

Performance of inclined self-tapping screw :

Effect of the thin wood part in inclined screw connection on shear and withdrawal resistance

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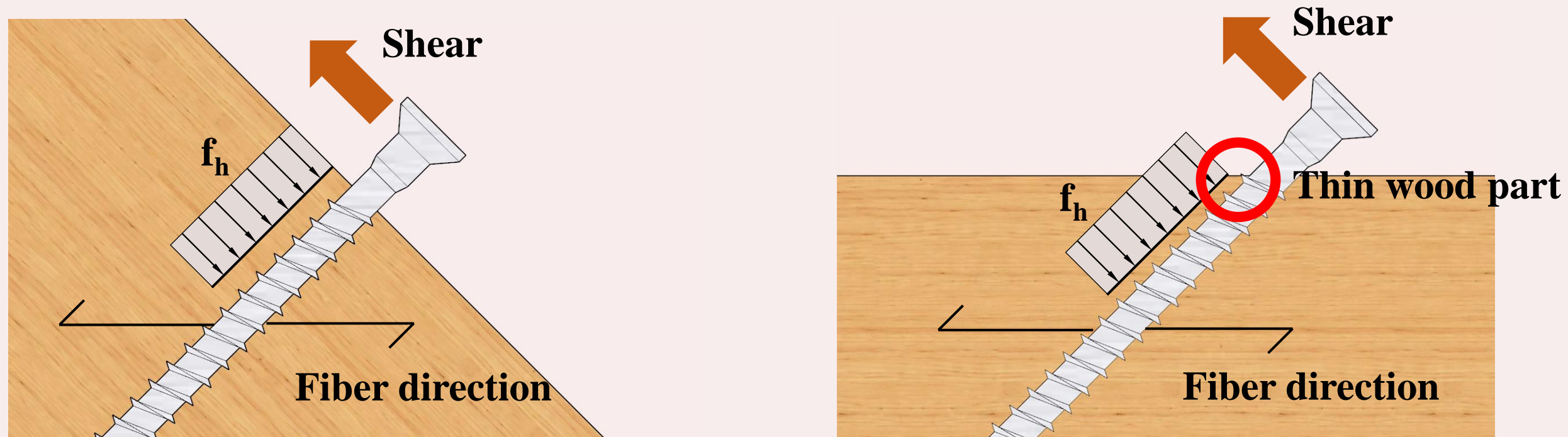
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Introduction

○ Necessity of study

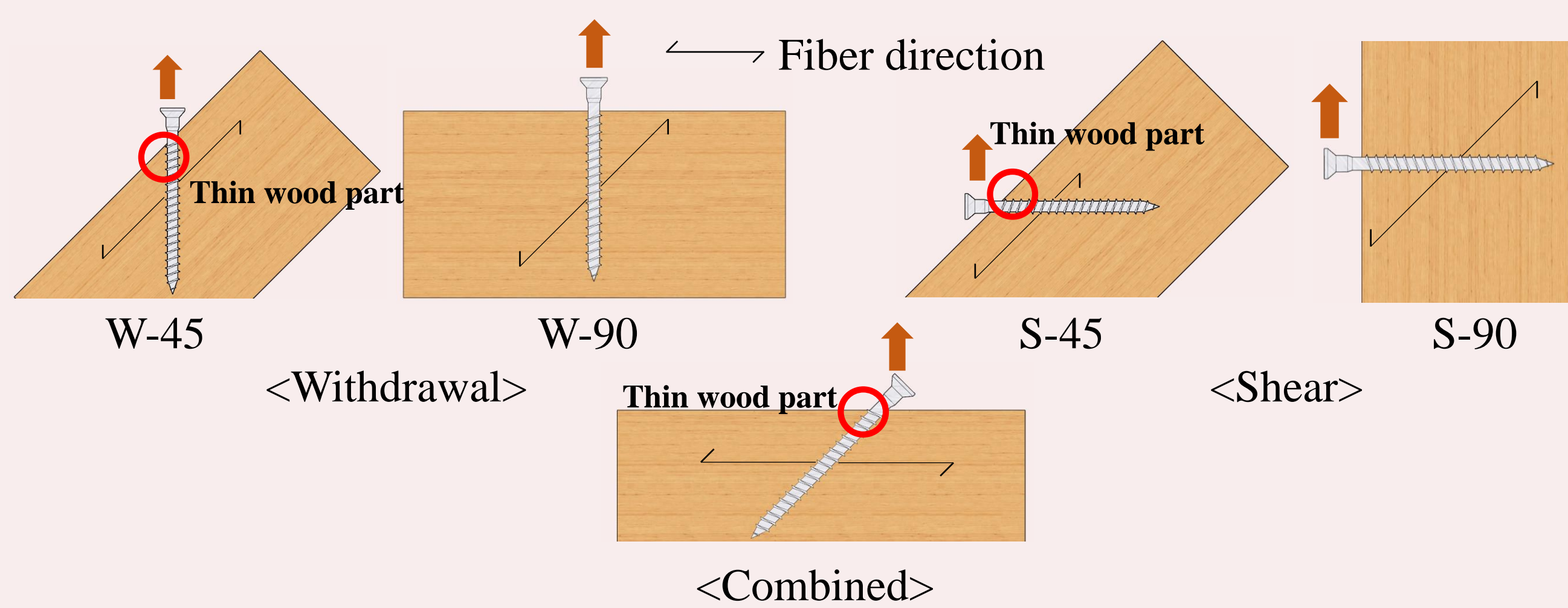
- Mid- / High-rise timber buildings
- Growing Importance of connection performance

