TENSILE CAPACITIES of CFRP ANCHORS

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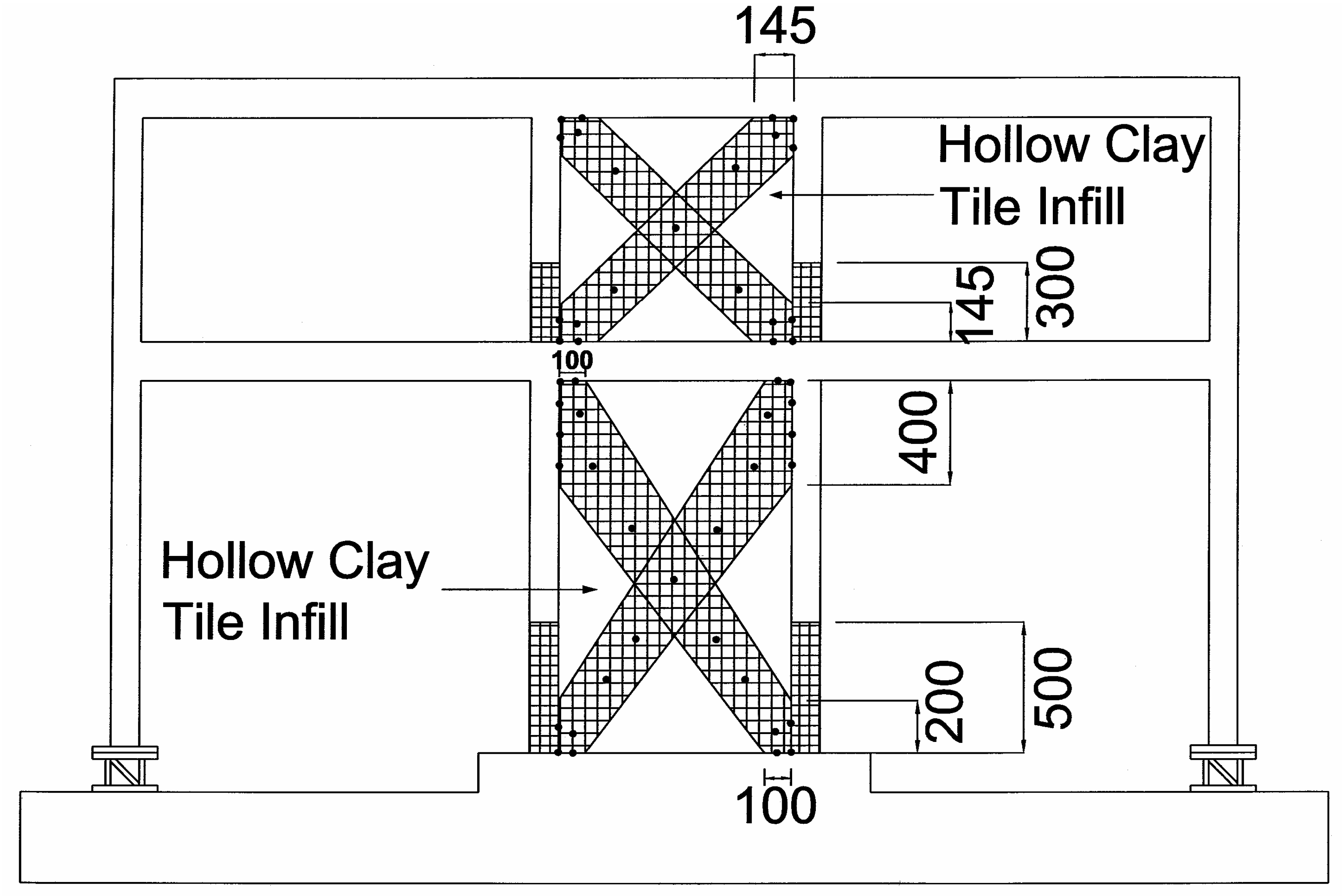
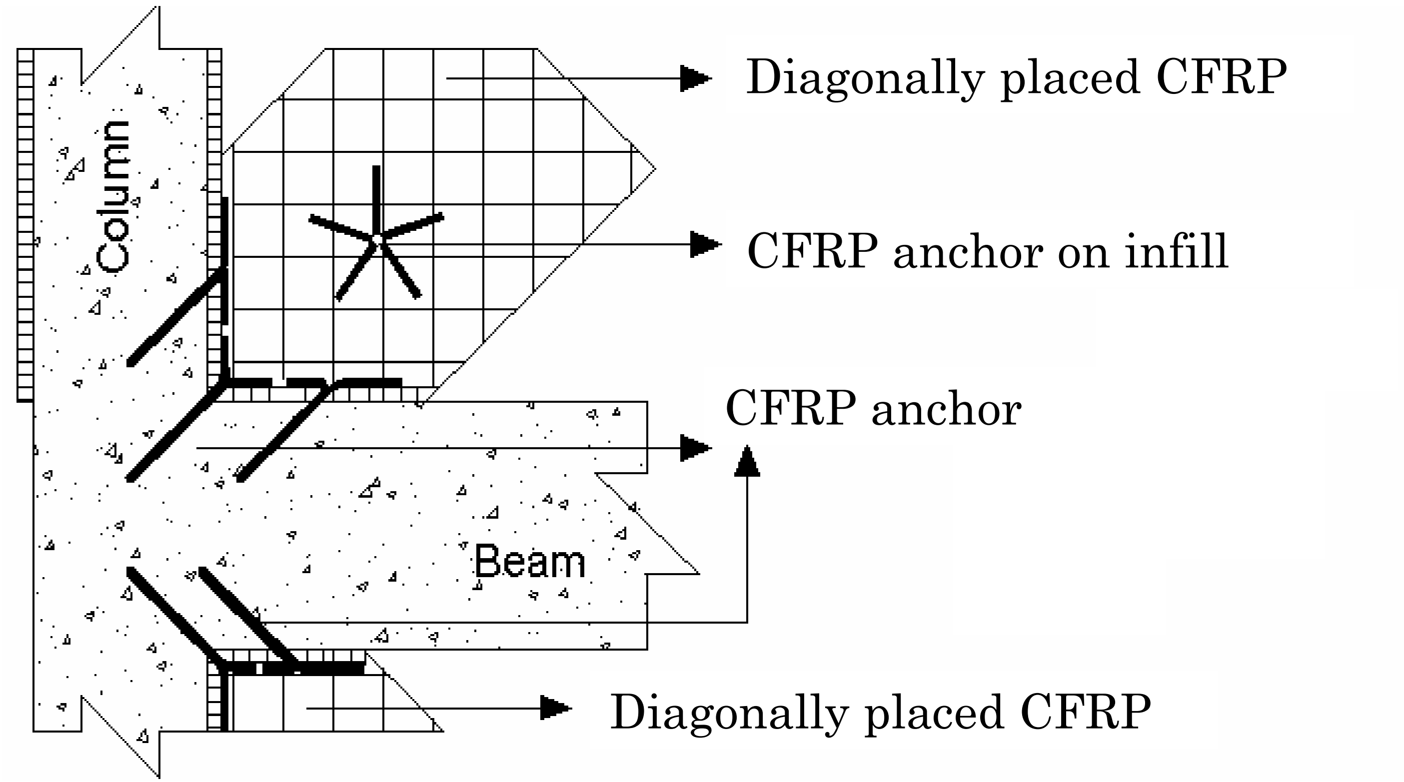
NATO SfP 977231 - SEISMIC ASSESSMENT AND REHABILITATION OF EXISTING BUILDINGS

