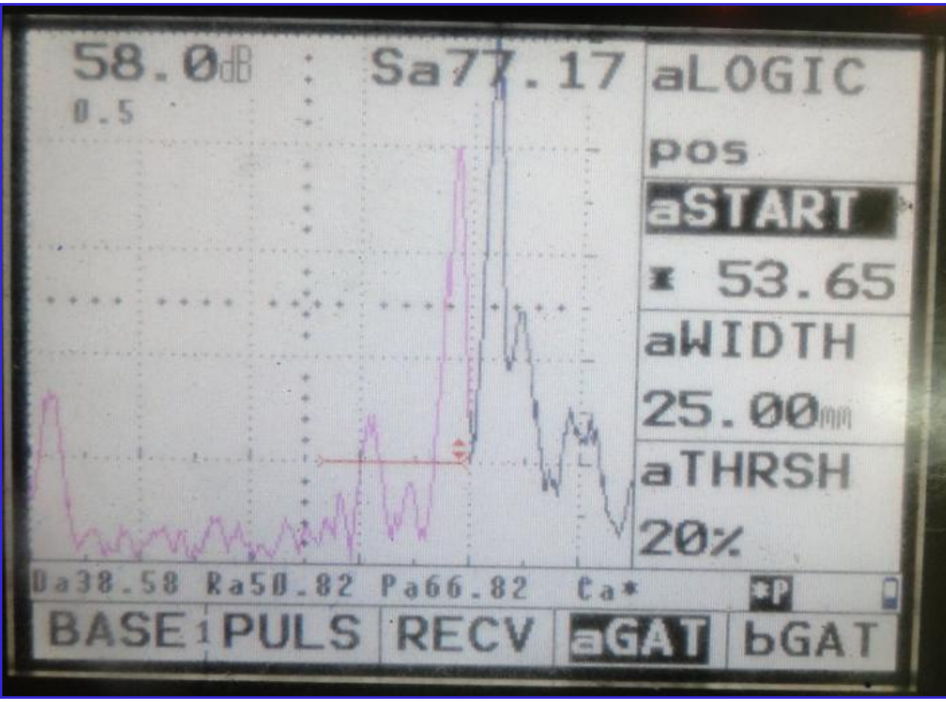
UT on small bore (6" & 8") cladded piping weld



Presented by

R.Baskar, AMIE (Mech)

ASNT NDT Level III RT,UT,PT & MT

CSWIP 3.2

AWS – SCWI

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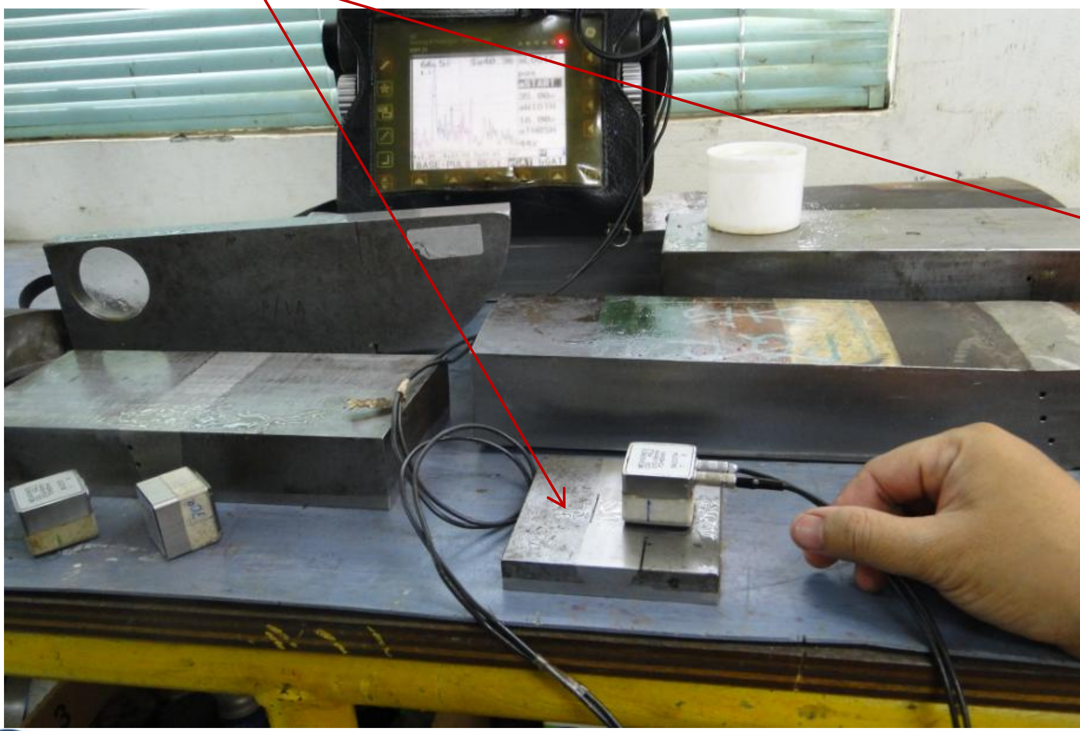
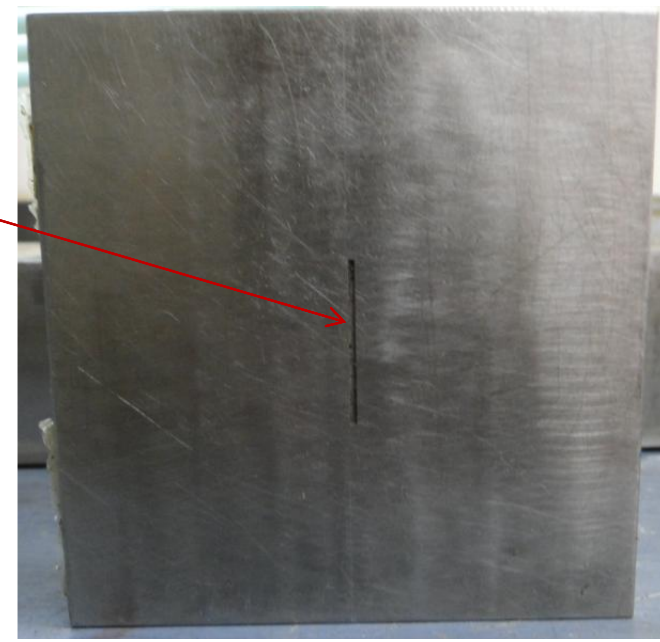
vetcogray
a GE Oil & Gas business

Analysis consideration

Checked with DNV scope weld register and noticed 6" diameter hub to pipe weld connection as worst case and analysis based on 6" x 22.8 / 18.0 mm WT

Used 15 mm flat reference cladded block with 1mm width x 1mm depth x 25mm long notch





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Inherent problem

Inherent problem of using UT on small wall thickness with angled compressional wave probe

1) **45° probe hits base material, and not reaching root weld region.**

2) **70° probe is not suitable for root scanning because shear wave response from back surface appears before longitudinal wave response appears in the CRT screen**

