

Mixed adhesive technique in single lap joints with steel adherends

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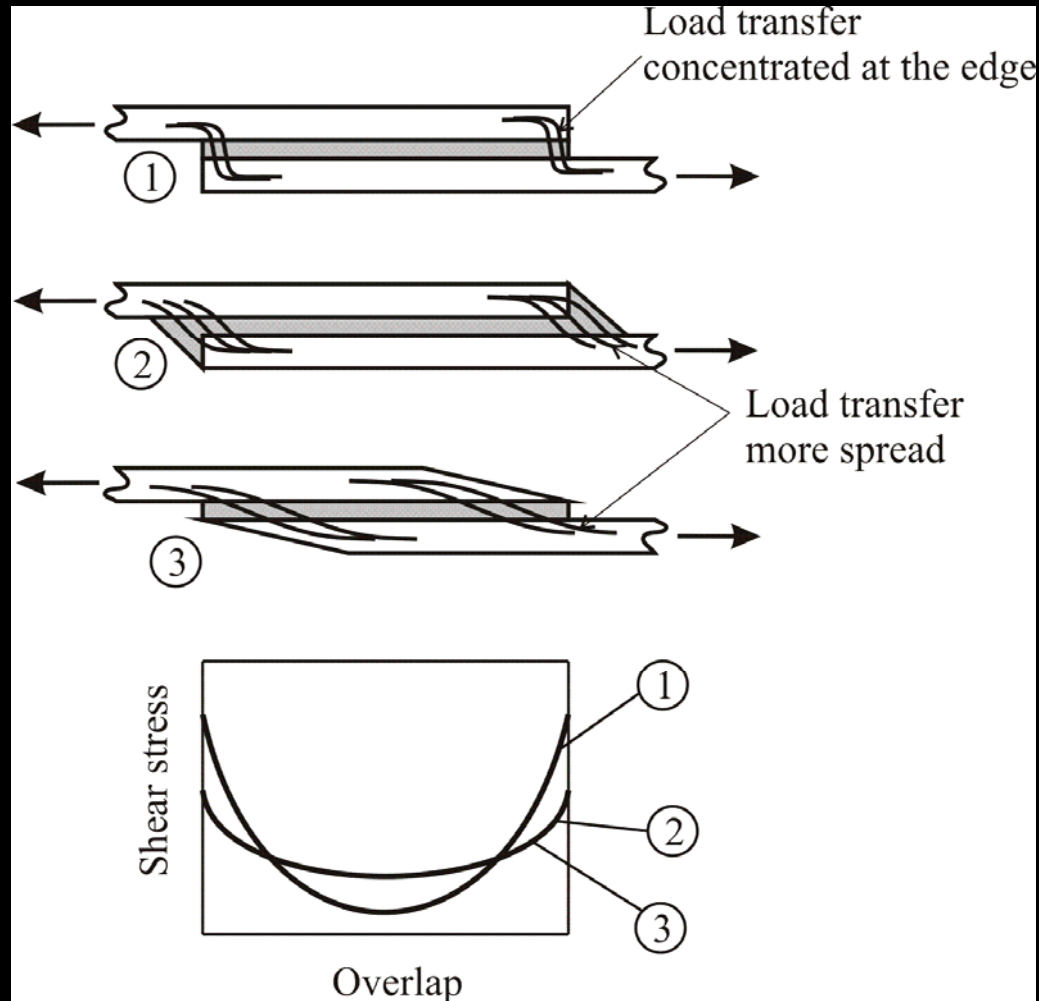
Mixed adhesive technique in single lap joints with steel adherends

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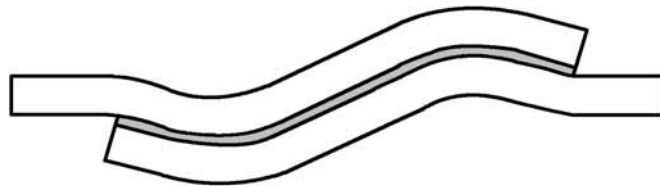
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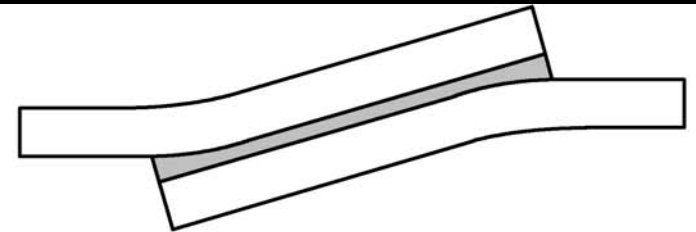
Introduction



