Thermal and Mechanical Behaviour of MBT Rebar Couplers under Elevated Temperature Conditions

Author: Matthew Alford
Supervisor: Professor Luke Bisby

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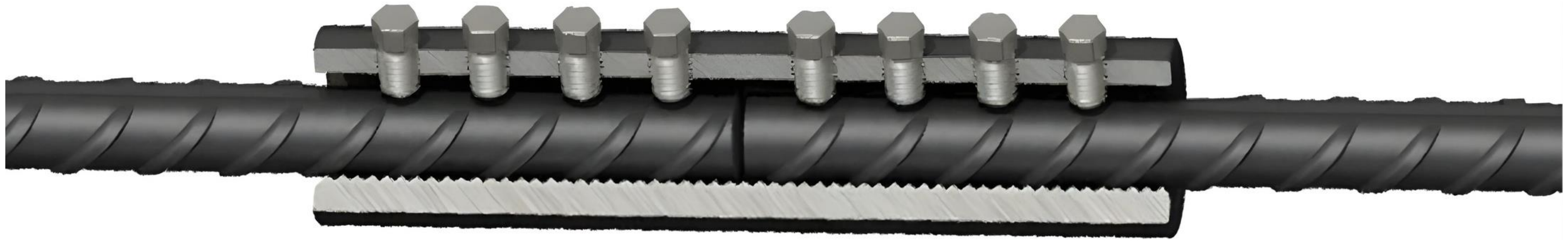
MBT - Lock Shear Bolt Couplers

Research Question: Does the failure mechanism of a lock shear bolt coupler at sustained loading under elevated temperatures change?