3) **In case of 60° probe both the waves are almost close / merge together and not covering far distance of other side fusion face and HAZ**

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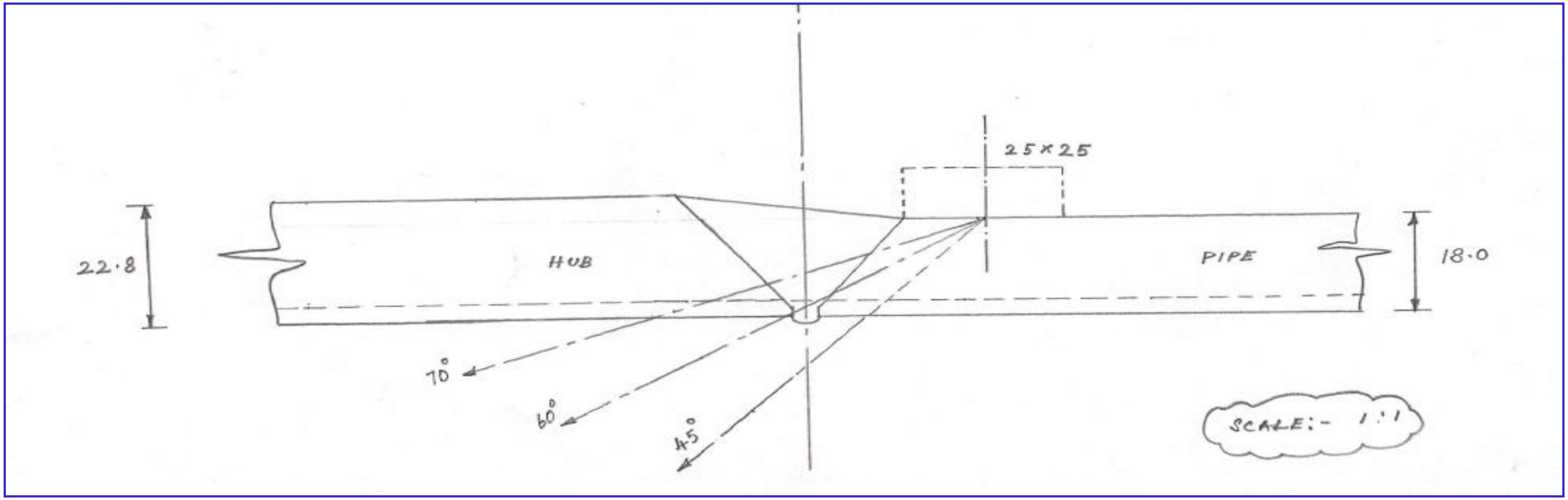
Inherent problem -1

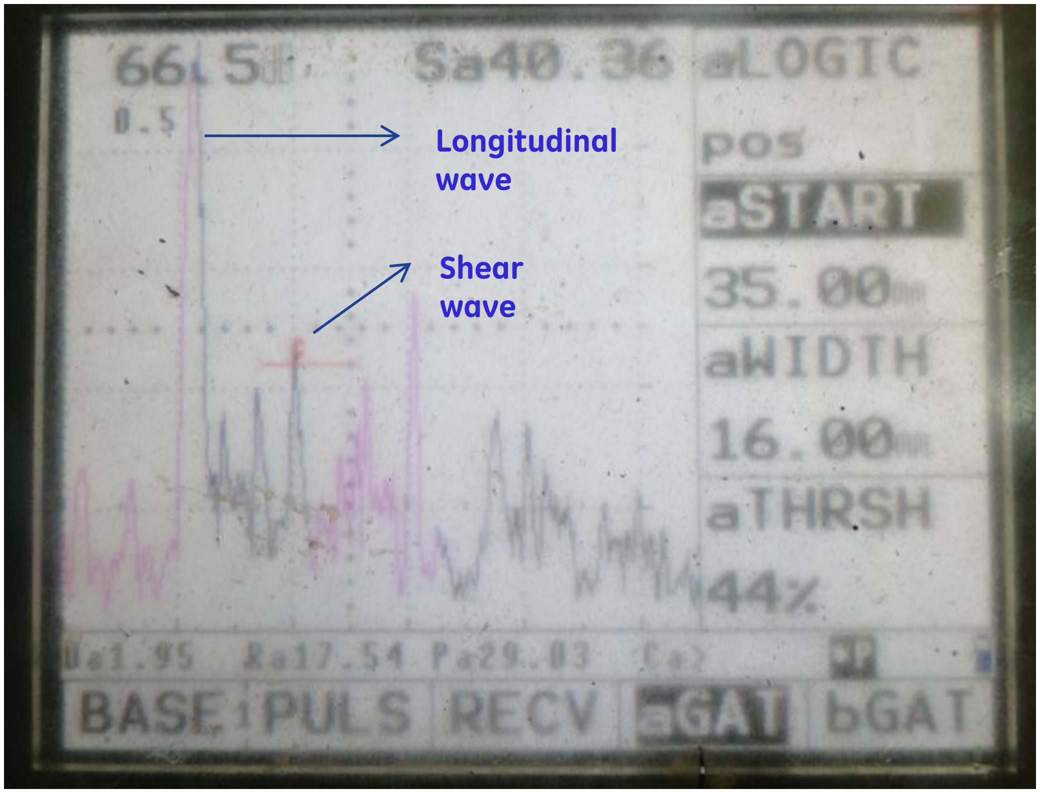
Inherent problem of using UT on small wall thickness with angled compressional wave probe

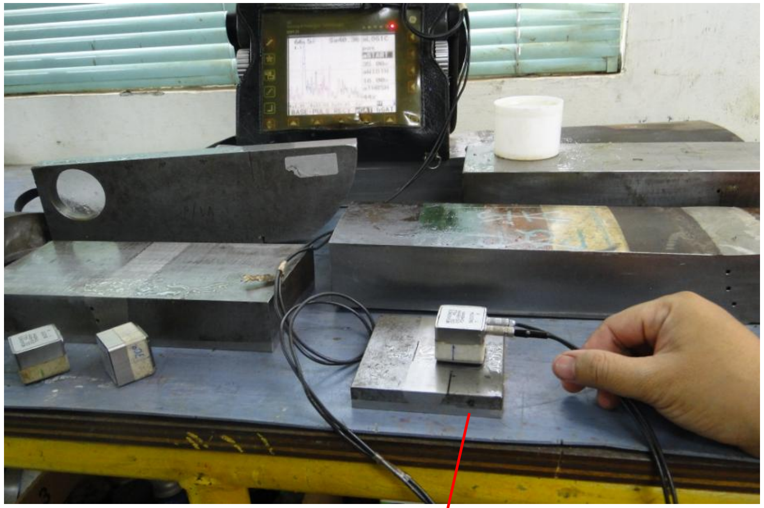
1) **45° probe hits base material, and not reaching root weld region.**



