EFFECT OF SHEAR REINFORCEMENT TO REINFORCED CONCRETE BEAM BEHAVIOR

HASHEM TALAL HADI AL-HAMED

B. ENG(HONS.) CIVIL ENGINEERING
UNIVERSITI MALAYSIA PAHANG
EFFECT OF SHEAR REINFORCEMENT TO REINFORCED CONCRETE BEAM BEHAVIOR

HASHEM TALAL HADI AL-HAMED

Thesis submitted in fulfilment of the requirements for the award of the Bachelor Degree in Civil Engineering

Faculty of Civil Engineering and Earth Resources

UNIVERSITI MALAYSIA PAHANG

JANUARY 2019
SUPERVISOR’S DECLARATION

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor Degree of B. Eng (hons.) Civil Engineering

________________________________________
(Supervisor’s Signature)

Full Name : DR. FADZIL BIN MAT YAHAYA

Position : LECTURER

Date : 14/1/2019
STUDENT’S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

__________________________________________
(Student’s Signature)

Full Name : HASHEM TALAL HADI AL-HAMED

ID Number : AA14270

Date : 14/1/2019
ACKNOWLEDGEMENTS

In the name of Allah SWT, most Grateful and most Merciful, All the praise and thanks are to Allah SWT for giving me strength and endurance in finding my thesis. This dissertation would not have been possible without the guidance of several individuals who extended their valuable assistance in preparation and completion of this study.

My sincere gratitude to my supervisor Dr.FADZIL BIN MAT YAHAYA, who had given guidance for my work and came up with some inspiring suggestion, in the meantime, his patience in guidance me and for all his knowledge sharing, advices, enable me to develop an understanding of the subject. I also sincerely thanks to Dr FADZIL for the time spent proofreading and correcting my many mistakes. It is an honor for me to thanks for everything, sir. Also thank to all the staff that help me in many way and their excellent co-operation especially during preparation and testing sample at laboratory, with their helps and guidance I have accomplished the testing according to the time.

Lastly, I would like to express my gratitude to all dear friends and classmate especially and fellow student of Civil Engineering for their heart whelming in giving idea in many ways, and support during this study. Thank you very much to all. Hopefully this research can be shared and thus provide benefits to the needy.
ABSTRACT

The flexural strength is one of the mechanical properties of concrete. The flexural strength of concrete is needed to determine the maximum deflection and also maximum loads that concrete can maintain at certain times. Shear reinforcements, which are norally provided as vertical stirrups, are placed at varying intervals depending upon the shear conditions acting on a beam. The flexural failure in reinforced concrete beams does not happen suddenly but instead it shows some warning of distress that will occur in the near future. Contradictory to this, the shear failure is sudden, catastrophic and devastating. To avoid any such sudden shear failure, shear reinforcements are provided. Also, the shear reinforcement has a control over the shear strength of the beam. The shear stirrups and are used to increase the shear strength of concrete beams, to avoid the shear failure and to cause a flexural failure. The main aim of this research is to study the effects of shear reinforcement on flexural strength in concrete beam. The concrete mixture used in the present study consists of cement, course aggregates, fine aggregates and water. Two types of tests i.e. compressive and flexural were carried out. The samples for compressive strength included cubes with size of 150 mm x 150 mm x 150 mm, while the size of the beams used for flexural strength tests were 150 mm width x 150mm depth x 750mm length. The results show there is no difference in flexural capacity between 3 shear links and 4 shear links, but when add 5 shear links we notice slight increase in the flexural capacity, it is concluded that the addition of links as shear reinforcement slightly effect the flexural capacity.
TABLE OF CONTENT

SUPERVISOR'S DECLARATION IV
STUDENT'S DECLARATION V
ACKNOWLEDGEMENTS VI
ABSTRAK VII
ABSTRACT VIII
TABLE OF CONTENT VIII
LIST OF TABLES XII
LIST OF FIGURES ERROR! BOOKMARK NOT DEFINED.
LIST OF SYMBOLS ERROR! BOOKMARK NOT DEFINED.
LIST OF ABBREVIATIONS ERROR! BOOKMARK NOT DEFINED.

CHAPTER 1 INTRODUCTION 1
1.1 Backgrond Of Study 1
1.2 Problem Statement 4
1.3 Research Objectives 5
1.4 Scope Of Study 5
1.5 Significant Of Study 6

CHAPTER 2 LITERATURE REVIEW 8
2.1 Introduction 8
2.2 Flexural Strength 9
2.3 Ductility