Ambient Temperature Test - 2mm/min tension

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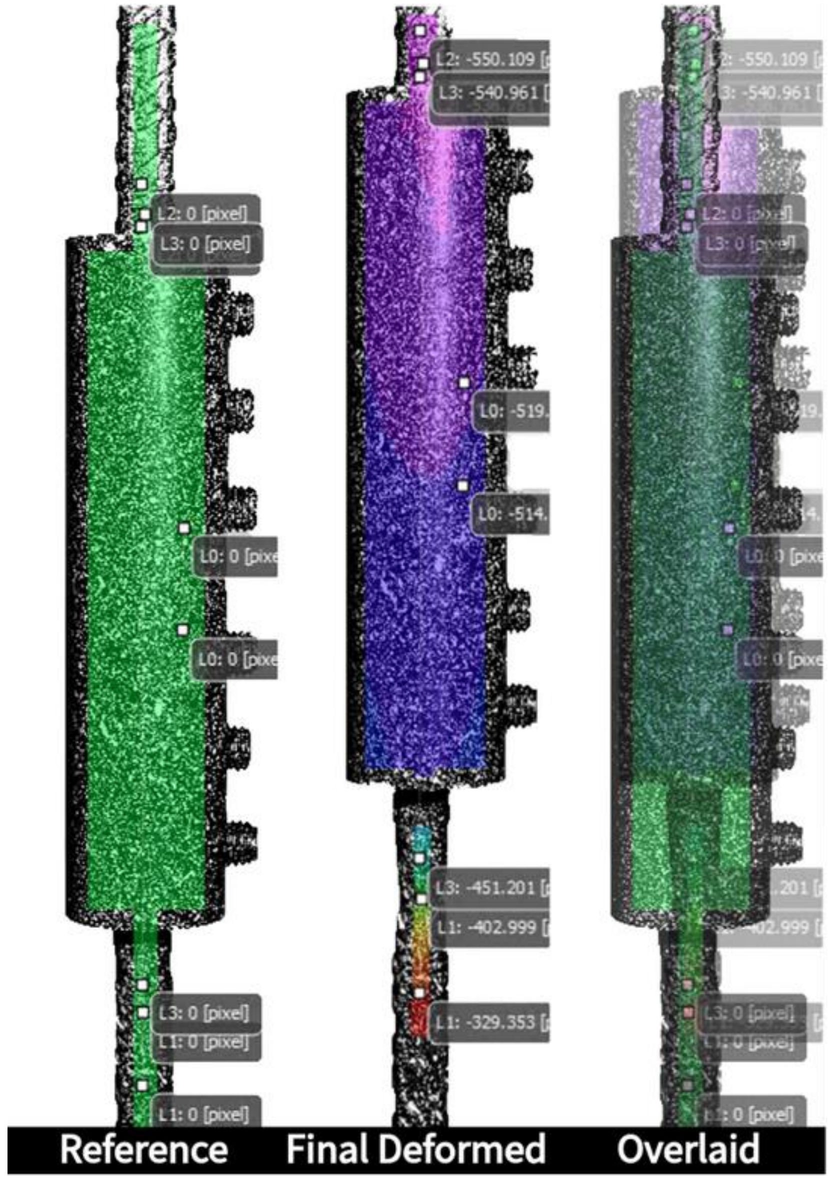