45° Probe response with 15 mm flat reference cladded block with 1mm width x 1mm depth x 25mm long notch

- **Shear wave response from back surface appears after longitudinal wave response appears in the CRT screen and able to distinguish in the CRT screen**
- **Longitudinal wave only used / considered in this technique and shear is considered as noise and not used / considered**



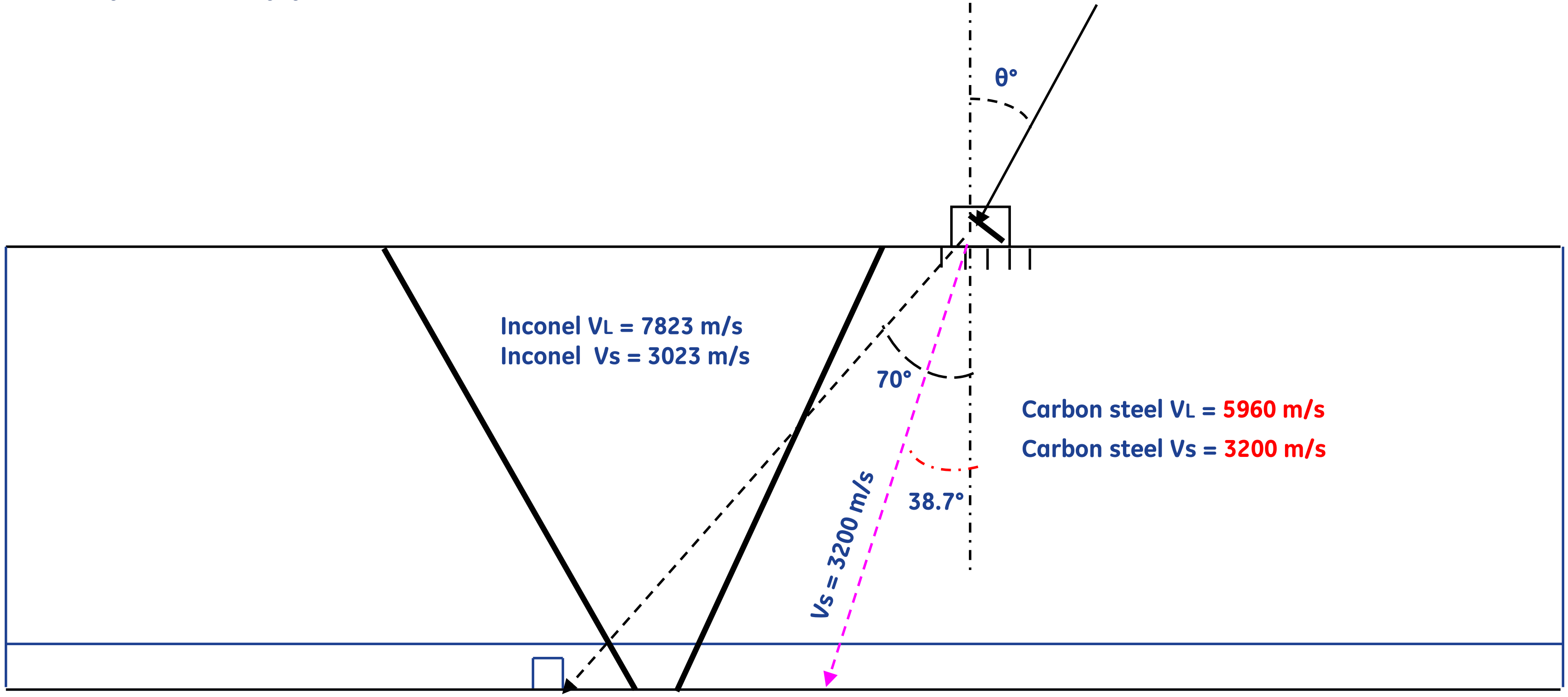


45° probe

Inherent problem - 2

Inherent problem of using UT on small wall thickness with angled compressional wave probe

2) **70° probe** is not suitable for root scanning because shear wave response from back surface appears before longitudinal wave response appears in the CRT screen



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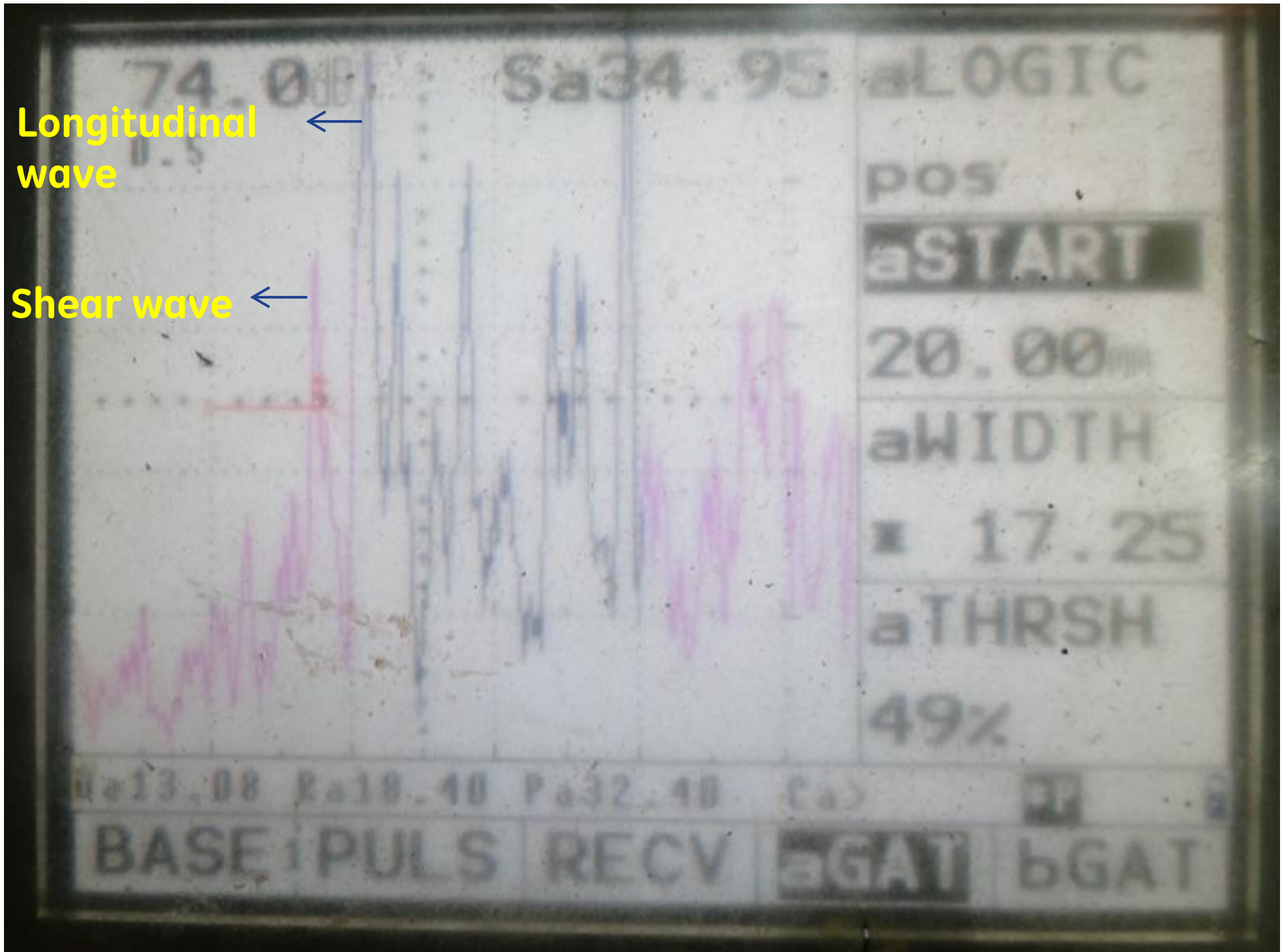
70° Probe response with 15 mm flat reference cladded block with 1mm width x 1mm depth x 25mm long notch

