BEHAVIOR OF SPANDREL BEAMS STRENGTHENED WITH STEEL FIBERS UNDER COMBINED LOADING

OMER FAROUK IBRAHEEM

UNIVERSITI SAINS MALAYSIA

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By

OMER FAROUK IBRAHEEM

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Oleh

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Tesis yang diserahkan untuk

memenuhi keperluan bagi ijazah

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A_e = Cross-sectional area of a concrete element

A_f = Area of the link8 element representing fiber

d_f = Diameter of steel fiber

e = Eccentricity of the applied load

f_c = Ultimate uniaxial compressive strength

f_t = Ultimate uniaxial tensile strength of the concrete

l_f = Length of steel fiber

N_f = Number of fibers per unit cross section area

P_{cr} = Cracking vertical load

P_{max} = Maximum vertical load

S_{rm} = Average spacing

T_c = Stiffness multiplier constant

T_{cr} = Cracking torsional moment

T_{max} = Maximum torsional moment

V_f = Volume fraction of steel fibers

w_k = Maximum crack width

β_t = Shear transfer coefficient

η_0 = Orientation factor

θ_{cr} = Angle of twist at mid span under cracking load

θ_{max} = Angle of twist at mid span under maximum load

$Ø$ = Bar diameter

Δ_{cr} = Vertical deflection at mid span under cracking load

Δ_{max} = Vertical deflection at mid span under maximum load

ε_{rm} = Strain in steel

ρ_r = Effective reinforcement ratio

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ABSTRACT

Important concrete members are subjected to significant torsion accompanied by bending and shear. Until recent years, the design codes of reinforced concrete members assumed that the effects of torsion could be safely neglected due to high safety factors for shear and bending moment. Thus, members under combined loading were not treated with serious attention. However, this assumption cannot be applied anymore as torsion issues become common and play a significant role in structural members, such as spandrel beams. The spandrel beam, or the L-beam, lies on the perimeter of buildings. Any failure in spandrel beams can seriously damage slabs, beam-column connections, and punch concrete flat-plates. By incorporating steel fibers, it can enhance torsional behavior of spandrel beam under combined load in addition to the structural performance such as maximum load, ductility and cracking resistance. Steel fibers may provide resistance to combined loading as stirrups and longitudinal bars, this investigation is still scare and limited. Moreover, a worldwide interest in utilizing fiber reinforced concrete structures for civil infrastructure applications has increased. This study presents the advantage of using steel fiber concrete in strengthening spandrel beams under different reinforcement and loading cases. An experimental investigation was conducted to assess the behavior of steel fiber reinforced concrete spandrel beams subjected to combined torsion, bending, and shear. A total of 18 spandrel beams were