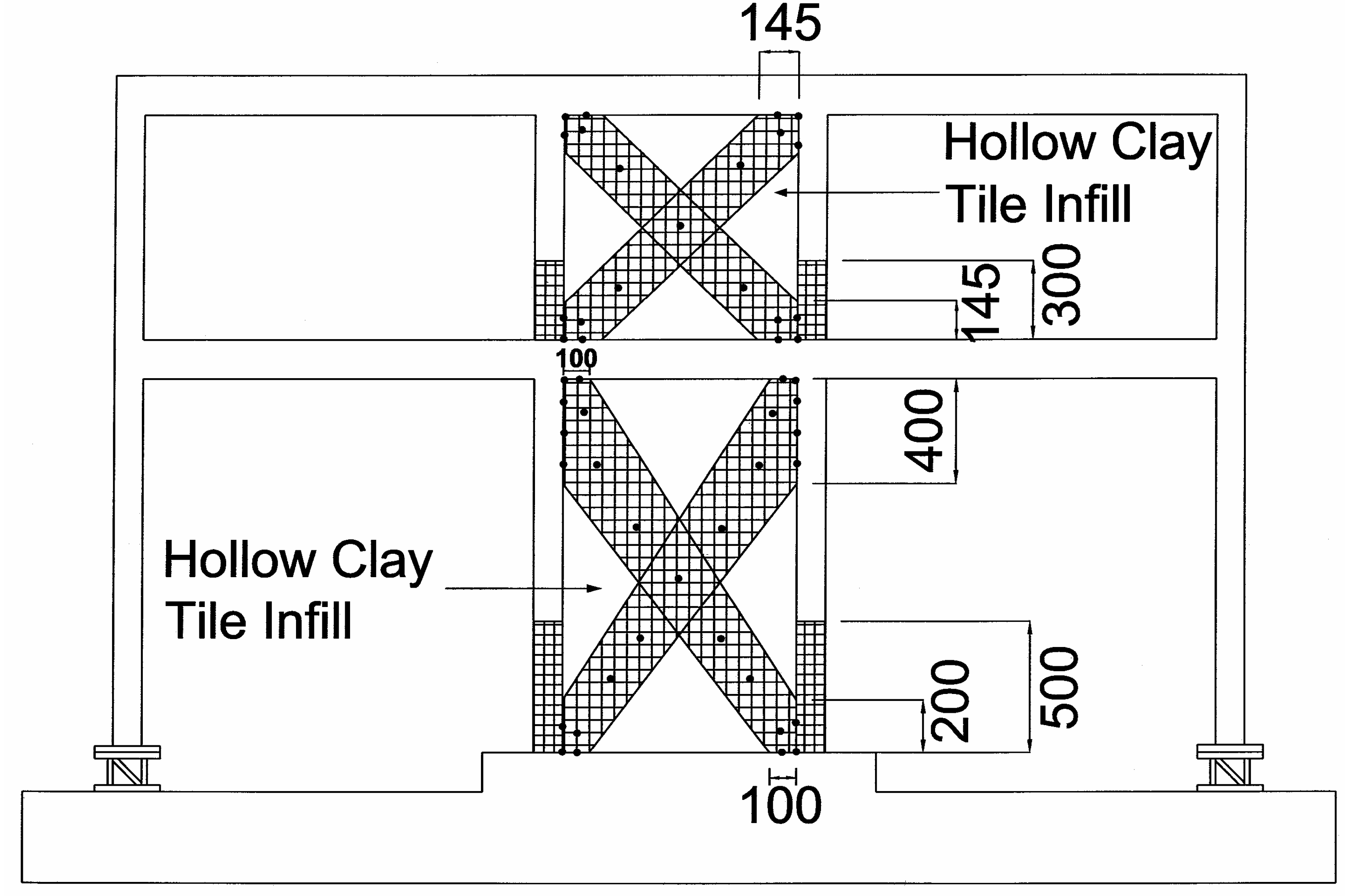


CONNECTION DETAIL



Taken from Erdem et al 2004

NATO SfP 977231 - SEISMIC ASSESSMENT AND REHABILITATION OF EXISTING BUILDINGS



WHY CFRP ANCHORS ?