- Shear wave response from back surface appears before longitudinal wave response appears in the CRT screen and able to distinguish in the CRT screen

- Longitudinal wave only used / considered in this technique and shear is considered as noise, so not used / considered

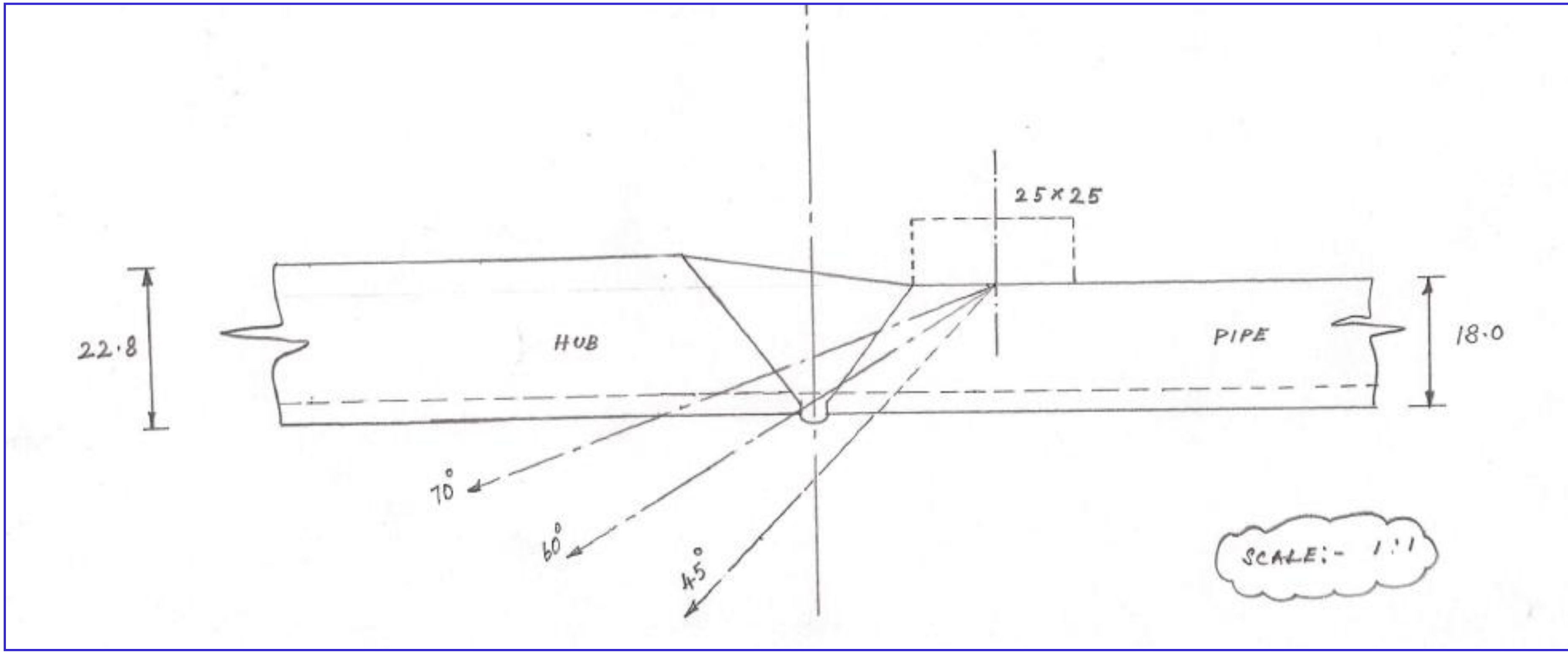


70° probe

Inherent problem - 3

Inherent problem of using UT on small wall thickness with angled compressional wave probe

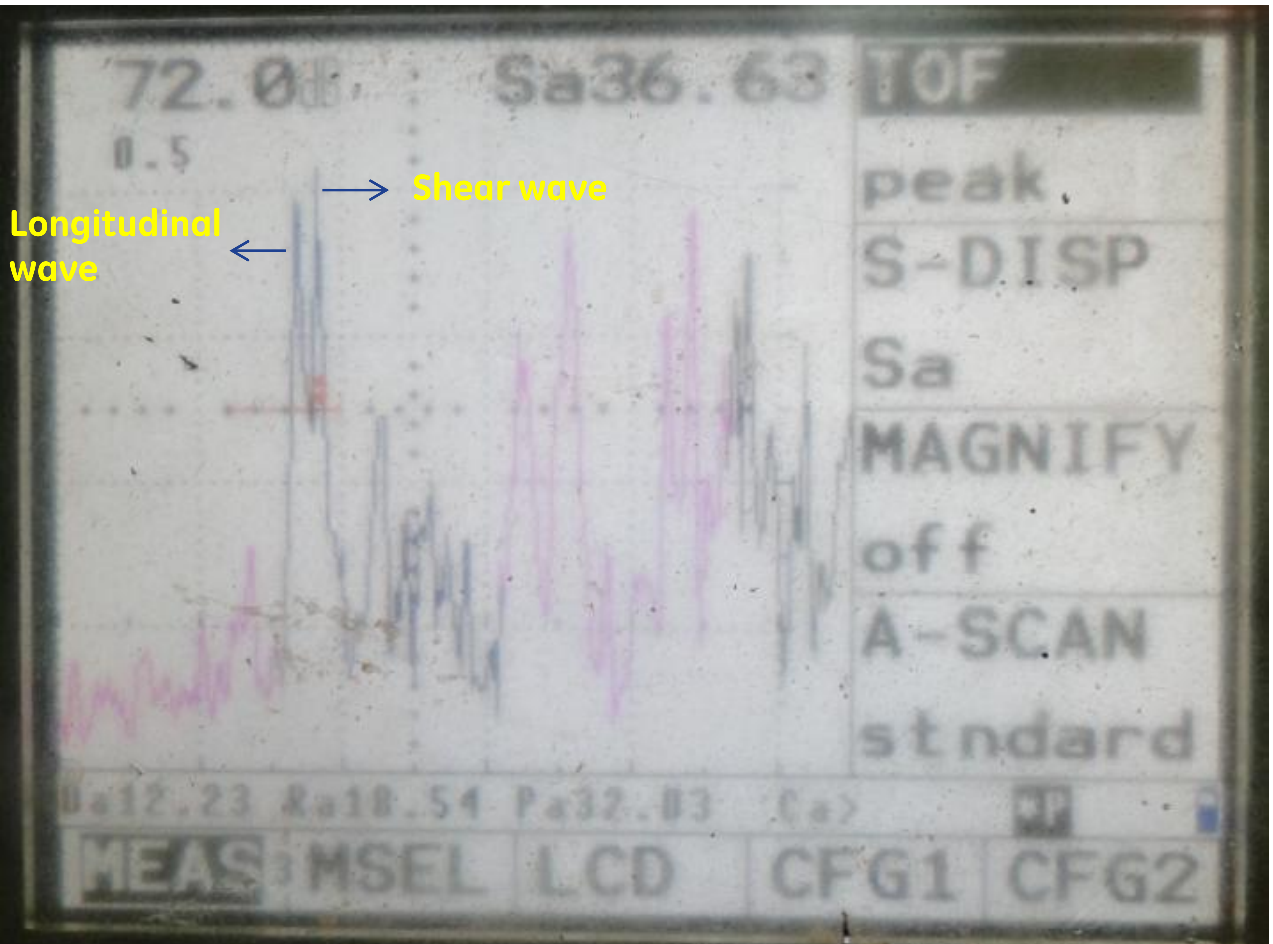
3) In case of 60° probe both the waves are almost close / merge together and not covering far distance of other side fusion face and HAZ