○ Thin wood part and inclined self-tapping screw



- In EN 1995-1-1, design formula for shear capacity is for screws installed perpendicular to timber surface (Left)
- When screw is installed inclined to the surface, thin wood part above the screw is not likely to give sufficient embedment strength (Right)

○ In this study



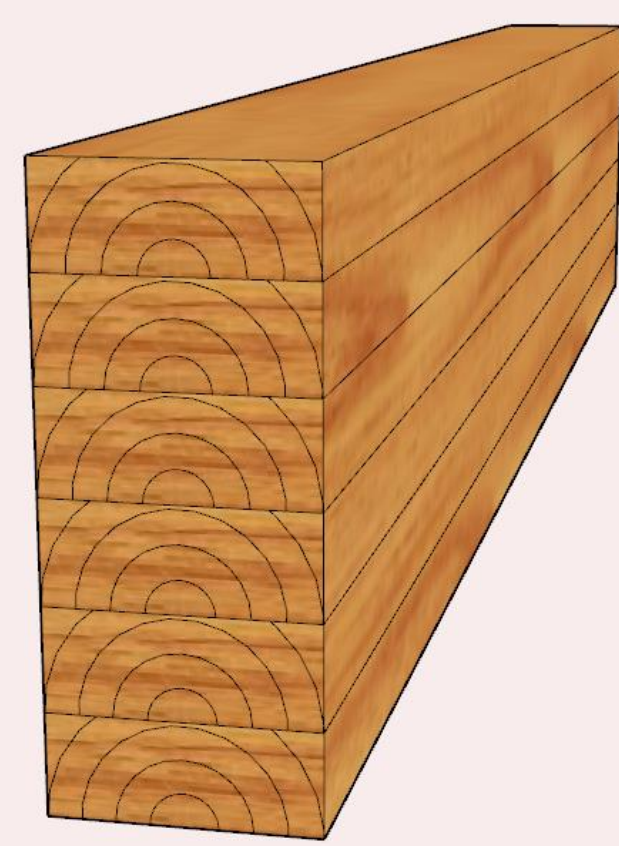
- Examine the effect of thin wood part on withdrawal, shear capacity
- Investigate conservativeness of EN 1995-1-1 through combined test