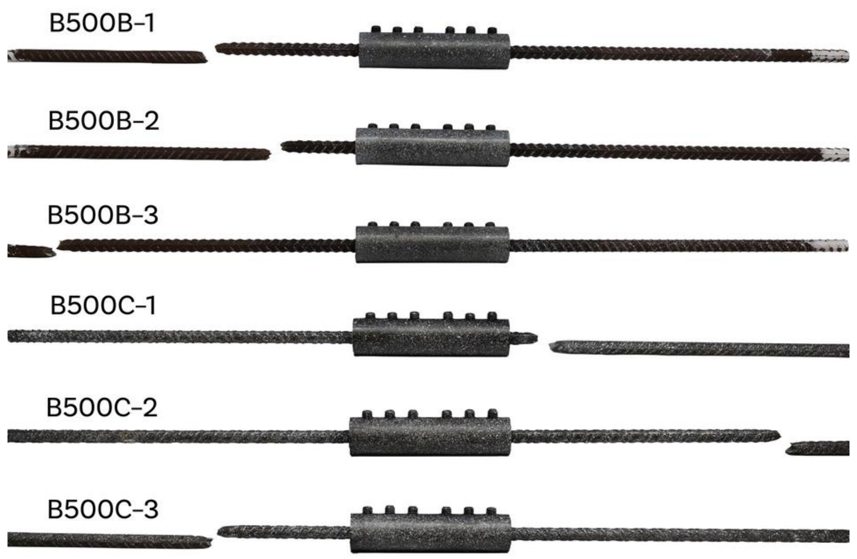
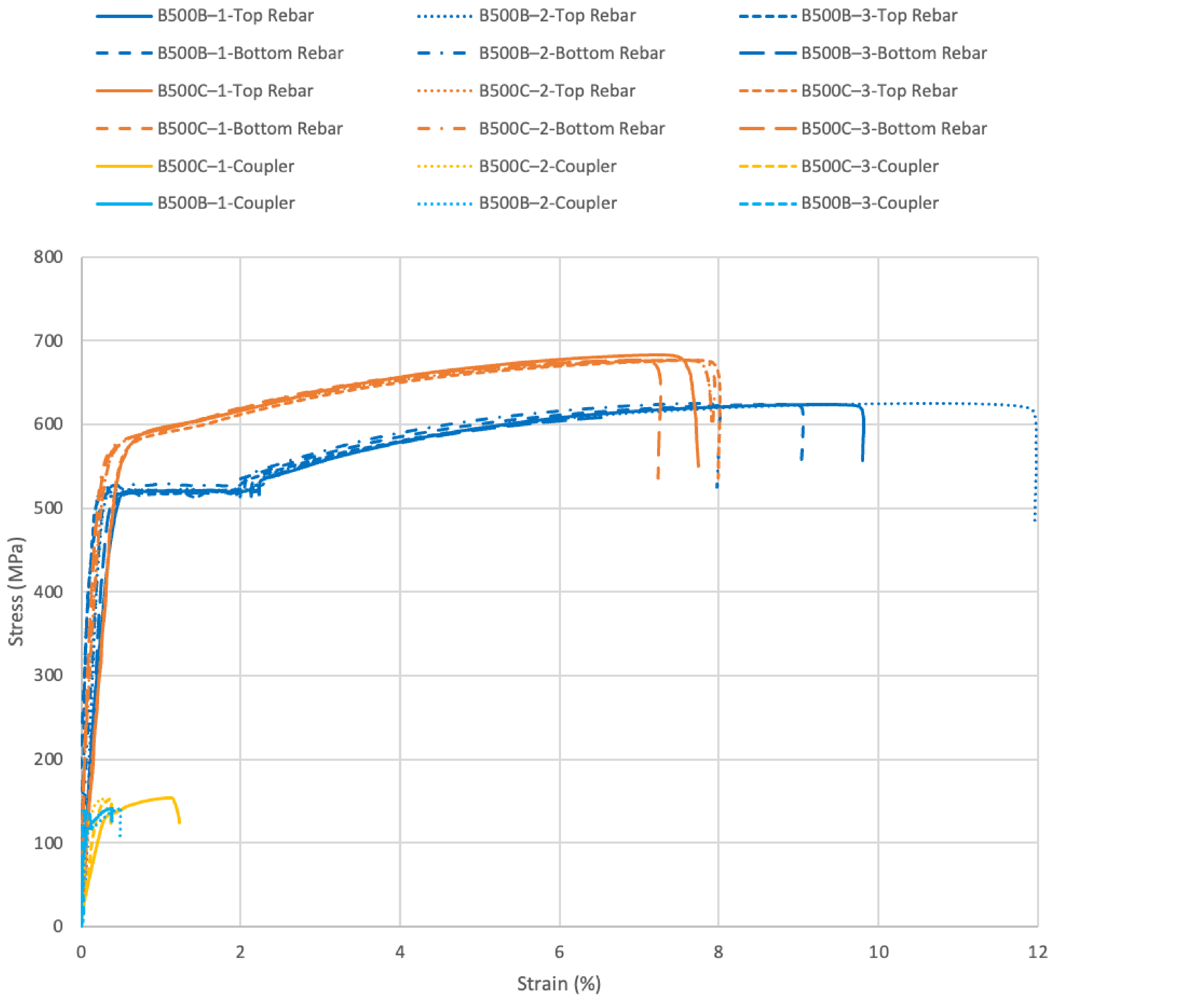
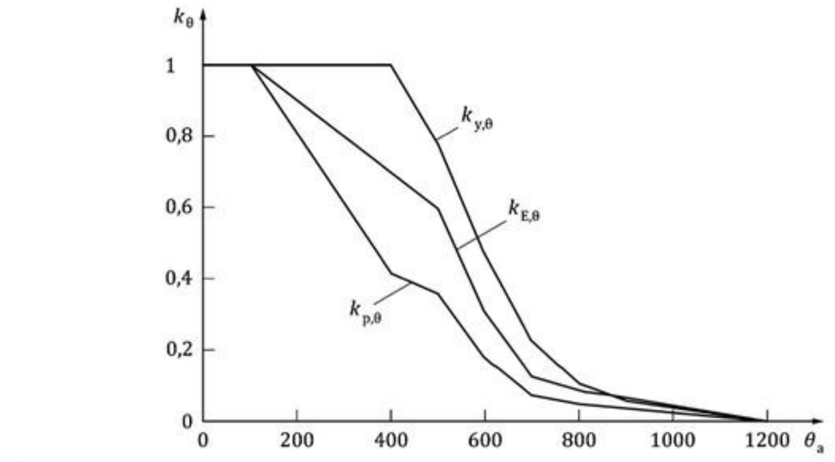