60° Probe response with 15 mm flat reference cladded block with 1mm width x 1mm depth x 25mm long notch

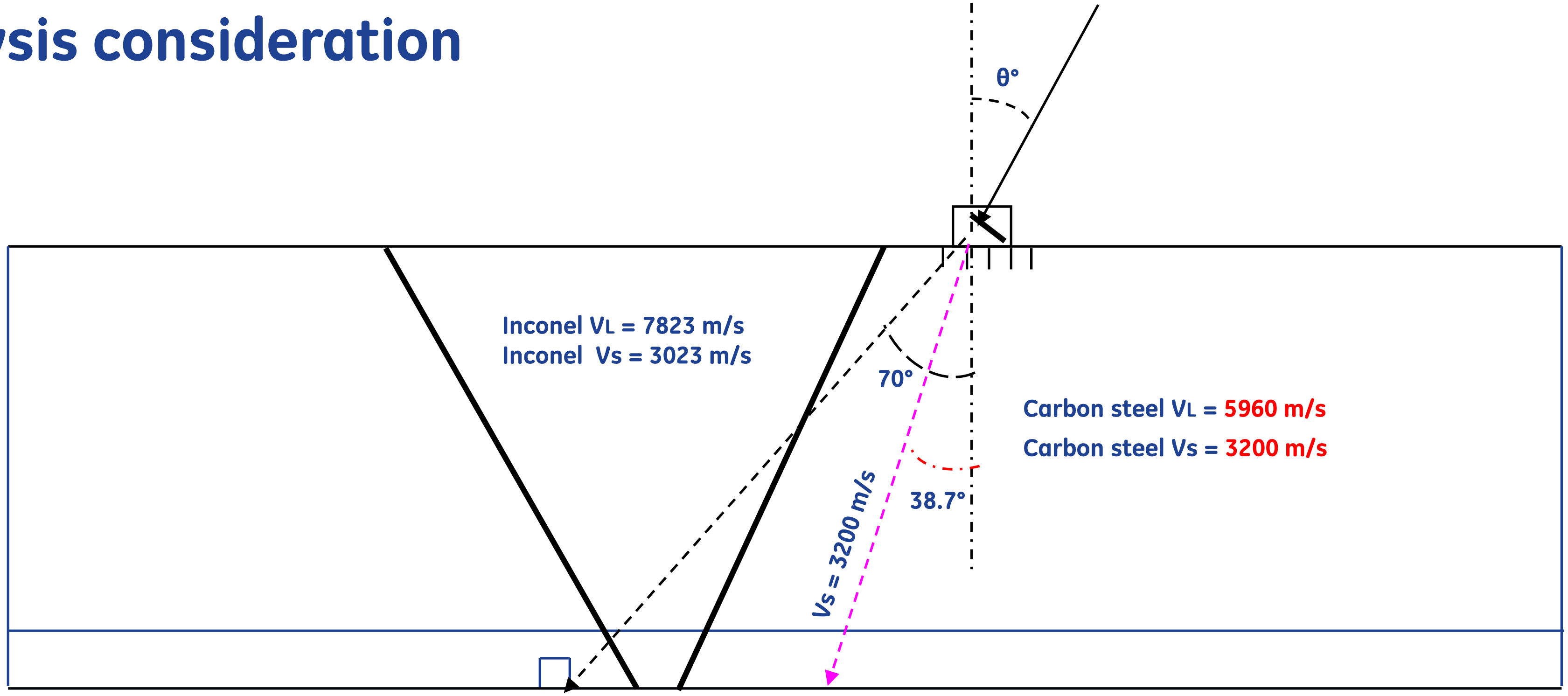
- 60° probe both the waves are almost close / merge together and not able to distinguish in the CRT screen. Moreover, not covering far distance of other side fusion face and HAZ

- Longitudinal wave only used / considered in this technique and shear is considered as noise, so not used / considered



60° probe

Analysis consideration



- **Analysis based on sound velocity in carbon steel. Since sound travels in both carbon steel and Inconel, we have considered the worst case and used carbon steel parameters**
- **Calculation of echo response of both shear and longitudinal waves are detailed in the next page.**