- The most remarkable conclusion drawn from previous experimental studies is the importance of the CFRP anchors in the effectiveness of the strengthening with CFRP sheets.

CFRP anchors must be designed properly.

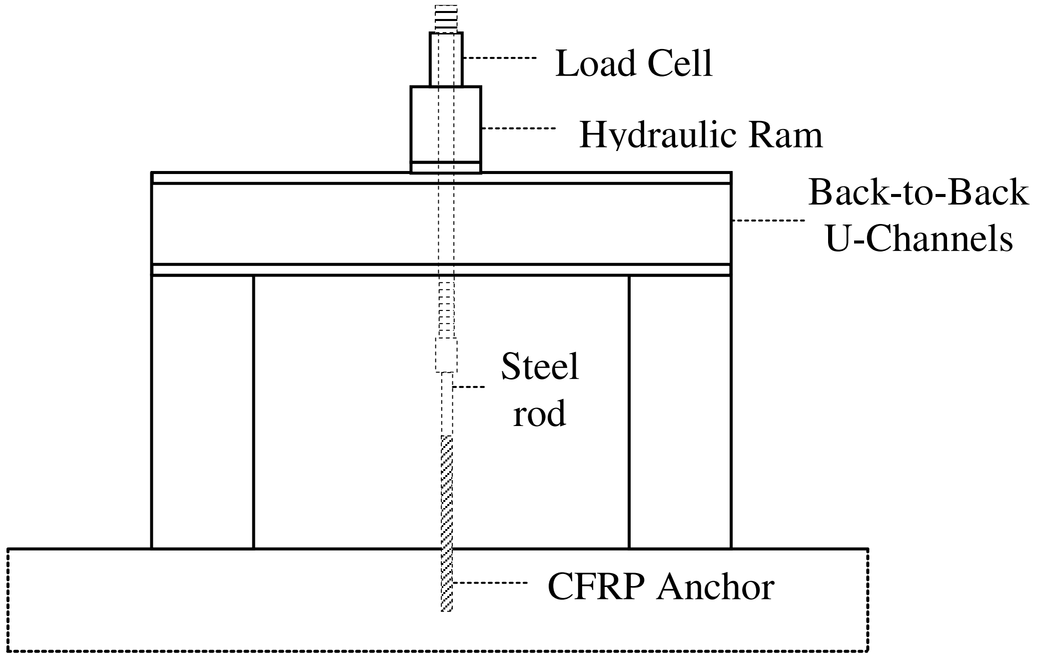
OBJECTIVE

- **To determine the direct tensile capacities of the CFRP anchors.**

PARAMETERS

- Compressive strength of concrete (10 MPa, 16 MPa, 20 MPa)
- Embedment depth of CFRP anchors (50 mm, 70 mm, 100 mm, 150 mm)
- Anchor hole diameter (12 mm, 14 mm, 16 mm, 20 mm)
- CFRP sheet width (80 mm, 120 mm, 160 mm)

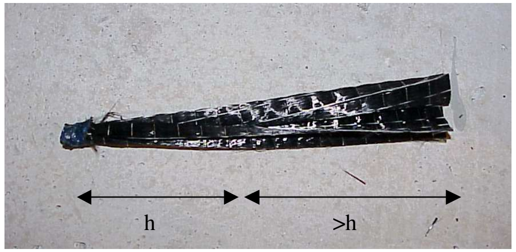
TEST SETUP



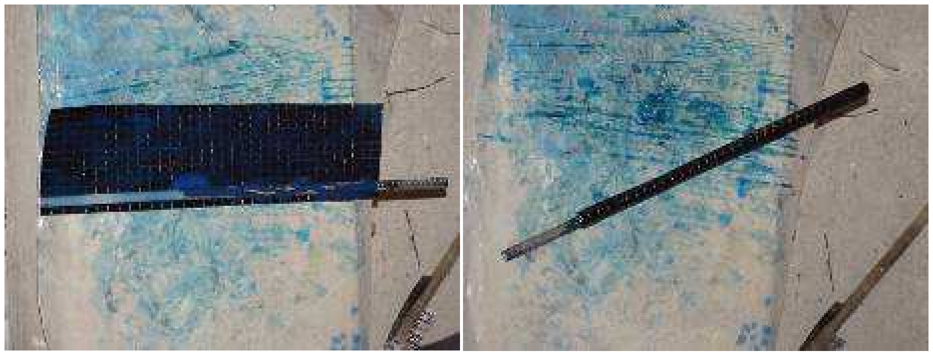
Load Cell
Hydraulic Ram
Back-to-Back U-Channels
Steel rod
CFRP Anchor