Eurocode 3 - Elevated Temperature Strain Model



Key

k_θ reduction factor

θ_a steel temperature in [°C]

$k_{y,\theta} = f_{y,\theta} / f_y$ reduction factor for the effective yield strength

$k_{E,\theta} = E_{a,\theta} / E_a$ reduction factor for the slope of linear elastic range

$k_{p,\theta} = f_{p,\theta} / f_y$ reduction factor for the proportional limit

Table 5.2 — Stress-strain relationship for steel at elevated temperatures

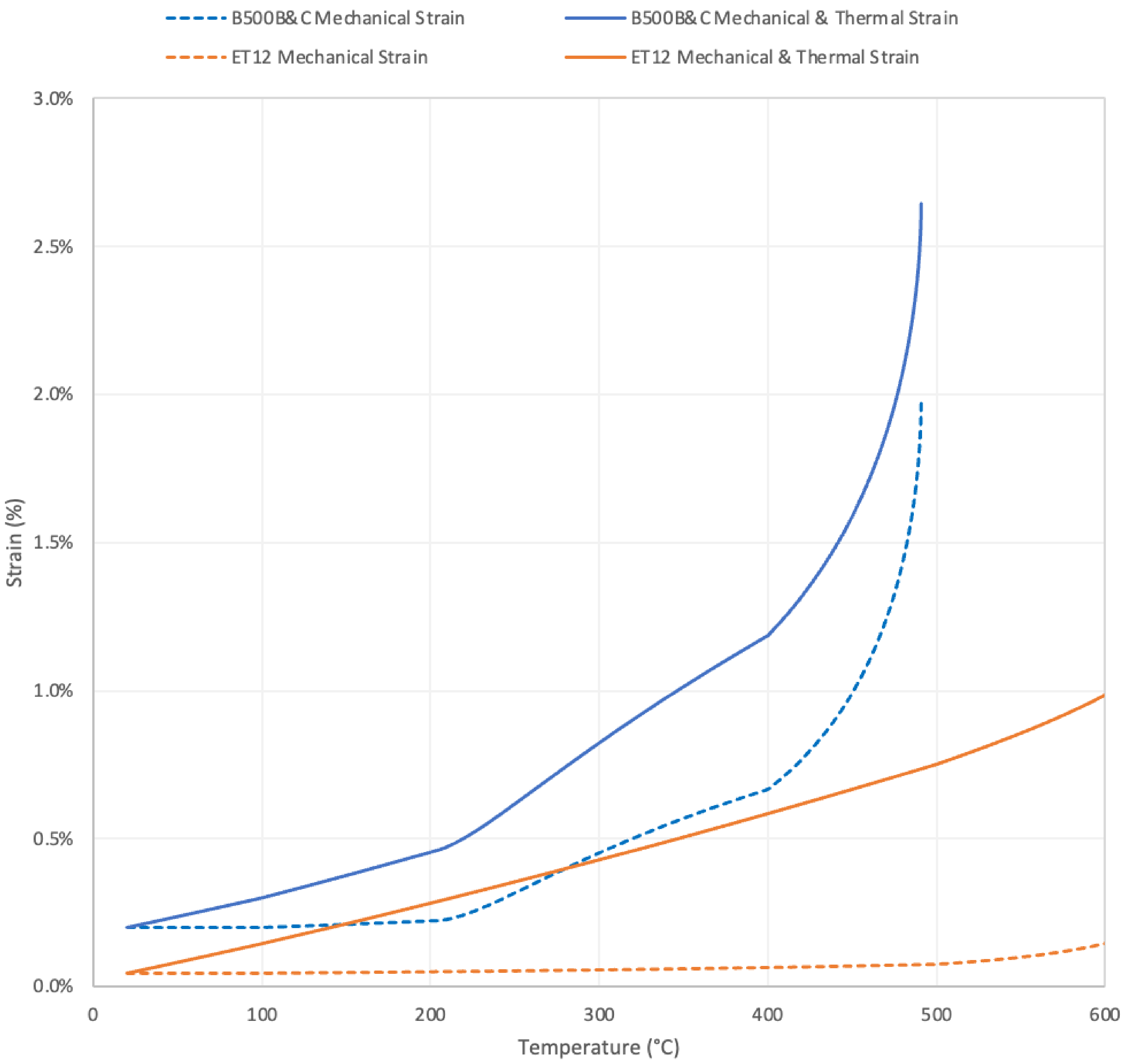
Strain range	Stress σ_θ	Tangent modulus
$\varepsilon_\theta \leq \varepsilon_{p,\theta}$	$\varepsilon_\theta E_{a,\theta}$	$E_{a,\theta}$
$\varepsilon_{p,\theta} < \varepsilon_\theta < \varepsilon_{y,\theta}$	$f_{p,\theta} - c + (b/a)\left[a^2 - (\varepsilon_{y,\theta} - \varepsilon_\theta)^2\right]^{0,5}$	$\dfrac{b(\varepsilon_{y,\theta} - \varepsilon_\theta)}{a\left[a^2 - (\varepsilon_{y,\theta} - \varepsilon_\theta)^2\right]^{0,5}}$
$\varepsilon_{y,\theta} \leq \varepsilon_\theta \leq \varepsilon_{t,\theta}$	$f_{y,\theta}$	0
$\varepsilon_{t,\theta} < \varepsilon_\theta < \varepsilon_{u,\theta}$	$f_{y,\theta}\left[1 - (\varepsilon_\theta - \varepsilon_{t,\theta})/(\varepsilon_{u,\theta} - \varepsilon_{t,\theta})\right]$	-
$\varepsilon_\theta = \varepsilon_{u,\theta}$	0,00	-
Parameters	$\varepsilon_{p,\theta} = f_{p,\theta} / E_{a,\theta}$ $\varepsilon_{y,\theta} = 0,02$	$\varepsilon_{t,\theta} = 0,15$ $\varepsilon_{u,\theta} = 0,20$
Functions	$a^2 = (\varepsilon_{y,\theta} - \varepsilon_{p,\theta})(\varepsilon_{y,\theta} - \varepsilon_{p,\theta} + c / E_{a,\theta})$ $b^2 = c(\varepsilon_{y,\theta} - \varepsilon_{p,\theta})E_{a,\theta} + c^2$ $c = \dfrac{(f_{y,\theta} - f_{p,\theta})^2}{(\varepsilon_{y,\theta} - \varepsilon_{p,\theta})E_{a,\theta} - 2(f_{y,\theta} - f_{p,\theta})}$	