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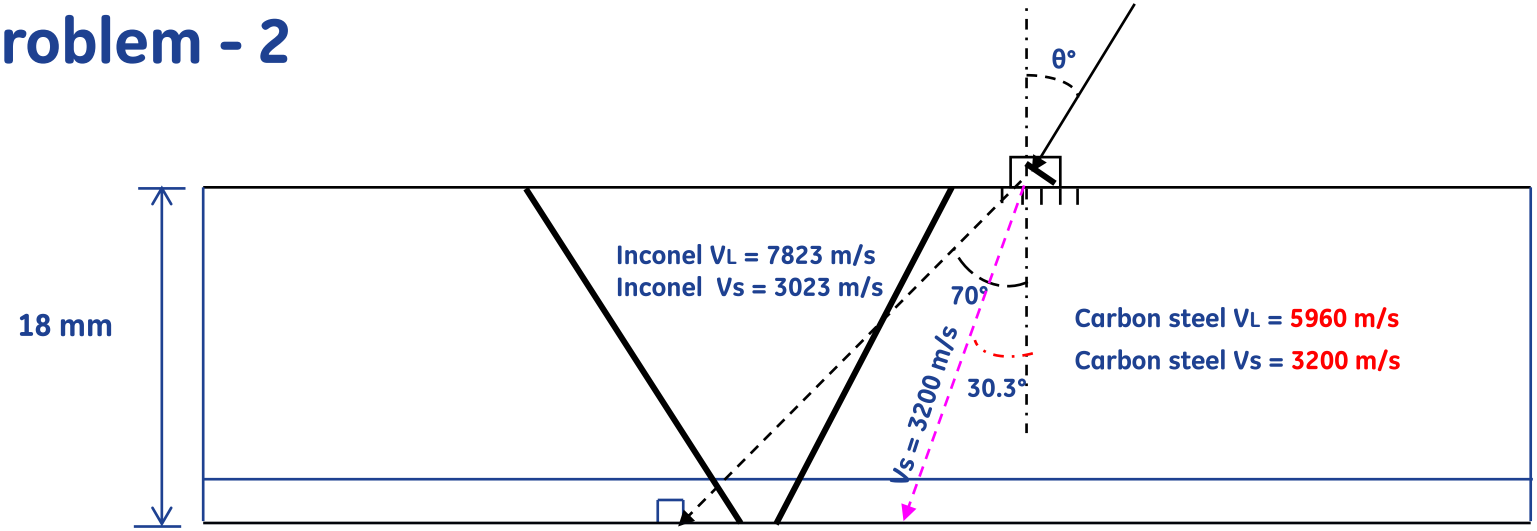
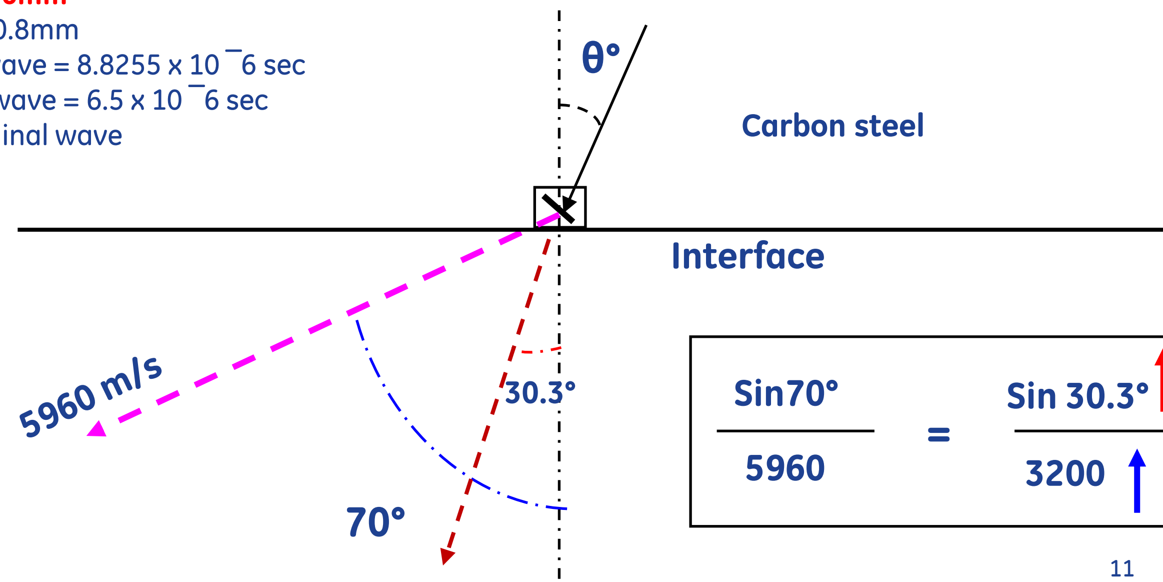
Inherent problem - 2



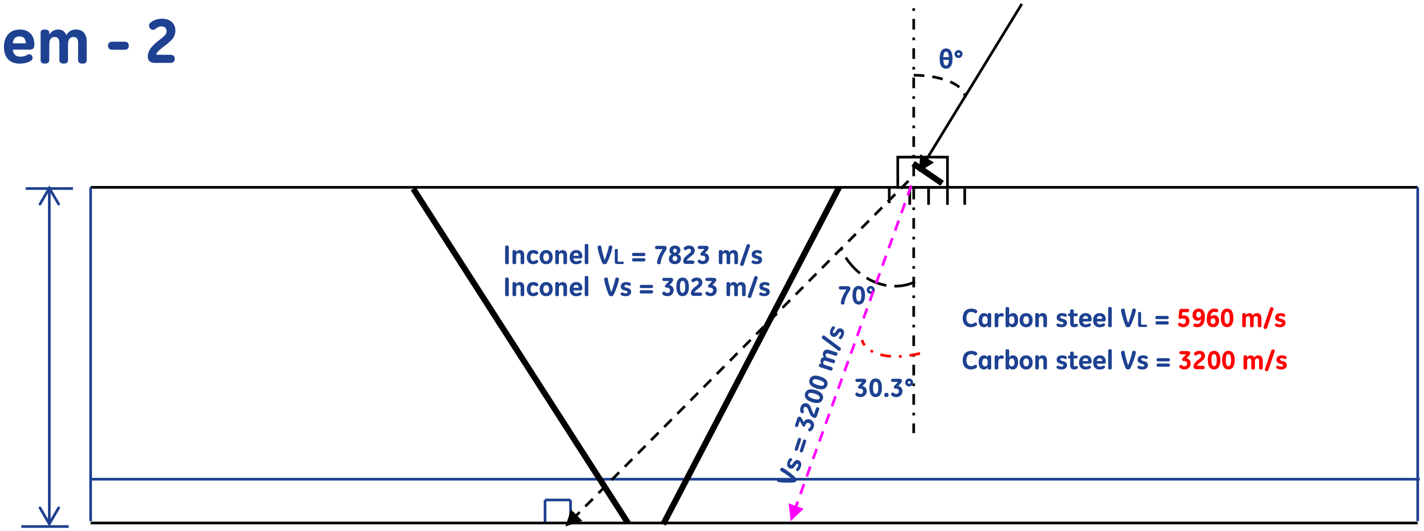
Calculation

- Piping size considered for the calculation is **6" x 22.8 / 18.0 mm WT**
- Longitudinal wave velocity = 5960 m/sec
- Shear wave velocity = 3200 m/sec
- Longitudinal wave beam path from the notch = **52.6mm**
- Shear wave beam path from back wall surface = 20.8mm
- Time taken to travel 52.6mm beam path by long .wave = 8.8255×10^{-6} sec
- Time taken to travel 20.8mm beam path by shear wave = 6.5×10^{-6} sec
- Echo response of shear wave corrected to longitudinal wave in the CRT screen = **38.7mm**
- Shear wave diffraction angle 30.3°



$$\frac{\sin 70^\circ}{5960} = \frac{\sin 30.3^\circ}{3200}$$

Inherent problem - 2



Thickness	Echo Response								
	45° probe			60° probe			70° probe		
	E_L	E_S	Θ_S	E_L	E_S	Θ_S	E_L	E_S	Θ_S
18.0	**22.5**	**36.3**	22.5	**36.0**	**37.8**	27.7	**52.6**	**38.7**	30.3