TEST ELEMENTS

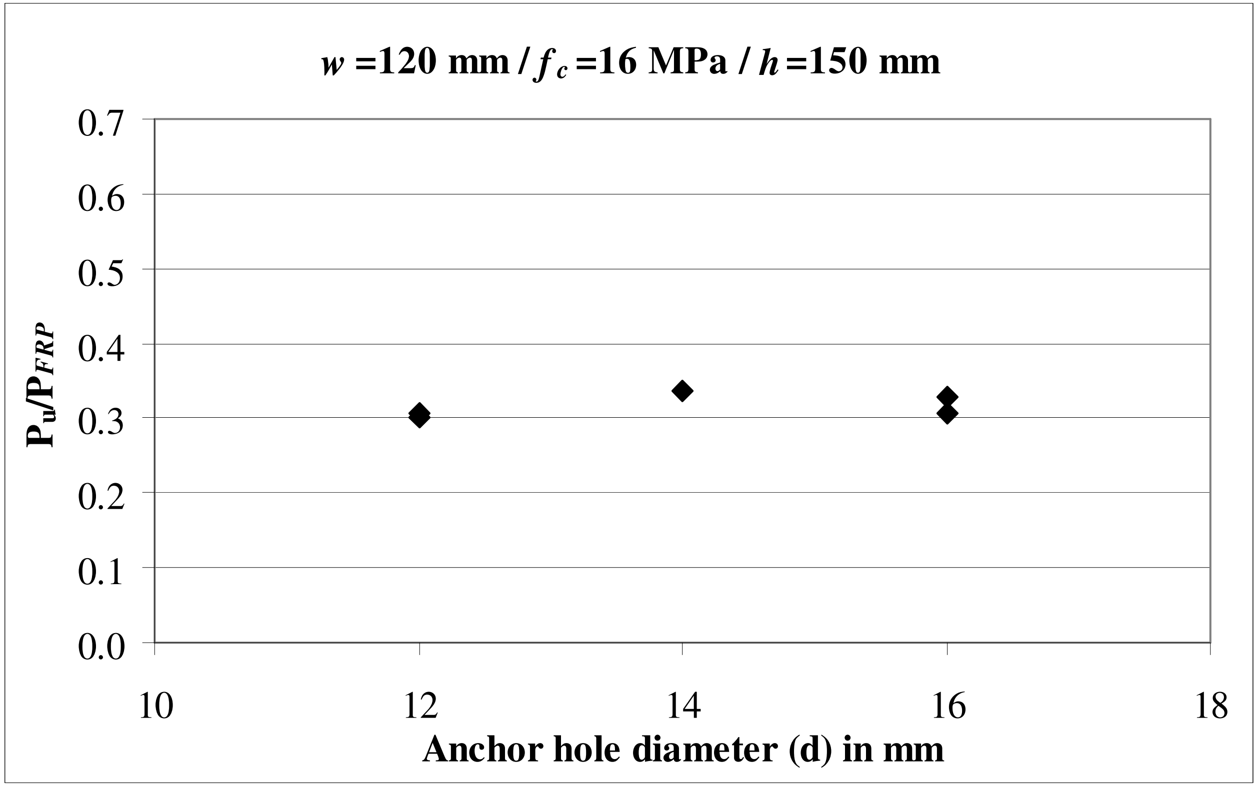
- Type-1 anchors



- Type-2 anchors

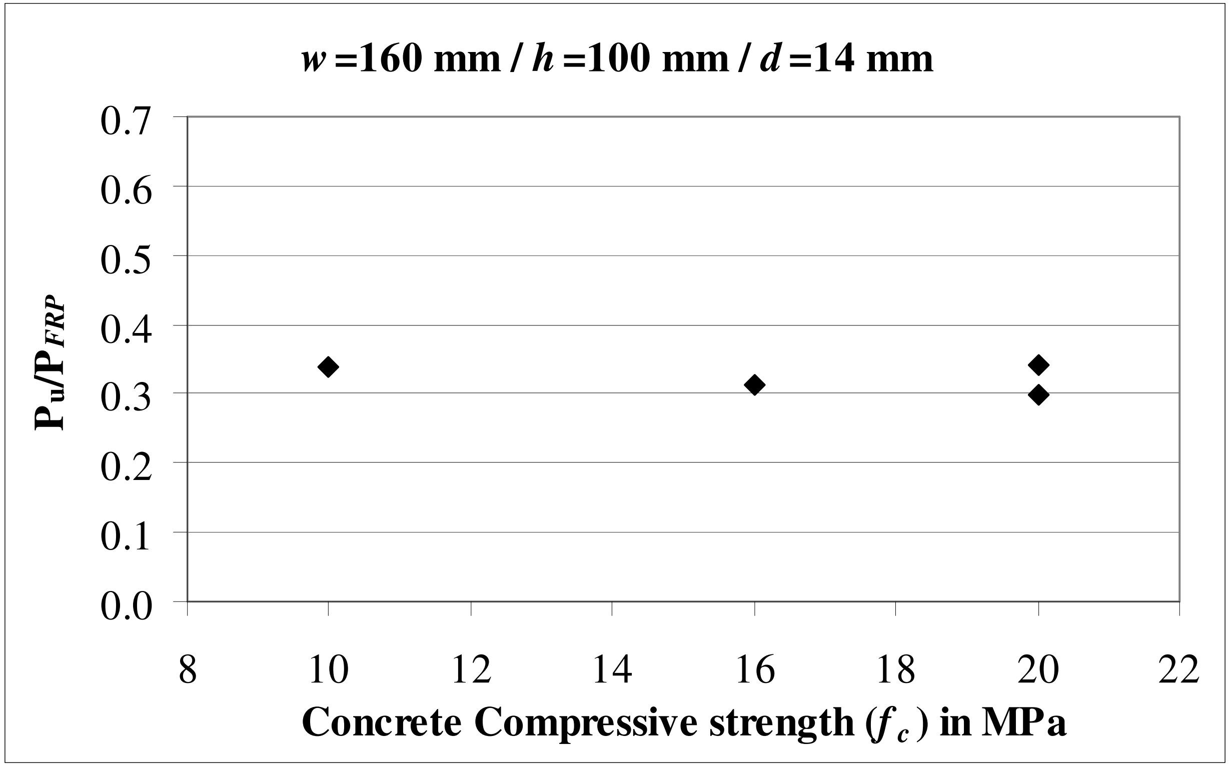


EFFECT of HOLE DIAMETER (Type-1 anchors)