Materials and Methods

○ Materials

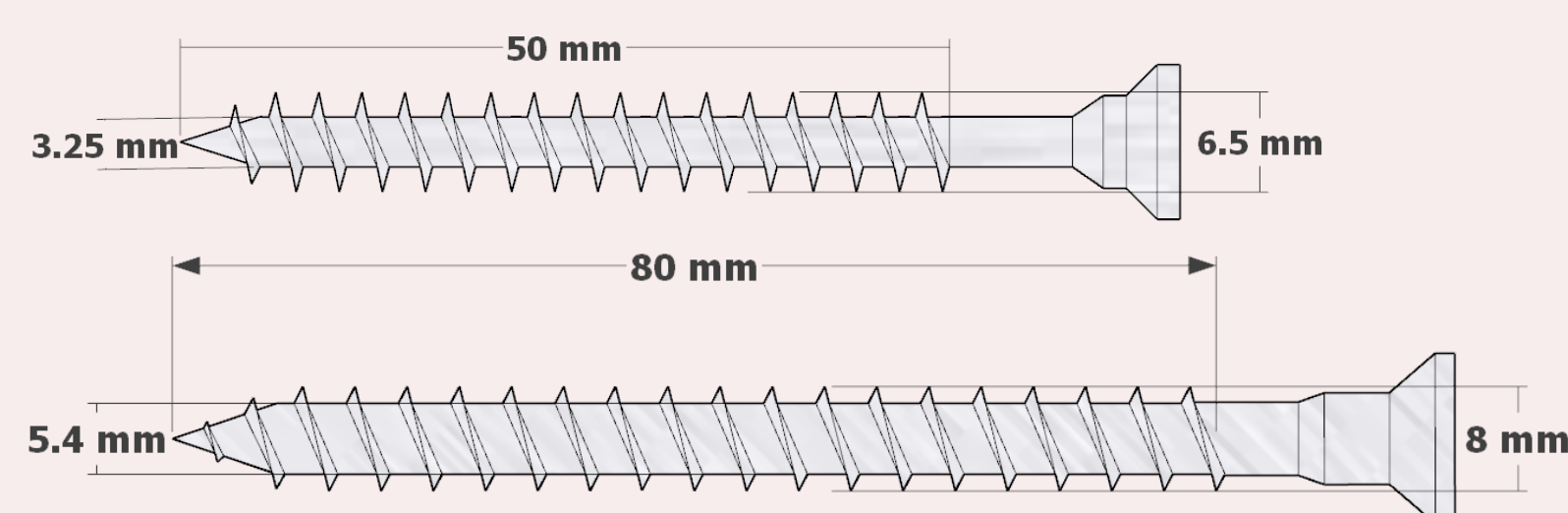
<GLT>

- Six layer glued-laminated timber
- Grade : 10S-30B (KDS 41 33 05)
- Species : *Pinus densiflora*
- Characteristic Density : 428.16 kg/m³
- Moisture Content : 10% (±2)



<Self-tapping screws>

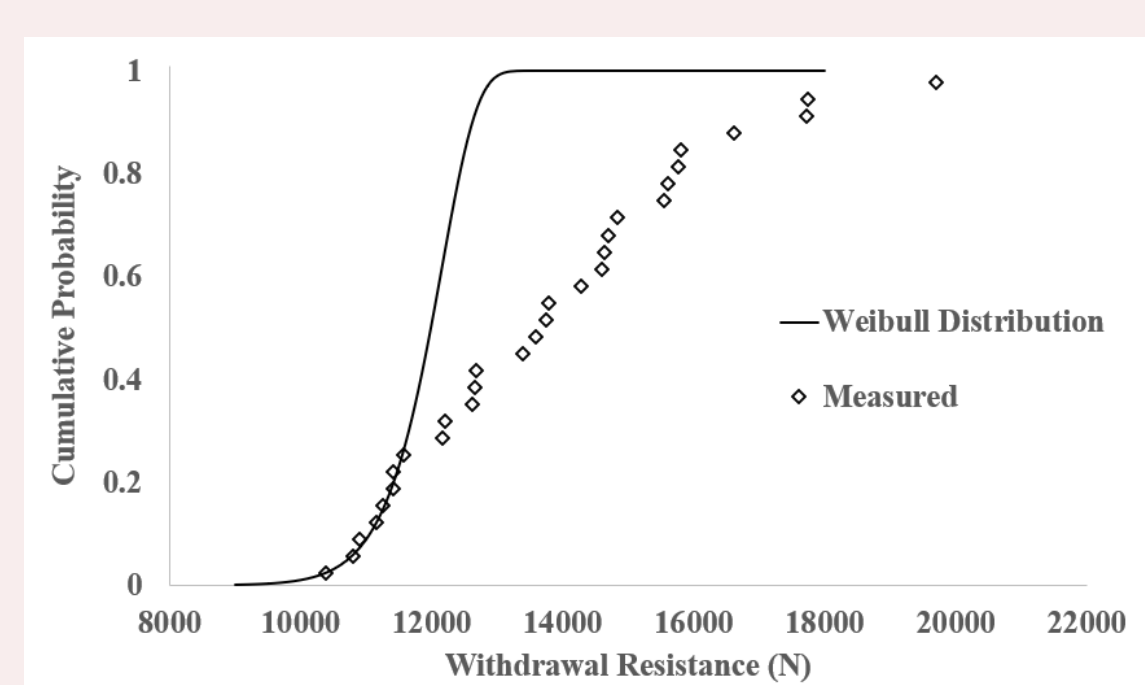
- SHERPA special screws 6.5 x 65 mm, 8.0 x 100 mm