E_L – Longitudinal wave echo response from notch at back wall surface
E_S – Shear wave echo response from back wall surface
Θ_S – Shear wave diffraction angle

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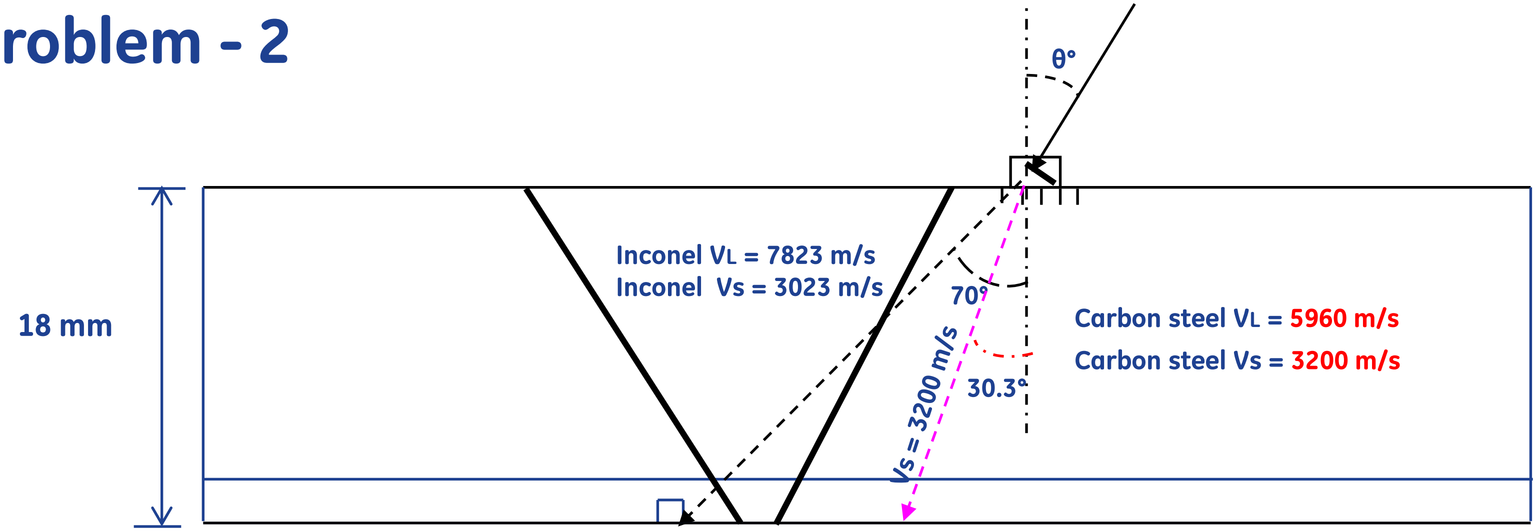
Inherent problem - 2



Calculation

- Piping size considered for the calculation is **6" x 22.8 / 18.0 mm WT**
- Longitudinal wave velocity = 5960 m/sec
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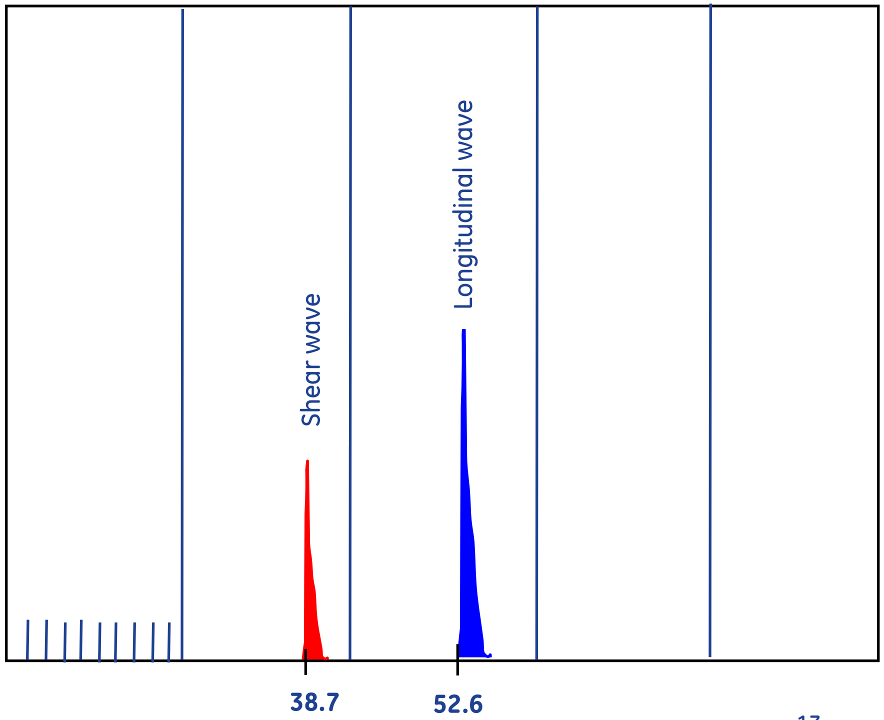
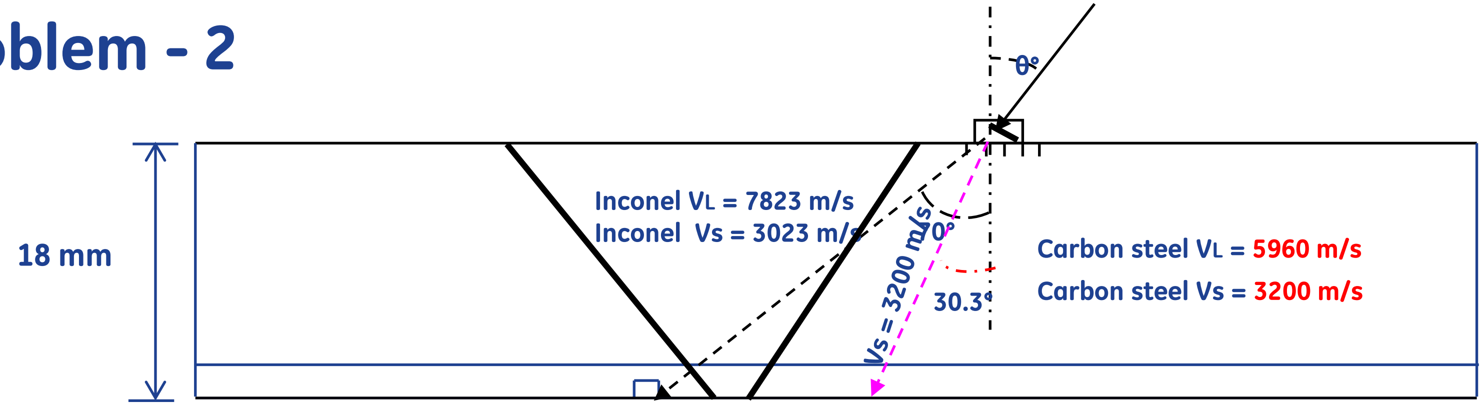