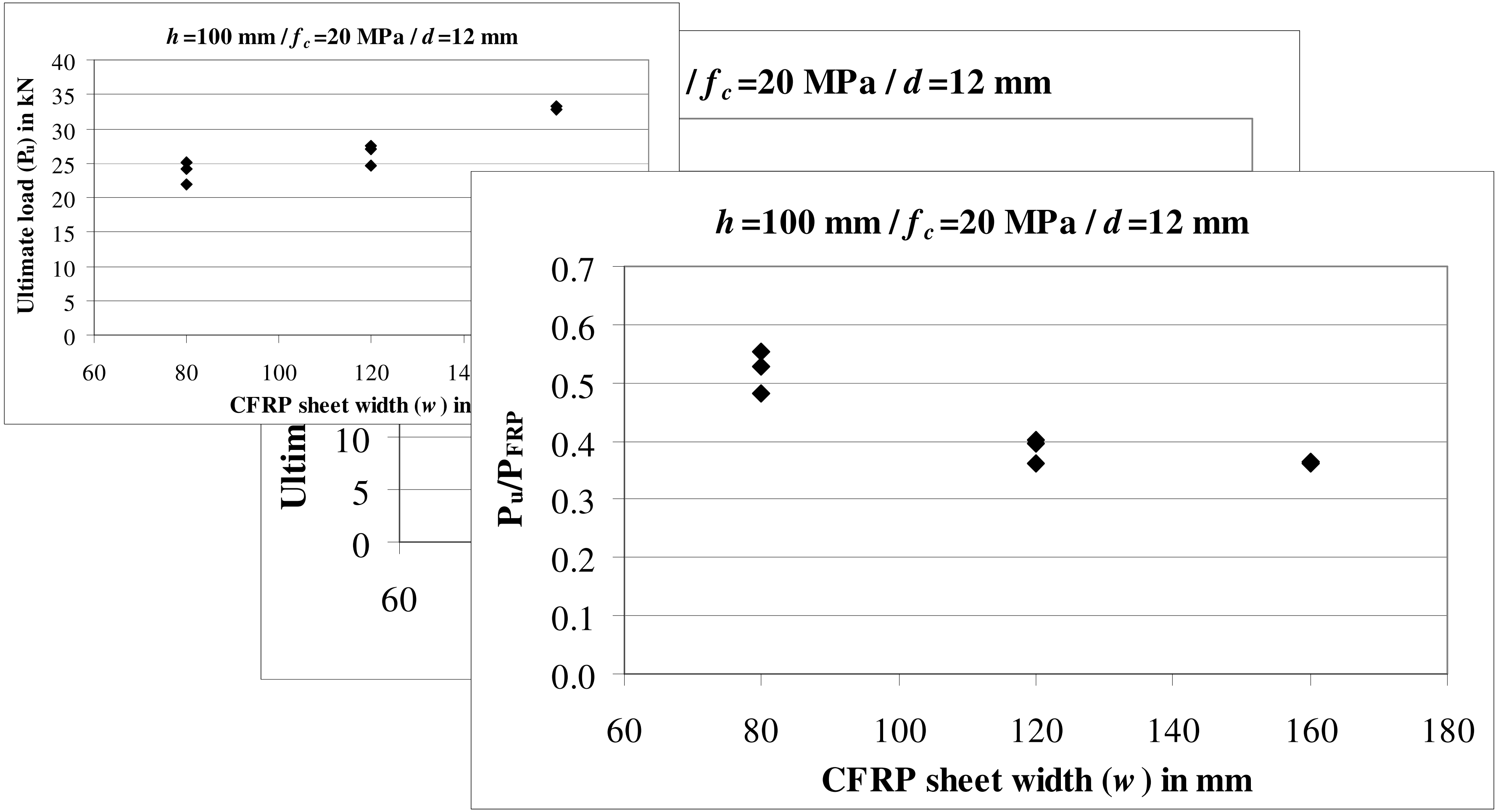


$$P_{FRP} = w \times t \times f_u$$

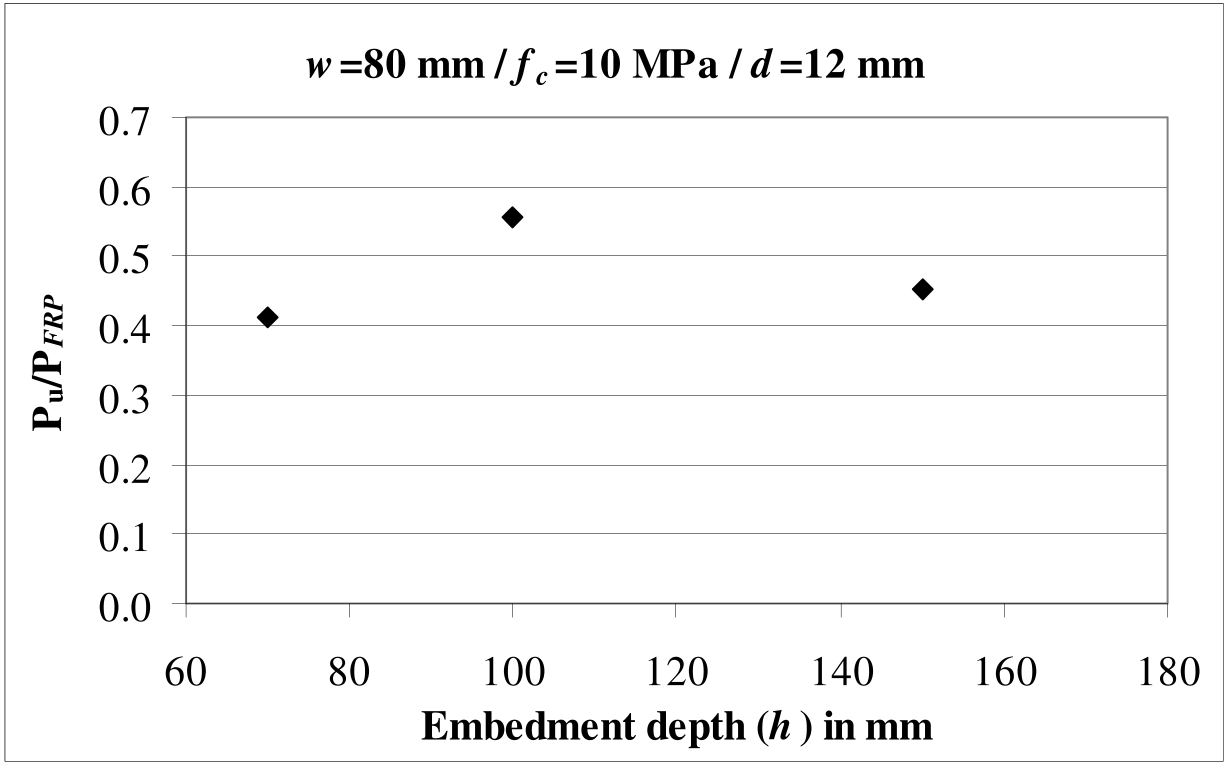
EFFECT of COMPRESSIVE STRENGTH (Type-1 anchors)



