Frattura ed Integrità Strutturale – Fracture and Structural Integrity

Visual Abstract

A Numerical Study on Predicting Bond-Slip Relationship of Reinforced Concrete using Surface Based Cohesive Behavior

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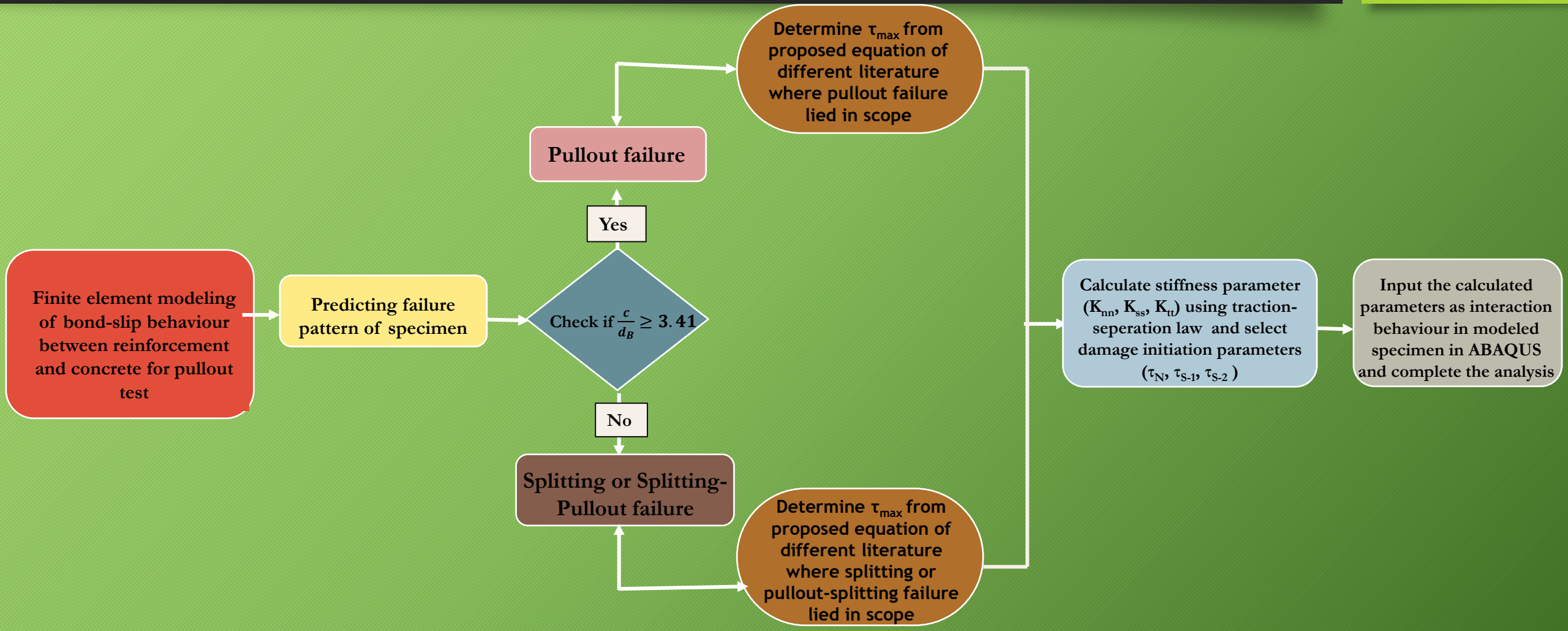
Objectives

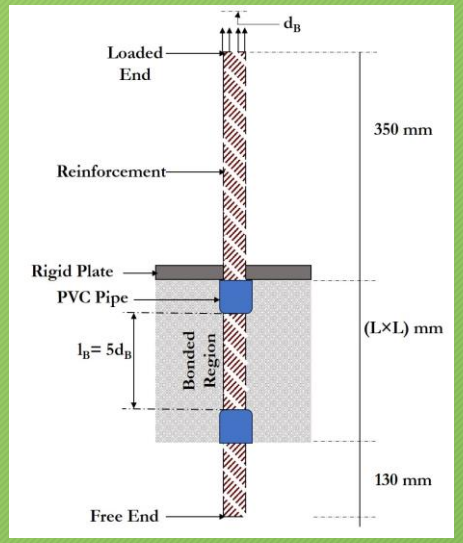
- To propose a well-defined FE modeling strategy in ABAQUS to predict the bond-slip relationship of reinforced concrete under the pullout test using surface-based cohesive behaviour as the interaction between reinforcement and concrete.