2.3.1 Yield Deformation 10

2.3.2 The Maximum Available (Ultimate) Deformation 10

2.4 Shear And Its Importance 10

2.5 Factors Influencing The Shear Behavior And Capacity Of RC Beam 11

2.5.1 Factors Influencing The Shear Behaviour 11

2.5.2 Factors Influencing The Shear Capacity 12

2.6 Effect Of Shear Reinforcements On Flexural Strength 12

2.7 Summary 13

CHAPTER 3 RESEARCH METHODOLOGY 15

3.1 Introduction 15

3.2 The Materials Used In Concrete Mixing 15

3.2.1 Cement 15

3.2.2 Aggregates 17

3.2.2.1 Coarse Aggregate 17

3.2.2.2 Fine Aggregate 18

3.3 Water 19

3.3 Pre-Mixing Experiments 20

3.3.1 Mixing process 20

3.3.2 Compacting process 20

3.3.3 Curing process 21

3.4 Sample Preparation 21
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.5</td>
<td>Determination Of Concrete Performance</td>
<td>22</td>
</tr>
<tr>
<td>3.5.1</td>
<td>Concrete workability test</td>
<td>22</td>
</tr>
<tr>
<td>3.5.1.1</td>
<td>Slump test</td>
<td>22</td>
</tr>
<tr>
<td>3.5.2</td>
<td>Concrete strength test</td>
<td>24</td>
</tr>
<tr>
<td>3.5.2.1</td>
<td>Compressive strength test</td>
<td>24</td>
</tr>
<tr>
<td>3.5.2.2</td>
<td>Flexural test</td>
<td>25</td>
</tr>
</tbody>
</table>

CHAPTER 4 DATA ANALYSIS AND DISCUSSION | 27

4.1 | Introduction | 27 |
4.2 | Concrete Compression Test | 27 |
4.3 | Flexural Strength Test | 28 |
4.4 | Analysis Of Slump Test Result | 29 |
4.5 | Analysis Concrete Compression Test | 29 |
4.6 | Analysis Of Flexural Strength Test | 32 |

CHAPTER 5 CONCLUSION & RECOMMENDATION | 37

5.1 | Introduction | 37 |
5.2 | Conclusion | 37 |
5.3 | Recommendation | 38 |

REFERENCES | 39

APPENDEX A SAMPLES DURING FLEXURAL TEST AND COMPRESSION TEST | 41

APPENDEX B SAMPLES AFTER FLEXURAL TEST AND COMPRESSION TEST | 42
LIST OF TABLES

Table 1.1 Detail About Beams Design 5
Table 3.1 Gantt Chart Of Project Planning 15
Table 3.2 Sample Of Beams For Testing 21
Table 3.3 Sample Of Cubes For Testing 22
Table 4.1 Compressive Strength For Cubes After 7 Days 30
Table 4.2 Compressive Strength For Cubes After 28 Days 31
# List of Figures

<table>
<thead>
<tr>
<th>Figure 3.1</th>
<th>Types of Portland cement</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 3.2</td>
<td>Example of coarse aggregates</td>
<td>18</td>
</tr>
<tr>
<td>Figure 3.3</td>
<td>Example of fine aggregate</td>
<td>19</td>
</tr>
<tr>
<td>Figure 3.4</td>
<td>Types of slump</td>
<td>23</td>
</tr>
<tr>
<td>Figure 3.5</td>
<td>Compressive strength test equipment</td>
<td>25</td>
</tr>
<tr>
<td>Figure 3.6</td>
<td>Flexural test equipment</td>
<td>26</td>
</tr>
<tr>
<td>Figure 3.7</td>
<td>Loading arrangement on the specimen</td>
<td>26</td>
</tr>
<tr>
<td>Figure 4.1</td>
<td>Compressive strength and load for cubes tested after 7 days</td>
<td>32</td>
</tr>
<tr>
<td>Figure 4.2</td>
<td>Compressive strength and load for cubes tested after 28 days</td>
<td>32</td>
</tr>
<tr>
<td>Figure 4.3</td>
<td>Flexural strength of samples with 3 shear links</td>
<td>33</td>
</tr>
<tr>
<td>Figure 4.4</td>
<td>Flexural strength of samples with 4 shear links</td>
<td>34</td>
</tr>
<tr>
<td>Figure 4.5</td>
<td>Flexural strength of samples with 5 shear links</td>
<td>35</td>
</tr>
<tr>
<td>Figure 4.6</td>
<td>Flexural strength Average of samples with 3, 4 and 5 shear links</td>
<td>36</td>
</tr>
</tbody>
</table>
## LIST OF SYMBOLS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/mm²</td>
<td>Newton per millimetre square</td>
</tr>
<tr>
<td>kN</td>
<td>Kilo Newton</td>
</tr>
<tr>
<td>N</td>
<td>Newton</td>
</tr>
<tr>
<td>mm</td>
<td>Millimetre</td>
</tr>
<tr>
<td>m</td>
<td>Metre</td>
</tr>
<tr>
<td>MPa</td>
<td>Megapascal</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Full Form</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------</td>
</tr>
<tr>
<td>BS EN</td>
<td>British Standard European Norm</td>
</tr>
<tr>
<td>ASTM</td>
<td>American Standard Test Method</td>
</tr>
<tr>
<td>MS</td>
<td>Malaysian Standard</td>
</tr>
<tr>
<td>OPC</td>
<td>Ordinary Portland Cement</td>
</tr>
</tbody>
</table>
CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