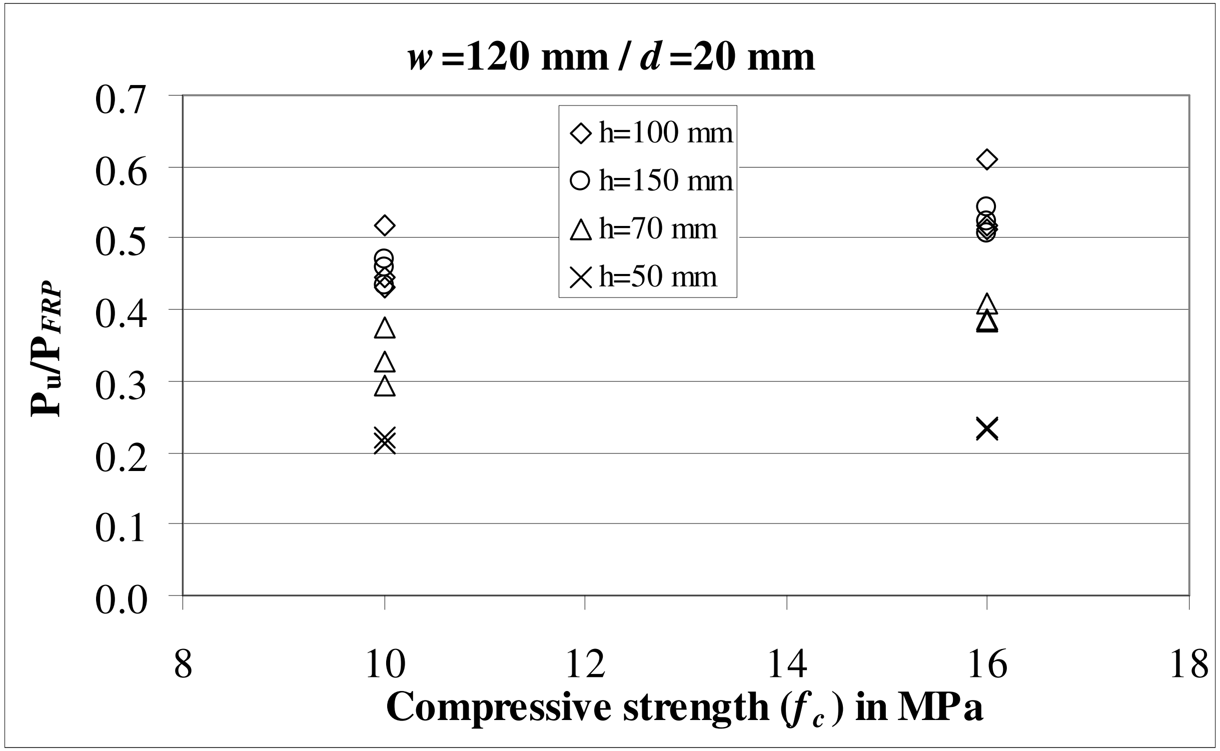
EFFECT of CFRP SHEET WIDTH (Type-1 anchors)



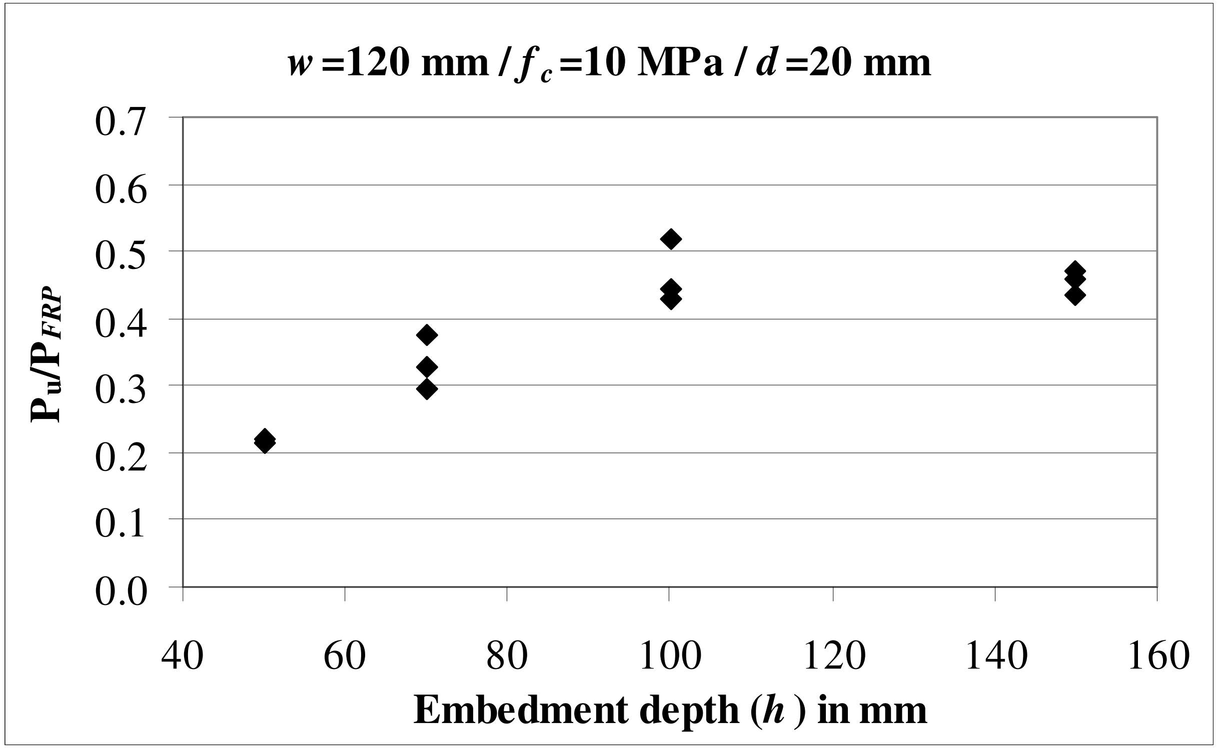
EFFECT of EMBEDMENT DEPTH (Type-1 anchors)