○ Methods

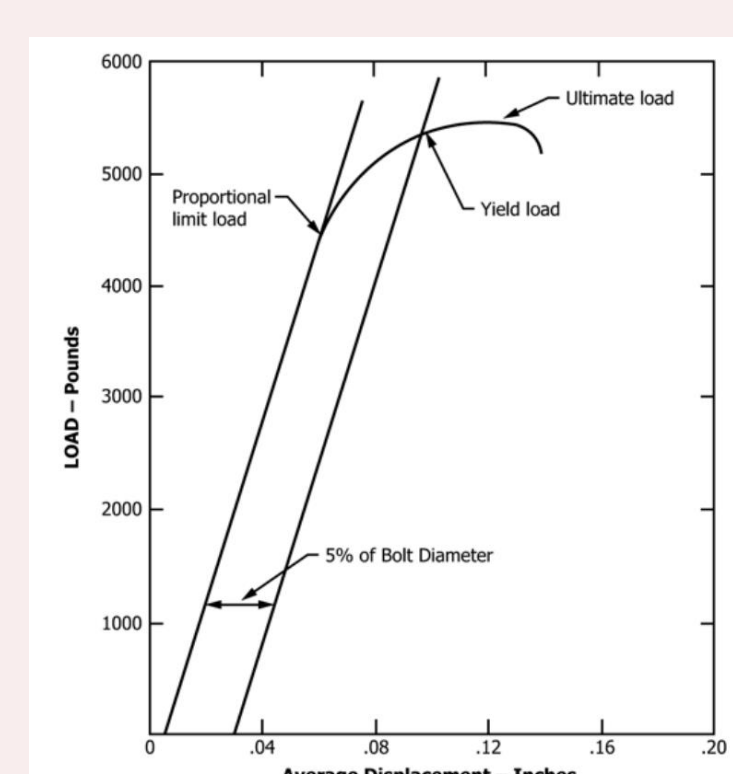
<Withdrawal, Combined tests>

- Ultimate load
- Weibull Distribution
- 20% Lower tail fit
- 5th Percentile value
- 30 tests for each type



