EFFICIENCY OF USING STEEL END CAPS IN IMPROVING THE POST-FIRE FLEXURAL BEHAVIOR OF FRP REINFORCED CONCRETE BEAMS

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by

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بسم الله الرحمن الرحيم

(يَرْفَعِ اللَّهُ الَّذِينَ آمَنُوا مِنكُمْ وَالَّذِينَ أُوتُوا الْعِلْمَ دَرَجَاتٍ وَاللَّهُ بِمَا تَعْمَلُونَ خَبِيرٌ)

سورة المجادلة – 11

In The Name of Allah, the Most Beneficent, the Most Merciful

(Allah will raise those who have believed among you and those who were given knowledge, by degrees. And Allah is acquainted with what you do)

Surat Al-Mujadala -11

DEDICATION

To my mother, father, sisters, and brothers,

To my beloved wife, sons and daughter,

To all my friends in Palestine, Malaysia, Jordan and UAE,

To everyone who was there when I needed support,

To all those who wished me luck,

I dedicate this work with all my love.

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LIST OF ABBREVIATIONS

AFRP	Aramid Fiber Reinforced Polymer
BE	Bar Elongation
B.S.	Bond Slip Failure
BFRP	Basalt Fiber Reinforced Polymer
BPE	Bertero- Popov-Eligehausen
C.C.	Concrete Crushing Failure
C3S	Portlandite
CFRP	Carbon Fiber Reinforced Polymer
CH	Calcium Hydroxide
CIMA	Cement Industries of Malaysia Berhad
CMR	Cosenza- Manfredi - Realfonzo
CSH	Calcium Silicate Hydrate
CTE	Coefficient of Thermal Expansion
DMA	Dynamic Mechanical Analysis
DMTA	Dynamic Mechanical Thermal Analysis
DSC	Differential Scanning Calorimetry
DTG	Derivative Thermo-Gravimetric Analysis
EC	End Cap
EFM	Expected Failure Mode
EPR	Epoxy Polymer Resin
EUS	Elongation at Ultimate Strength
FA	Fly Ash
FRP	Fiber Reinforced Polymer

GFRP	Glass Fiber Reinforced Polymer
H.T.	High Temperature
HFRHSC	Hybrid-Fiber-Reinforced-High-Strength-Concrete
HPC	High-Performance Concrete
HPSCC	High-Performance, Self-Consolidating Concrete
HSC	High Strength Concrete
I.S.	Initial Stiffness
ID	Inner Diameter
LVDT	Linear Variable Differential Transducers
MK	Metakaolin Concrete
N.A.	Not Available/ Not Applicable
N.T.	Normal Temperature
NSC	Normal Strength Concrete
OD	Outer Diameter
ODF	Overall Ductility Factor
OPC	Ordinary Portland Cement
PFA	Pulverized Fly Ash
PVC	Polyvinyl Chloride polymer
RC	Reinforced Concrete
RUBS	Residual Ultimate Bond Strength
S	Shear Failure
S.R.	Reduction in Stiffness
S.Y.	Steel Yielding Followed by Concrete Crushing
SABS	Slip at Maximum Bond Strength
SAF	Stroke at Maximum Force

SEM	Scanning Electronic Microscopy
SF	Silica Fume
Sp. #	Specimen Number
SS316L	Stainless Steel Grade 316L
T.C.	Thermocouple
TGA	Thermo-Gravimetric Analysis
UBS	Ultimate Bond Strength
UD	Uni-directional
UP	Unsaturated Polyester
US	Ultimate Strength
VER	Vinyl Ester Resign
YS	Yield Strength