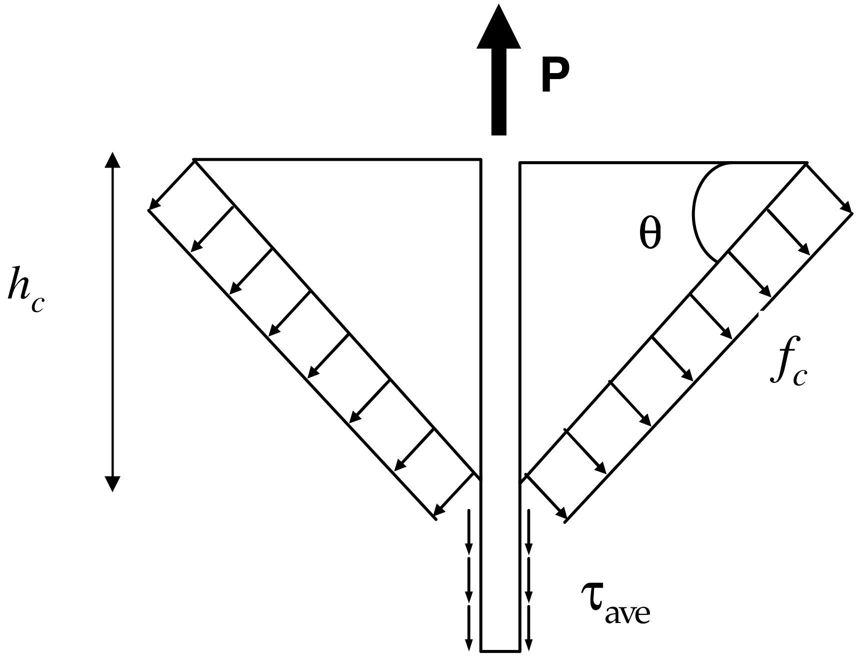
EFFECT of COMPRESSIVE STRENGTH (Type-2 anchors)



EFFECT of EMBEDMENT DEPTH (Type-2 anchors)



ADHESIVE ANCHOR MODEL (Cook et. al. 1993)



$$h_c = \frac{\tau_{ave}\pi d}{1.84\sqrt{f_c}}$$

$$P_u = 0.92h_c^2\sqrt{f_c} + \tau_{ave}\pi d(h - h_c)$$

h_c = concrete cone depth

τ_{ave} = average bond strength

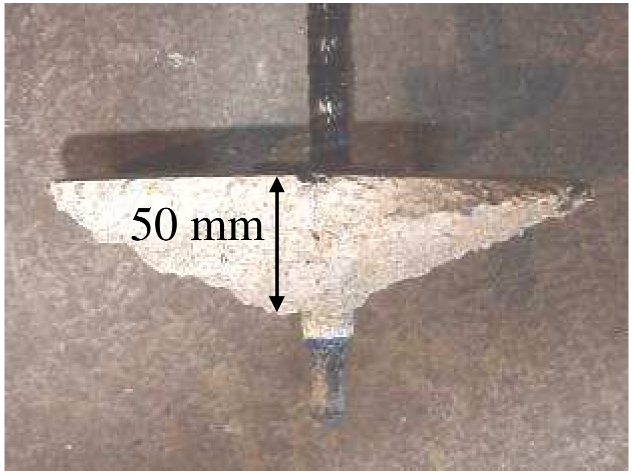
d = outer diameter of the anchor

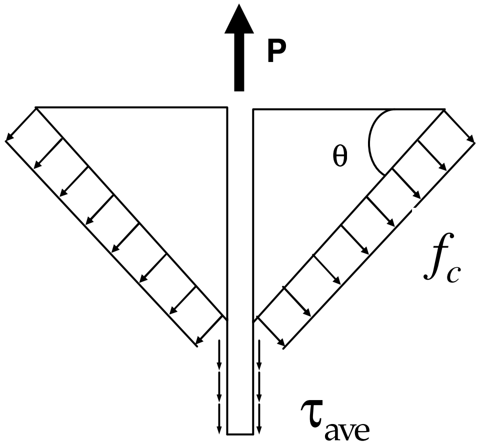
f_c = compressive strength of concrete

h = embedment depth of anchor

P_u = ultimate tensile load of the anchor

PREDICTION of TENSILE CAPACITY of CFRP ANCHOR

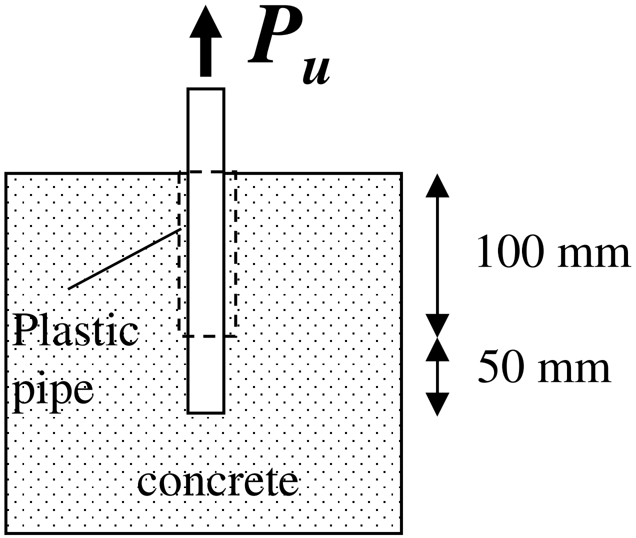




$$P_u = 0.33\sqrt{f_c}\left(d + \frac{h}{\tan\theta}\right)\frac{\pi h}{\sin\theta} \qquad h < 50mm$$