FINITE ELEMENT MODELLING STRATEGY

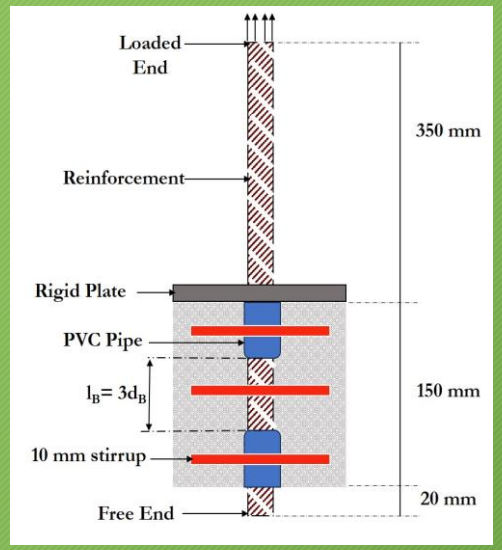


Finite Element Models of reference specimens

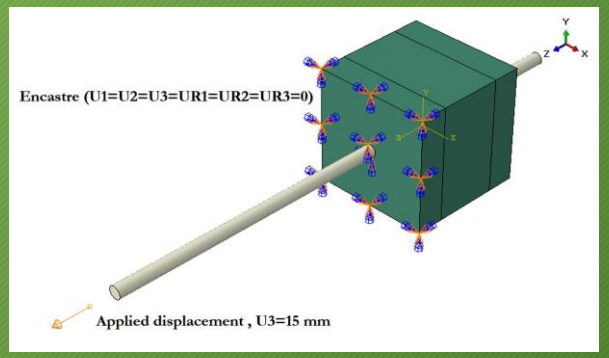
- Three specimens from Deng et al. [21] and one specimen from Tang and Cheng [12] have been selected as reference specimen to validate the proposed finite element modeling strategy with the experimental data.



Specimen E1R16, C1R20, E1R16-60 [21]



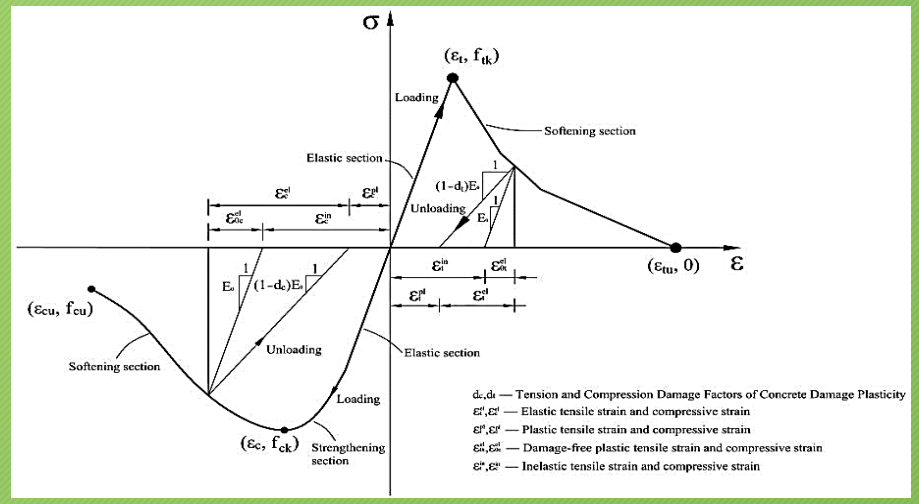
Specimen C20#8 [12]