5.3.1.2 Thermal expansion

(1) The relative thermal expansion of steel $\Delta l / l$ should be determined from the following:

— for 20 °C ≤ θ_a < 750 °C:

$$\Delta l / l = 1,2 \times 10^{-5}\,\theta_a + 0,4 \times 10^{-8}\,\theta_a^2 - 2,416 \times 10^{-4} \quad (5.7)$$



12mm bar-coupler assembly at 80% yeild strength (42.5kN)

Elevated Temperature Test - 10°C/min

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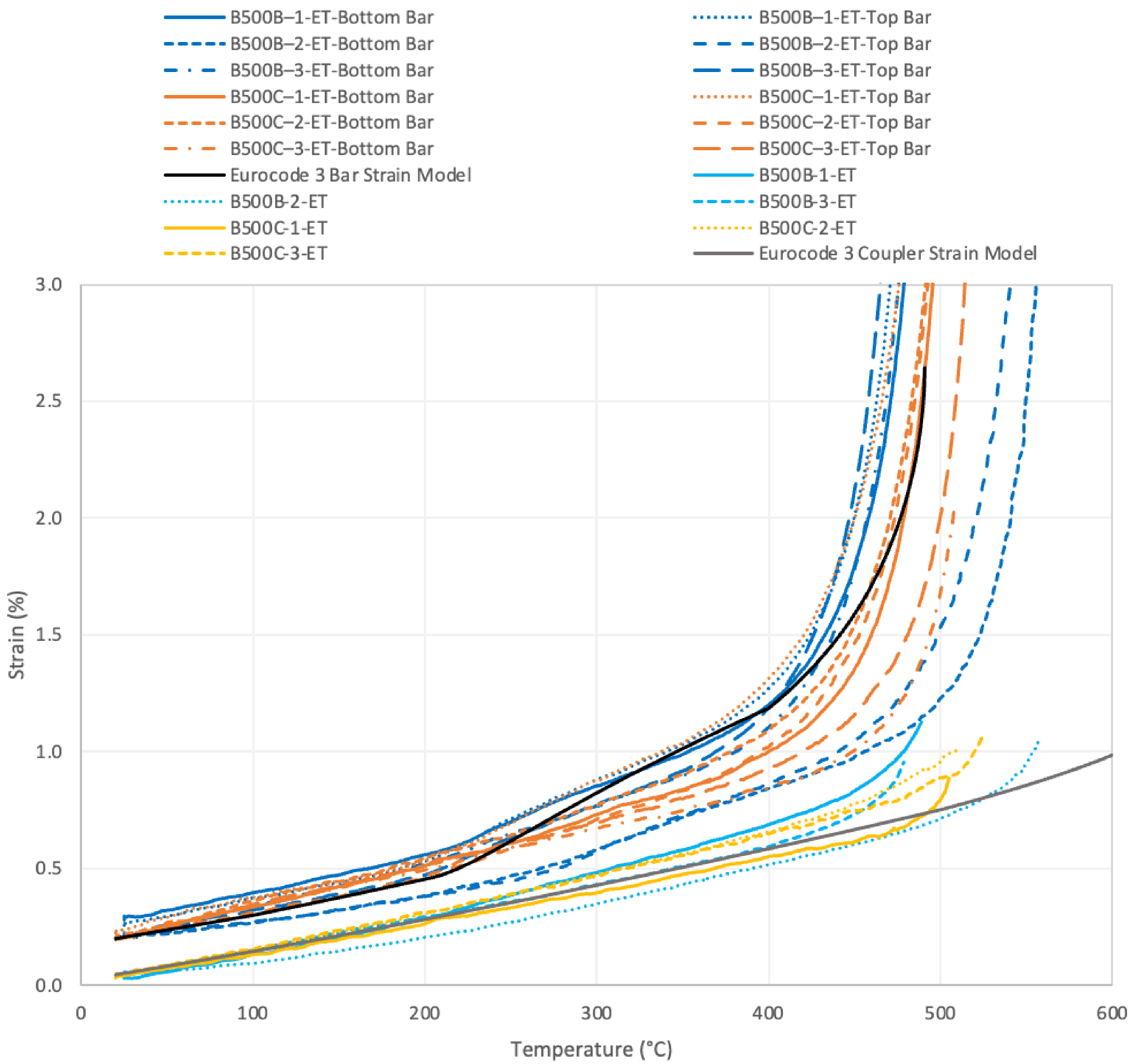
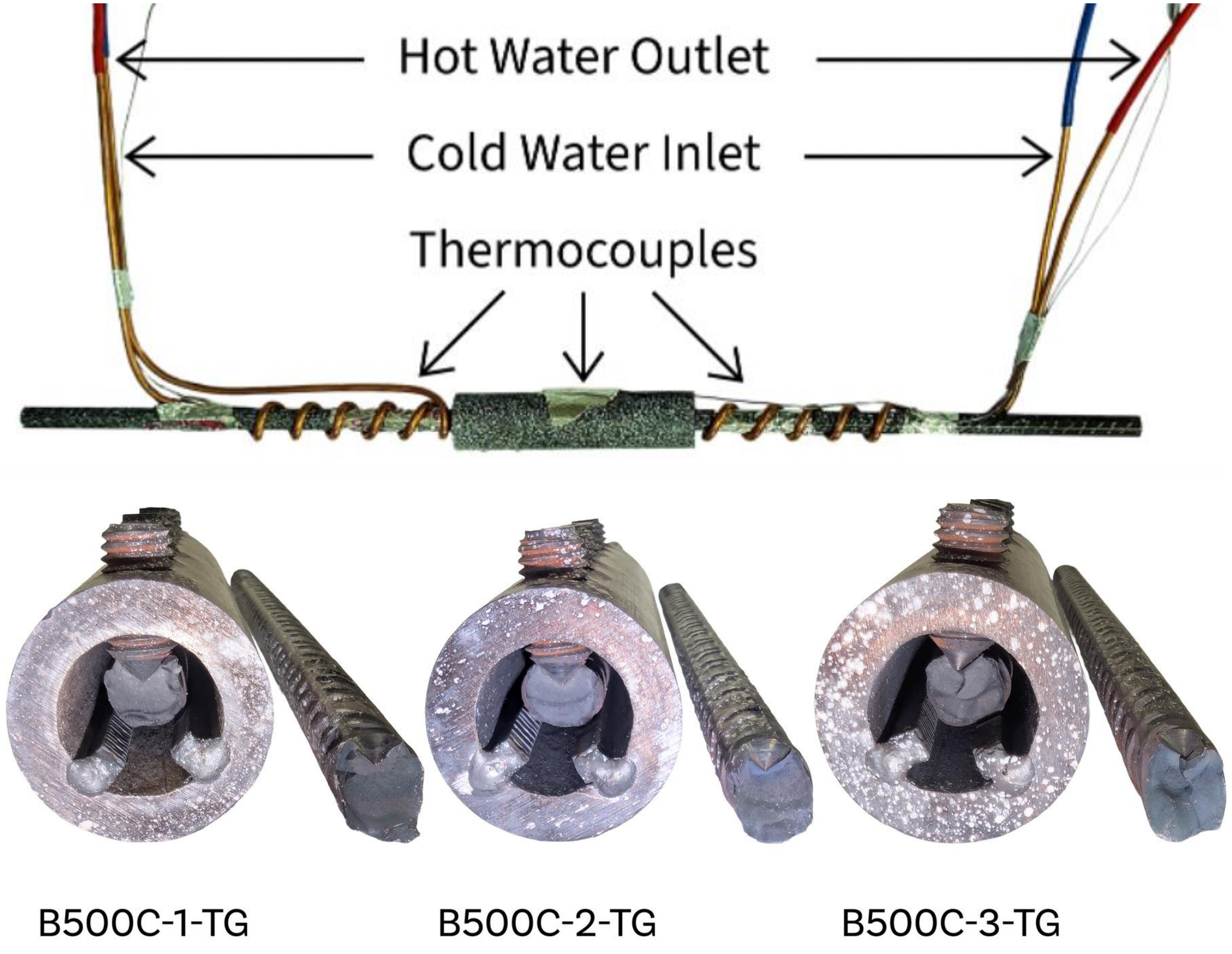
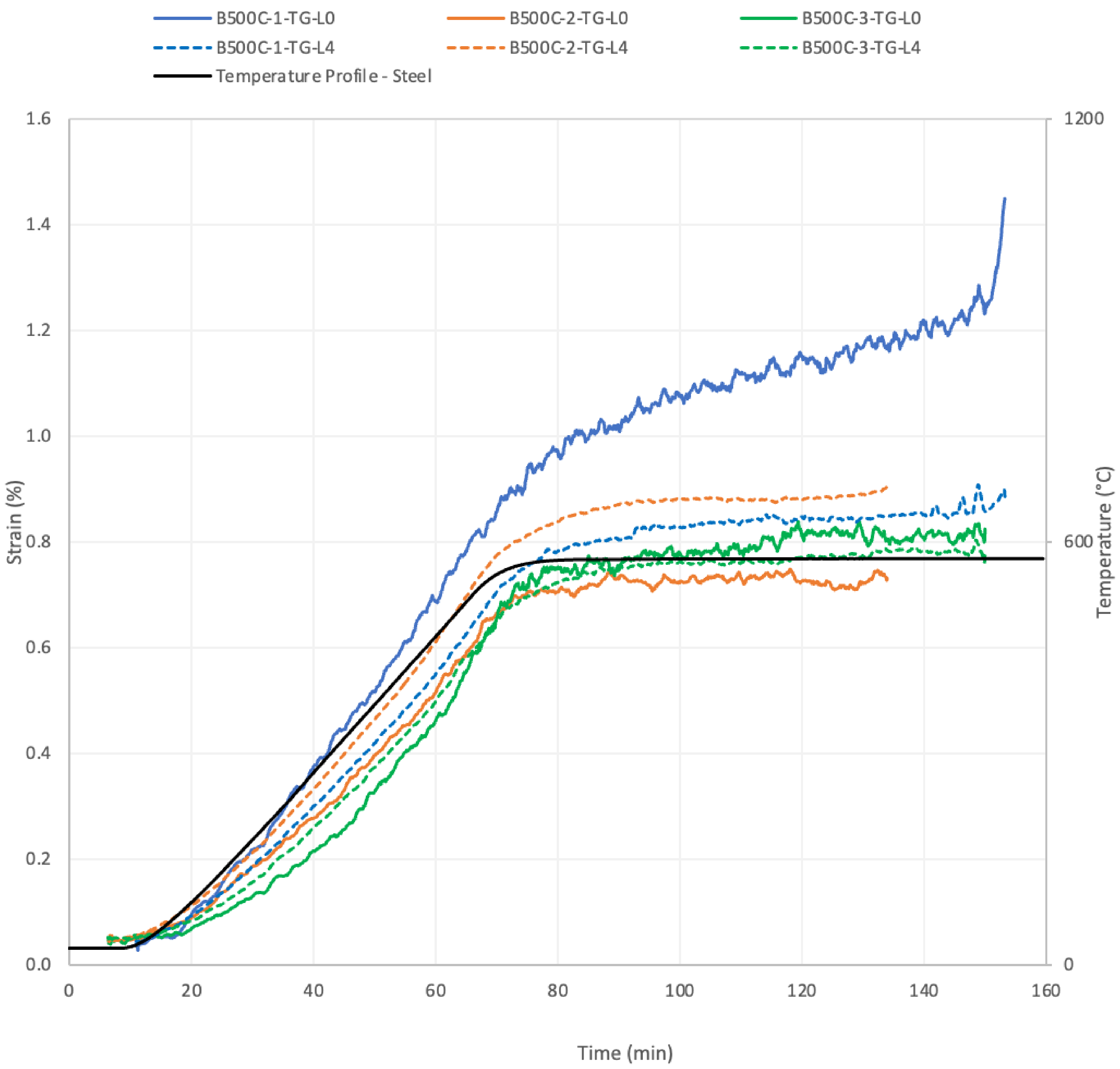