$$P_u = 0.33\sqrt{f_c}\left(d + \frac{50}{\tan\theta}\right)\frac{\pi \times 50}{\sin\theta} + \tau_{ave} \times \pi d \times (h - 50) \qquad h > 50mm$$

To FIND τ_{ave}



Partially bonded pullout tests

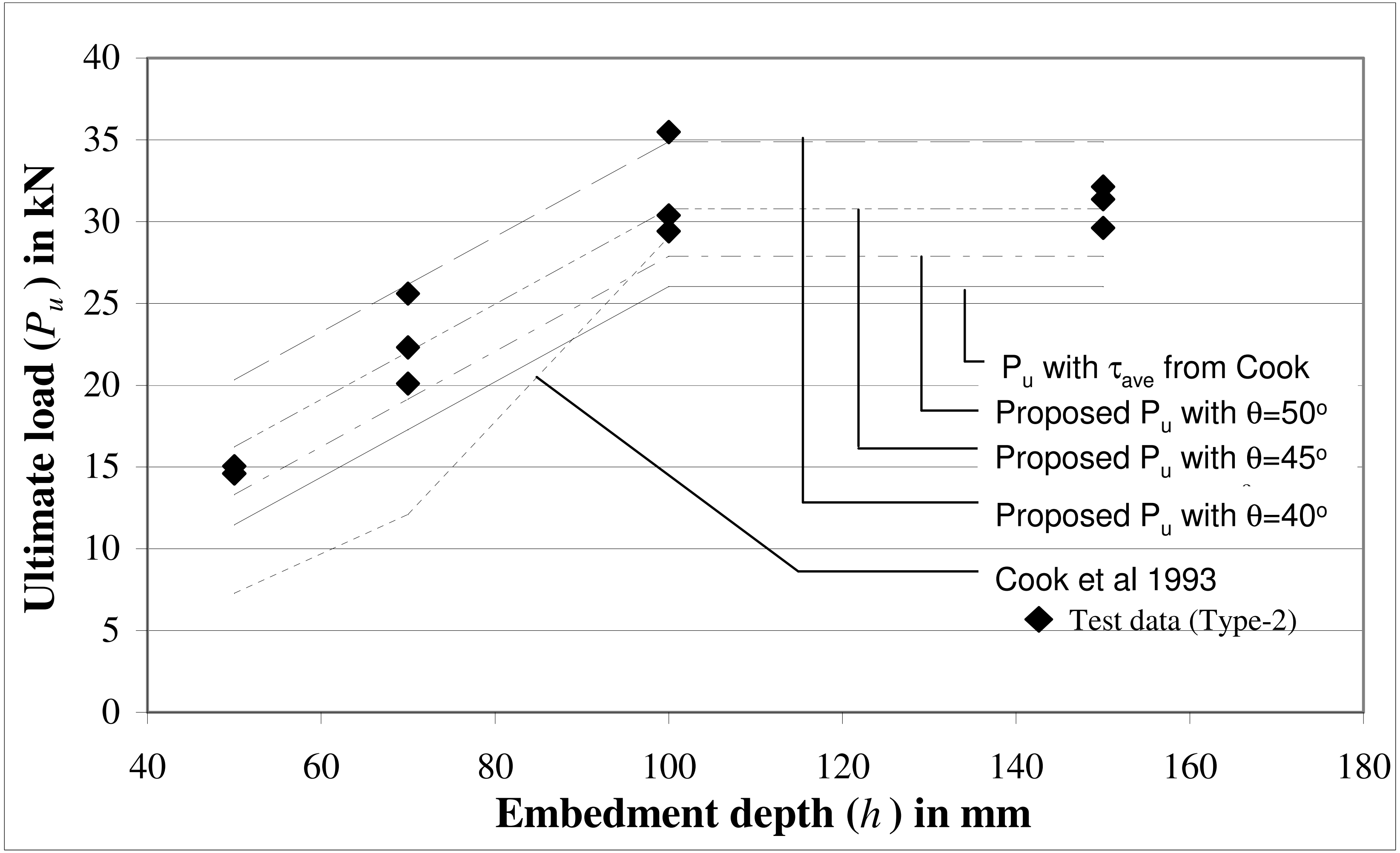
$$P_u = \tau_{ave} \pi d h_{ef}$$

$$\tau_{ave} = \frac{P_u}{\pi d h_{ef}}$$

d= anchor hole diameter

h_{ef}= unbonded length

COMPARISON of PREDICTION METHODS



CONCLUSIONS

- For a proper bond there should be at least 2-3 mm free space between structural element and anchor dowel.
- Increase in load capacities is proportional with the CFRP sheet width, but not linearly.
- As the embedment depth increases, the effect of concrete compressive strength becomes more significant.

CONCLUSIONS

- Effective bond length appears to be 100 mm.
- The model suggested by Cook et. al. 1993 gives almost the same results for only 100 mm embedment depth. This model is far away from being representative for other embedment depths.
- Proposed ultimate load capacity (P_u) gives the best prediction with 45^o crack angle. But it must be checked with different test results.

Thank you ...