Developed Finite Element Model

Finite Element Modeliing of reference specimens

- Material Model



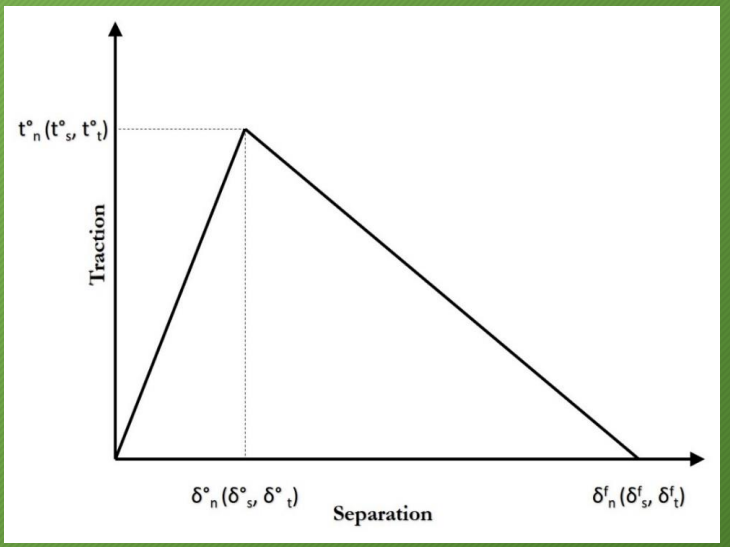
Concrete Damaged Plasticity Model for concrete

- Cohesive Surface Interaction Model

$$K_{ss} = K_{tt} = \frac{\tau_{max}}{s_1}$$

$$K_{nn} = 100K_{ss} = 100K_{tt}$$

$$\begin{Bmatrix} t_n \\ t_s \\ t_t \end{Bmatrix} = \begin{bmatrix} K_{nn} & 0 & 0 \\ 0 & K_{ss} & 0 \\ 0 & 0 & K_{tt} \end{bmatrix} \begin{Bmatrix} \delta_n \\ \delta_s \\ \delta_t \end{Bmatrix}$$



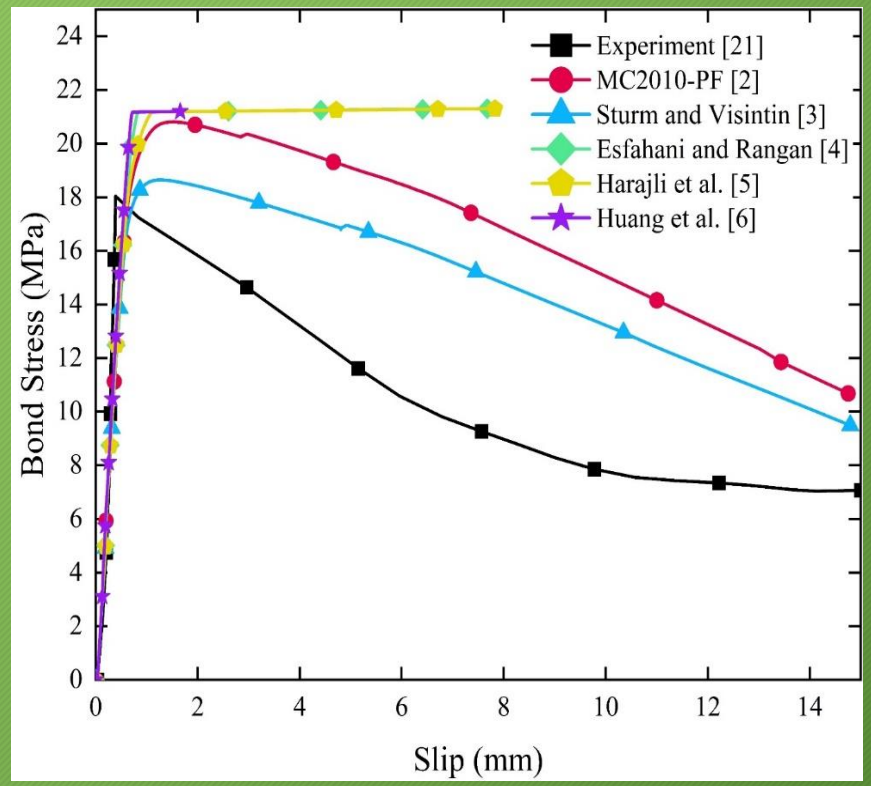
Traction separation Law for interaction of reinforcement and concrete