Beam is a structural element that firstly resists the loads applied horizontally to the beam's axis. When we apply the loads to the beam it causes reaction forces at the packet support points and this happening because the position of deviation of this beam is primarily by bending. The overall effect of all the forces acting on the beam is to produce shear forces and bending moments through the beam, this stimulates the internal stresses, strains and deflections of the beam. So, beams can be described as members that are mainly subjected to flexure and it is essential to focus on the analysis of bending moment, shear, and deflection. When the bending moment acts on the beam, bending strain is produced. The resisting moment is developed by internal stresses. Under positive moment, compressive strains are produced in the top of beam and tensile strains in the bottom. Concrete is a poor material for tensile strength and it is not suitable for flexure member by itself. The tension side of the beam would fail before compression side failure when beam is subjected a bending moment without the reinforcement. For this reason, steel reinforcement is placed on the tension side. The steel reinforcement resists all tensile bending stress because tensile strength of concrete is zero when cracks develop.

Beams are generally clarification of building or structural designing or civil engineering structural components. However, any structures, for example, car vehicle outlines, flying machine parts, machine outlines.
In engineering, there are several types of beams based on the supports which are Simply supported beam which a beam is supported on the ends that is allowed to rotate and have no moment resistance, fixed beam which a beam is supported on both ends and limited from rotation, over hanging which a simple beam extending toward its support on one side, double overhanging which a simple beam with both ends extending beyond its supports on both ends, continuous beam or nonstop supports beam which a beam extending over more than two supports, cantilever beam which the beam is settled just toward one side and trussed beam which a beam is strengthened by adding a cable or rod to form a truss.

Reinforced concrete is one of the modern building materials widely used. Concrete is an “artificial stone” obtained by mixing cement, sand, and aggregates with water. When aggregate is mixed together with dry Portland cement and water, the mix forms fresh liquid of concrete that is easily poured and molded into any shape we want to get, which is an inherent advantage over other materials, the cement reacts chemically with the water and other components to form a hard matrix that binds the materials together into a durable stone-like material that has many uses. After the production of Portland cement, concrete became very popular around the world; however, its limited resistance to tension prevented its widespread use in building construction, to overcome this weakness, steel bars are included in concrete to form a composite material called reinforced concrete. The modern reinforced concrete design and construction practice were developed by European engineers in the late 19th century, nowadays the reinforced concrete is widely used in many range of engineering applications such as building, bridges and dams.

In the late nineteenth century, reinforcing materials, such as iron or steel rods, began to be used to increase the tensile strength of concrete. Today steel bars are used as common reinforcing material. Usually steel bars have over 100 times the tensile strength of concrete; but the cost is higher than concrete. Therefore, it is most economical that concrete resists compression and steel provides tensile strength. Also, it is essential that concrete and steel deform together and deformed reinforcing bars are being used to increase the capacity to resist bond stresses.
Good structural analysis and design must be completed with appropriate reinforcement detailing to make sure that the whole structure acts as it designed by the designer. So the process of details and arrangement of the bar should be in the best way, practical, cost-effective, and suitable for their intended use, otherwise you may suffer from ugly cracks, excessive deflection, or even collapse because the poorly detailed structure.

Flexural strength, which also known as modulus of rupture, or bend strength, or transverse rupture strength is a substance property, which is defined as stress in a material before it is produced in a bend test (Michael Ashby 2011). Most often transverse bending test is used, in which we employ a rectangular or circular cross section that is bent until breaking or yield by using a three-point rupture of modulus test technique, the flexural strength is the highest pressure occurs within the material at its moment of yield, this is measured in terms of stress.

When the shape of an any object is a single material such as steel bar or wooden beam, it is faces a range of pressures through its depth, the stress will be at its maximum pressure value if the state of the edge is concave face means that the edge of the object is on the inside of the bend, on the other hand the stress will be at its maximum tensile value if the pressure at the outside of the bend which means convex face. These internal and external edges of the beam or rod are known as the 'extreme fibers'. The majority of substances fail under tensile stress before they fail under pressure stress, so the transverse rupture strength (bend strength) is the maximum value of tensile stress that can be sustained before the beam fails.

The flexural strength of a material is defined as its ability to resist deformation under load. For materials that deform significantly but do not break, the load at yield, typically measured at 5% deformation/strain of the outer surface, is reported as the flexural strength or flexural yield strength. The test beam is under compressive stress at the concave surface and tensile stress at the convex surface.
REFERENCES


Choi, K.-K. (May 2002 ). Reinforced Concrete Structure Design Assistant Tool.


Yakut, A. (n.d.). Middle East Technical University. Turkey.