Elevated Temperature Test - Thermal Gradient





Coupler Strain with thermal gradient

Independent of Temperature ↓ (A) **Thermal Decay** ↓ (f_y)

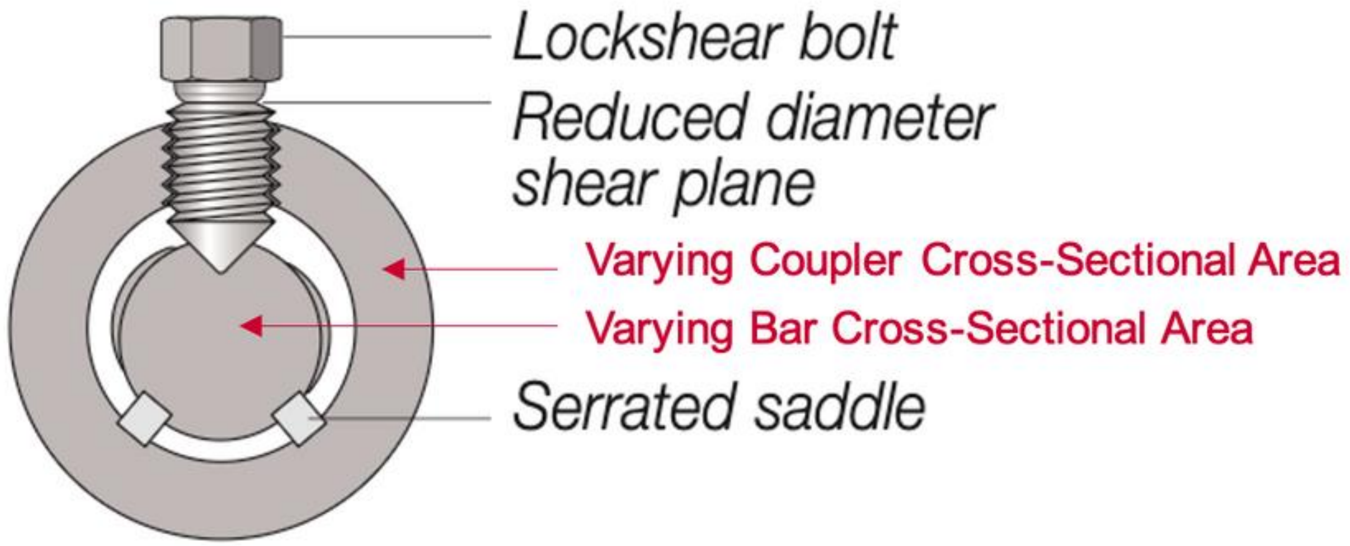
$$\text{Capacity (P)} = A \times f_y$$

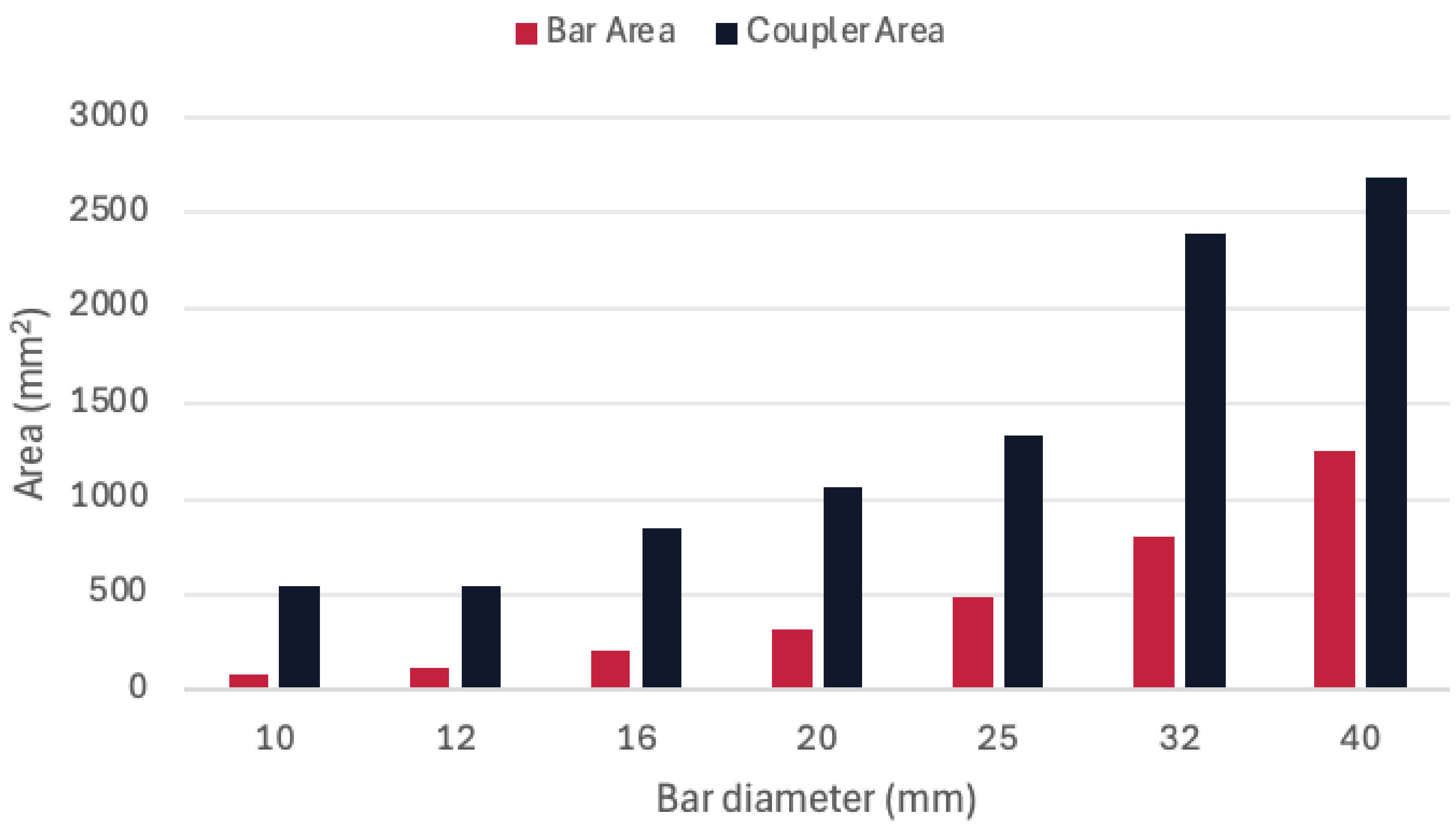
Where:

