<tr>
<td>3.8</td>
<td>Unconfined Compression test machine</td>
<td>20</td>
</tr>
<tr>
<td>3.9</td>
<td>Clay + fly ash mixing</td>
<td>26</td>
</tr>
<tr>
<td>3.10</td>
<td>Sample on plastic bag</td>
<td>26</td>
</tr>
<tr>
<td>3.11</td>
<td>Sample compaction</td>
<td>27</td>
</tr>
<tr>
<td>3.12</td>
<td>Research Flow Chart</td>
<td>31</td>
</tr>
<tr>
<td>4.1</td>
<td>Unit weight after water addition</td>
<td>34</td>
</tr>
<tr>
<td>4.2</td>
<td>Average moisture content</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>And weight dry volume</td>
<td></td>
</tr>
<tr>
<td>4.3</td>
<td>Friction Angle Value of Clay-Cement</td>
<td>39</td>
</tr>
<tr>
<td>4.4</td>
<td>Shear Strength Value of Clay-Cement</td>
<td>39</td>
</tr>
<tr>
<td>4.5</td>
<td>Cohesion of Clay-Cement</td>
<td>40</td>
</tr>
<tr>
<td>4.6</td>
<td>Friction Angle Value of Clay-Cement-Fly Ash</td>
<td>42</td>
</tr>
<tr>
<td>4.7</td>
<td>Shear Strength Value of Clay-Cement-Fly Ash</td>
<td>42</td>
</tr>
<tr>
<td>4.8</td>
<td>Cohesion Value of Clay-Cement-Fly Ash</td>
<td>43</td>
</tr>
</tbody>
</table>
## LIST OF APPENDICES

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unconfined Compression Test (UCS) Result</td>
</tr>
</tbody>
</table>
ABSTRACT

STABILIZATION OF CLAY BY FLY ASH AND CEMENT, prepared by Perdana Kusumah Gondo Wijaya, SN: 00 13 10252, year of 2010, Civil Engineering, Engineering Faculty, Atma Jaya Yogyakarta University.

Research about stabilization of clay with many kind of stabilizers such as cement, lime soil, cane pulp ash has been done. However, study of clay stabilization soil is still interesting subject to be investigated. This research investigated capability of fly ash, as a waste material, with the addition of cement as pozzolanic material, combined with clay soil, to increase the shear strength and cohesison of these clay.

The research was divided into 2 steps of test. The first was to find the OMC (Optimum Moisture Content) condition of clay. This step covered clay characteristics test (water content test) and standard proctor test (compaction method). The second step was Unconfined Compression test (UCS). This test was to find the optimum shear strength and cohesison of clay that was stabilized with fly ash and cement. The percentage of cement which added were 0%, 8%, 12%, and 16%; and the percentage of fly ash which added were: 0%; 12%, 24%, and 36%.

The results of the research were: clay reach the optimum moisture content when added with 901.54 ml of water, and reach the optimum shear strength and cohesison when added with cement as much as 8% of percent and fly ash as much as 12% of percent. Addition of cement and fly ash above that percentages were useless. Another results were shear strength and cohesison reach the optimum value on 14th day of curing time rather than 1st day and 7th days of curing times.

Keywords: Clay, fly ash, cement, water content, optimum moisture content, friction angle, cohesison, shear strength.