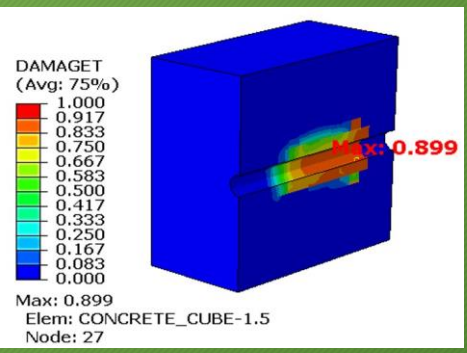
Results of Finite Element Analysis

- *Reference specimens expected to have pullout failure*

- The FEM developed using the analytical model by Strum and Visintin [3] showed the most accurate prediction, i.e., 96.7% accuracy in predicting maximum bond stress.

- In FE models developed using Model Code [2] and Strum and Visintin [3], failure was initiated by splitting followed by pullout failure.

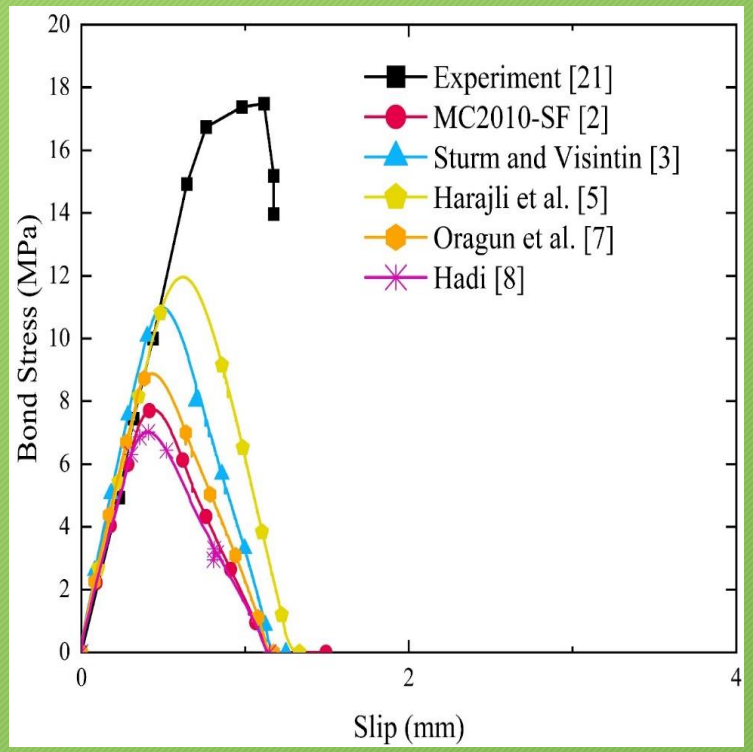




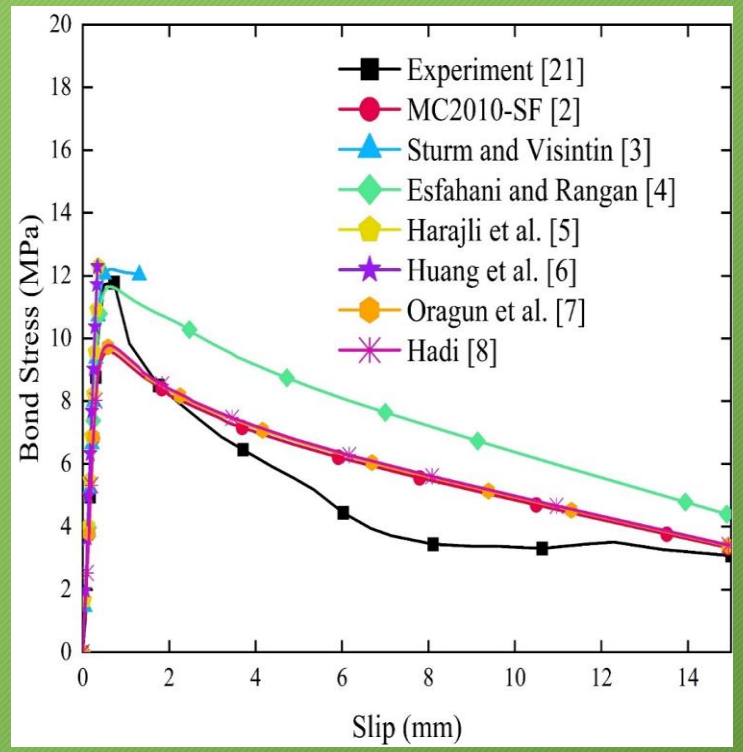
Pullout failure

Results of Finite Element Analysis

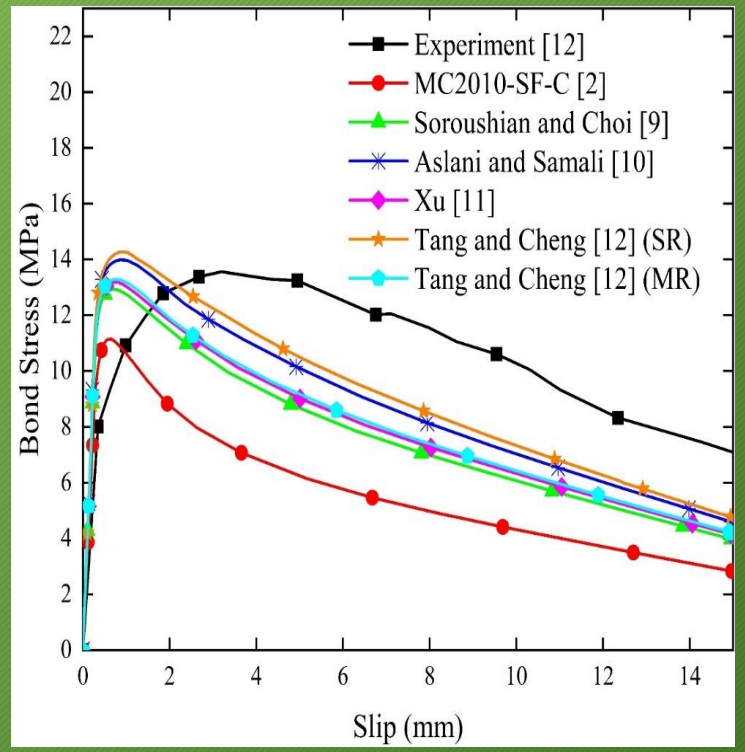
- *Reference specimens expected to have splitting or splitting-pullout failure*



Specimen C1R20



Specimen E1R16-60



Specimen C20#8

Conclusions

- The proposed finite element strategy and models have the capability to predict the bond-slip behavior in elastic regions accurately.
- The proposed finite element strategy and models showed satisfactory results regarding maximum bond stress for most of the reference pullout specimens, except for specimens (without confining reinforcement) that failed by splitting in reference experiment. FE models with analytical models of Sturm and Visintin [3], Esfahani and Rangan [4], and Tang and Cheng [12] have predicted maximum bond stress with 96.7%, 99.7%, and 97.9% accuracy when compared to experimental results.
- The developed FE models captured the crack propagation and failure mechanisms of reinforcement and concrete under the pullout test satisfactorily.