

**FLEXURAL BEHAVIOUR OF REINFORCED  
CONCRETE BEAM WITH CIRCULAR WEB  
OPENING**

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## **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 degree of Bachelor of Engineering (Hons) Civil Engineering.

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## **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.

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for the award of the  
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## LIST OF SYMBOLS

|                   |                                   |
|-------------------|-----------------------------------|
| P                 | Load                              |
| A                 | Cross sectional area              |
| d                 | Effective depth                   |
| F <sub>cc</sub>   | Stress in concrete in compression |
| F <sub>st</sub>   | Stress in steel in tension        |
| A <sub>s</sub>    | Area of reinforcement             |
| n                 | Coefficient for steel             |
| I <sub>cr</sub>   | Moment of Inertia                 |
| h                 | Height                            |
| c                 | Concrete cover                    |
| b                 | Width                             |
| Ø                 | Diameter                          |
| mm                | Millimetre                        |
| kg                | Kilogram                          |
| MPa               | Mega Pascal                       |
| kN                | Kilo Newton                       |
| N                 | Newton                            |
| N/mm <sup>2</sup> | Newton per millimetre square      |
| kNm               | Kilo Newton metre                 |
| GPa               | Giga Pascal                       |

## LIST OF ABBREVIATIONS

|      |  |
|------|--|
| ASTM | American Society for Testing And Materials |
| ACI  | American Concrete Institute                |
| IS   | Indian Standard                            |
| DOE  | Department of Environment                  |
| BS   | British Standard                           |
| pH   | Potential of Hydrogen                      |
| CB   | Control beam                               |
| B1   | Beam with 100 mm opening                   |
| B2   | Beam with 80 mm opening                    |
| B3   | Beam with 60 mm opening                    |