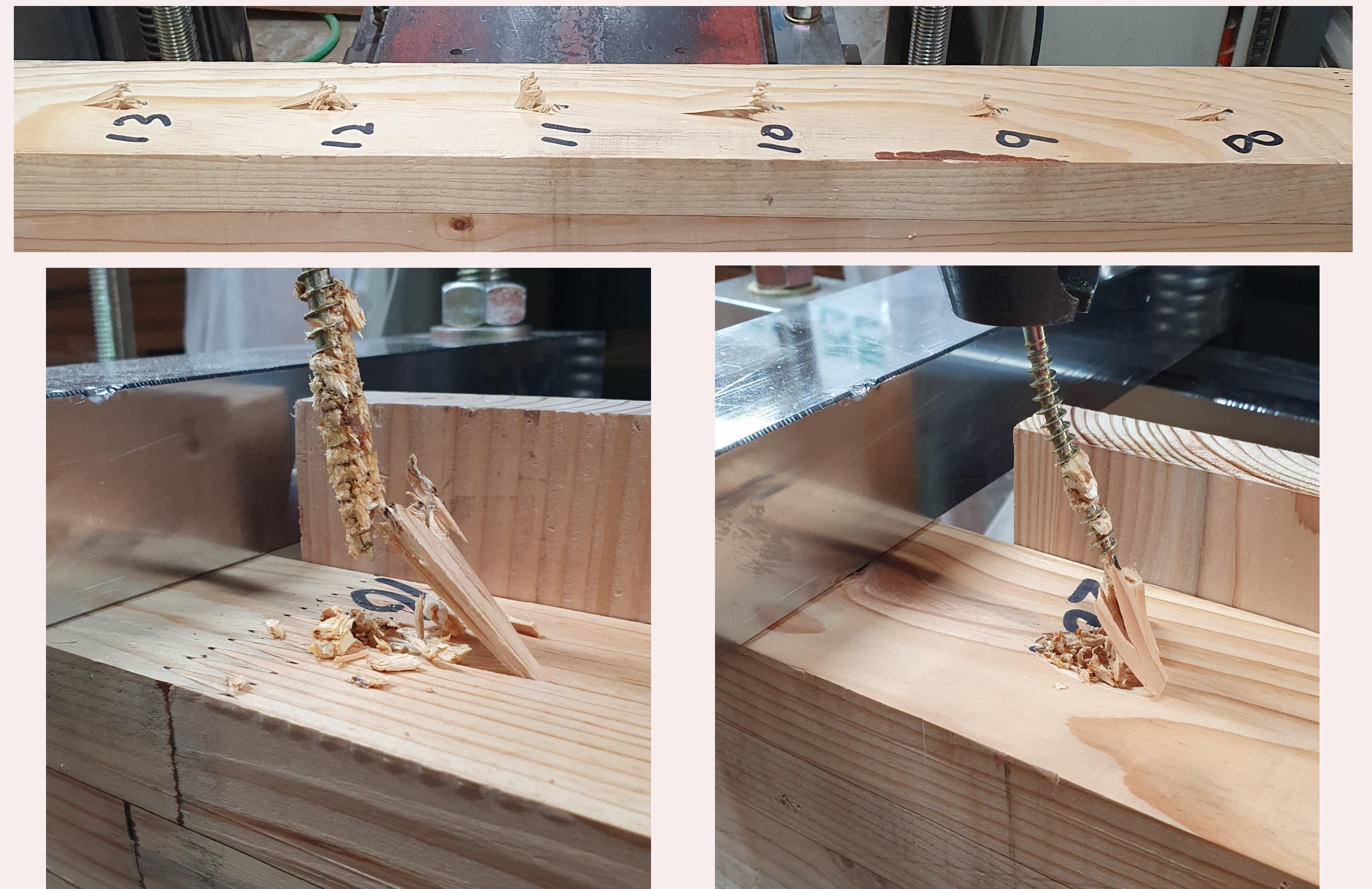
<Shear tests>

- Yield load
- 0.05d offset (ASTM D5652)
- Mean value
- 10 tests for each type



Results and discussion

○ Failure Modes in combined test



Failure of thin wood part was observed

○ Experimental Results

<Effect of thin wood part on withdrawal capacity>

Screw	Type	Capacity (N)	Difference (%)
Ø6.5x65	W-45°	5940.15	3.93
	W-90°	5711.29	
Ø8.0x100	W-45°	10759.15	0.35
	W-90°	10721.20	

- Withdrawal capacity showed relatively little differences

<Effect of thin wood part on shear capacity>

Screw	Type	Capacity (N)	Difference (%)
Ø6.5x65	S-45°	700.64	54.63
	S-90°	1227.25	
Ø8.0x100	S-45°	2326.77	21.85
	S-90°	2897.47	

- Shear capacity showed larger differences, which indicates that thin wood part affected shear capacity of self-tapping screw

<Conservativeness of EN 1995-1-1>

Screw	Type	Capacity (N)	Safety
Ø6.5x65	Measured	4276.81	Safe
	EN Prediction	3372.89	
Ø8.0x100	Measured	8966.90	Safe
	EN Prediction	6433.00	

- Even though there is no consideration about thin wood part, EN design code showed conservative prediction results
- However, to maximize the accuracy of inclined screw design, consideration of thin wood part effect seems to be required

Conclusions

- Thin wood part affected little on the withdrawal capacity (0.35%/3.93%)
- Thin wood part affected relatively large on the shear capacity (21.85%/54.63%)
- EN 1995-1-1 showed conservative results, despite the lack of consideration on the thin wood part in design code
- Decrement of the shear capacity due to thin wood part was observed, so consideration of the thin wood part in self-tapping screw formula is required to make a precise design