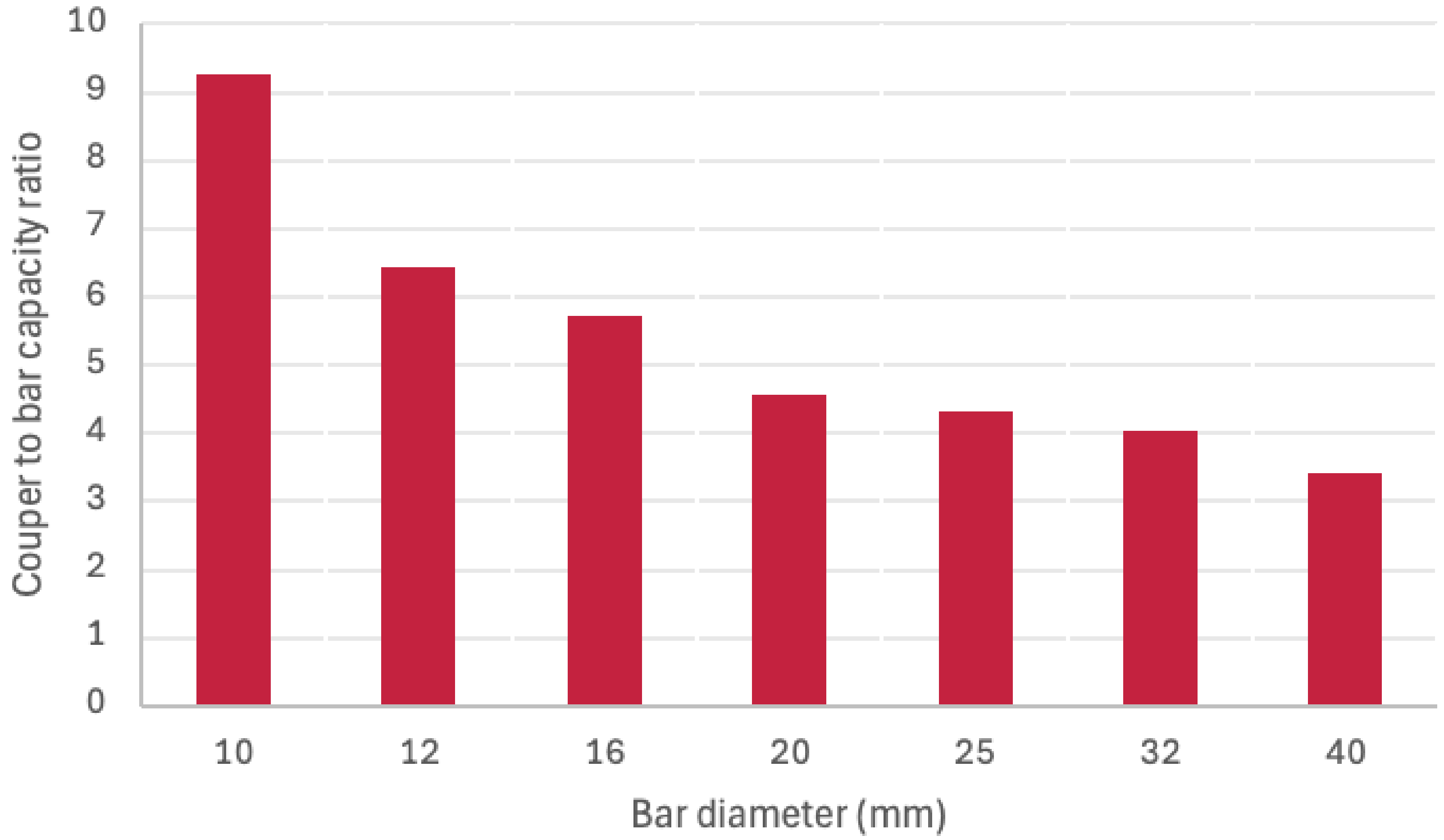
- A = Cross-sectional area of the bar
- f_y = Yield strength of the steel (in MPa or N/mm²)
- P = Load-carrying capacity in Newtons (N)

MBT ET Series	ET10	ET12	ET16	ET20	ET25	ET32	E[illegible]
Bar Diameter (mm)	10	12	16	20	25	32	[illegible]
Bar Yield Strength (MPa)	500	500	500	500	500	500	5[illegible]

Varying Coupler Size and Capacity







Recommended Future Research
Finite Element Method Heat Transfer