Inherent problem - 2



Thickness	Echo Response								
	45° probe			60° probe			70° probe		
	EL	Es	Θs	EL	Es	Θs	EL	Es	Θs
18.0	22.5	36.3	22.5	**36.0**	**37.8**	27.7	**52.6**	**38.7**	30.3

- **Echo response of expected shear wave reflection from back surface appears before response of longitudinal wave from notch, which will lead technician to mis-interpretate as discontinuity**

- **Only 45° probe is suitable for root scanning, because longitudinal and shear waves are very well positioned in the CRT screen, but 45° probe hits base material, and not reaching root weld region**

- **In case of 60° probe both the waves are almost close / merge together and not covering far distance of other side fusion face and HAZ**

- **70° probe is not suitable for root scanning because shear wave response from back surface appears before longitudinal wave response appears in the CRT screen**

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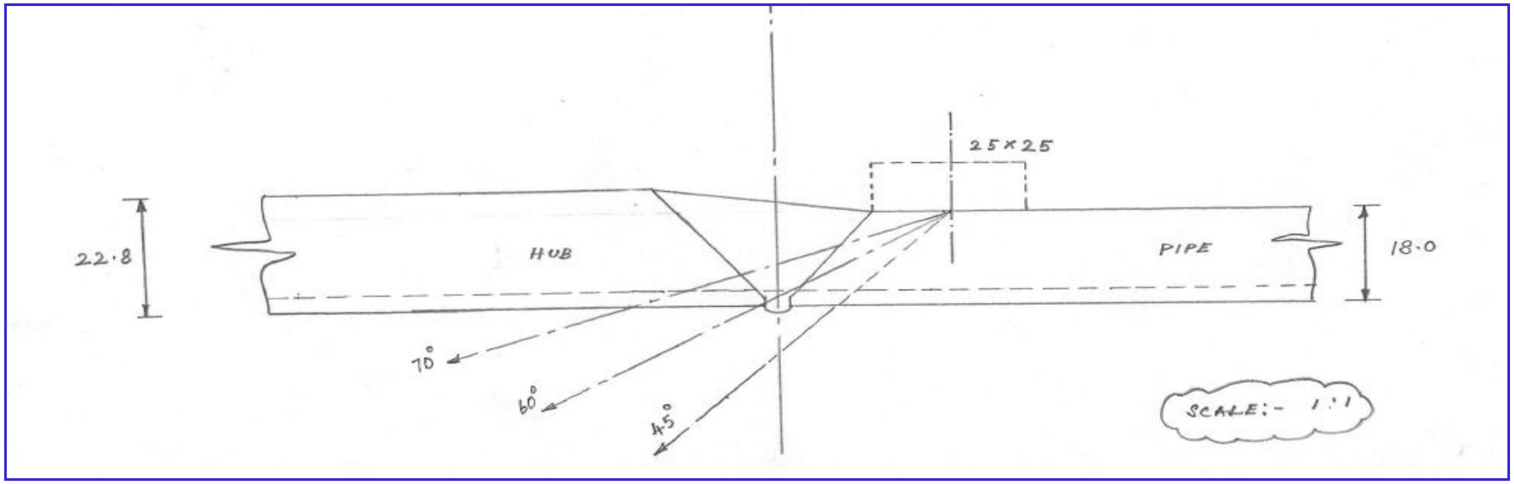
Summary

Inherent problem of using UT on small wall thickness with angled compressional wave probe

1) **Only 45° probe is suitable for root scanning, because longitudinal and shear waves are very well positioned in the CRT screen, but 45° probe hits base material, and not reaching root weld region**



2) **In case of 60° probe both the waves are almost close / merge together <u>and</u> not covering far distance of other side fusion face and HAZ**

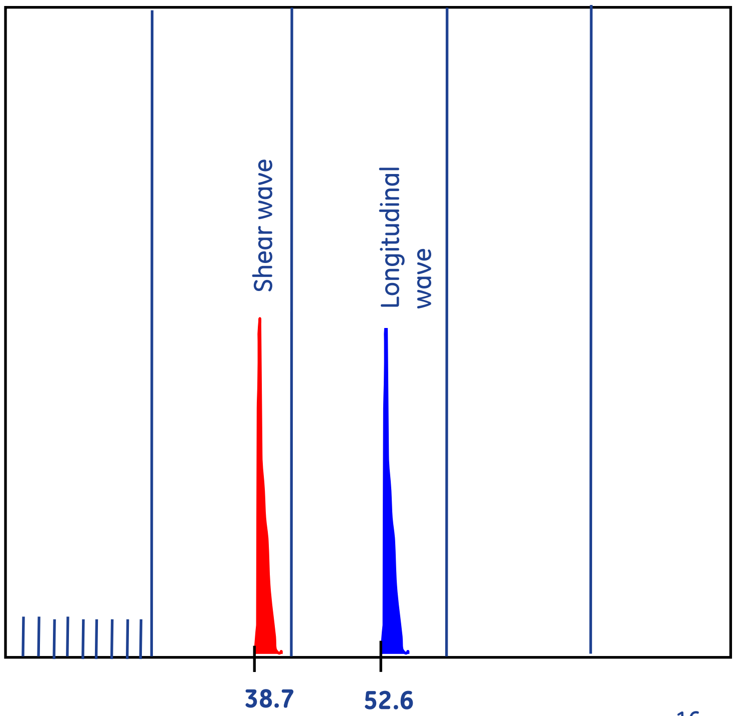
cont…..

Summary

Inherent problem of using UT on small wall thickness with angled compressional wave probe

3) 70° probe is not suitable for root scanning because shear wave response from back surface appears before longitudinal wave response appears in the CRT screen. Interpretation of indication will be the challenge to the operator.

Thickness	Echo Response								
	45° probe			60° probe			70° probe		
	E_L	E_S	Θ_S	E_L	E_S	Θ_S	E_L	E_S	Θ_S
18.0	22.5	36.3	22.5	36.0	37.8	27.7	**52.6**	**38.7**	30.3



Conclusion

Based on the above study RT will be the best option by considering all the above Inherent problem of using UT on small wall thickness with angled compressional wave probe.

GE recommend to use radiography with the following condition

- X-ray shall only be utilized when X-ray is practical
- If access restriction to use X-ray, then Isotope can be used
- Use Ir192 instead of Se 75 for piping nominal wall thickness from **14 mm with DWSI technique only**
- Use of Class A technique shall only be utilized when Class B technique is not practical.

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Thanks