Introduction



'Wavy' lap joint



'Reverse bent' joint

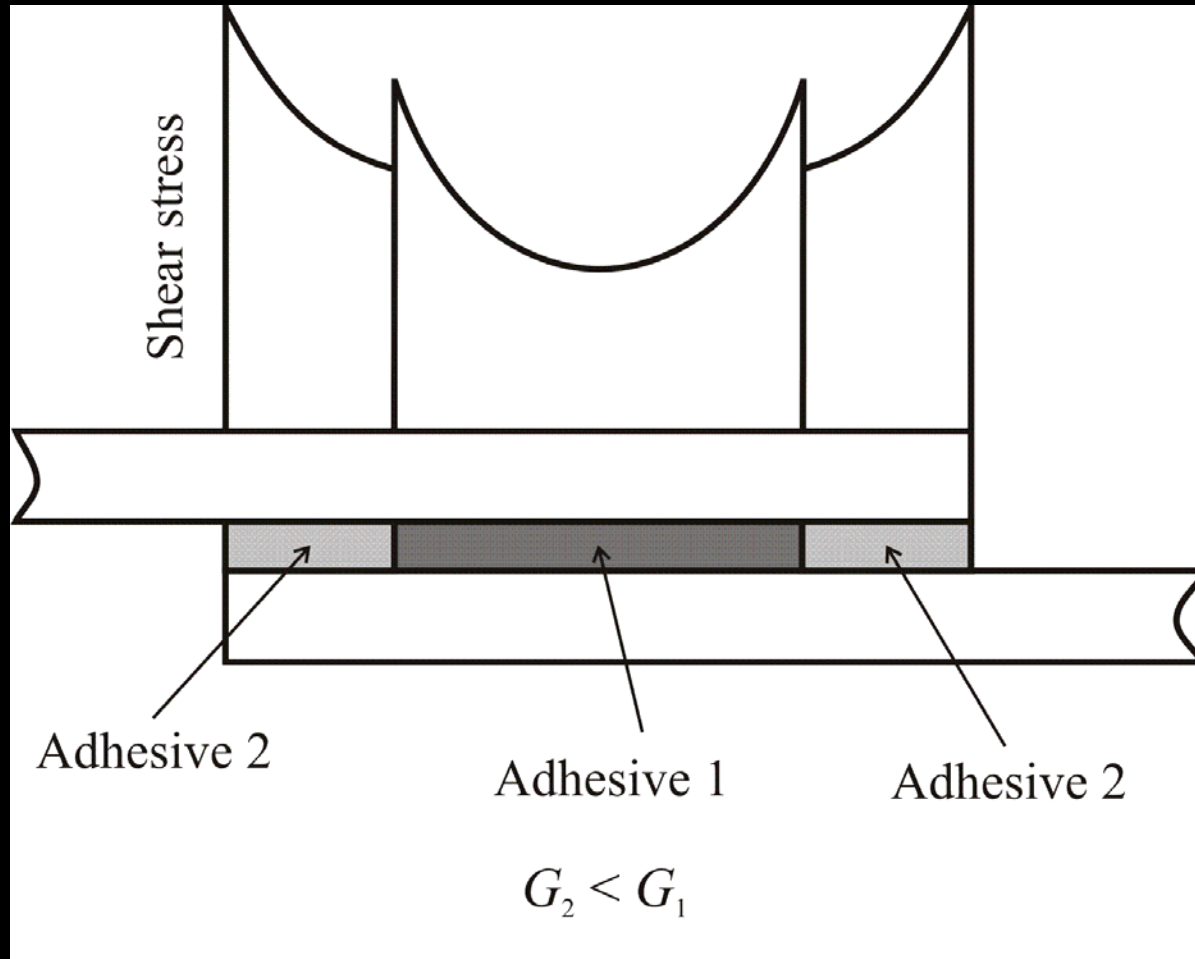


'Tongue and groove' joint



Scarf joint

Introduction



Experimental programme

- Materials (adhesives)

	AV138/HV998	2013	2021	DP-8005
Shear modulus G (MPa)	1559 ± 11	885.7 ± 78	403.6 ± 84	178.6 ± 8.0
Shear yield strength τ_y (MPa)	25.0 ± 0.55	21 ± 0.31	18.4 ± 0.19	5.26 ± 0.57
Shear strength τ_r (MPa)	30.2 ± 0.40	21.0 ± 0.31	18.4 ± 0.19	8.4 ± 1.9
Shear failure strain γ_f (%)	5.50 ± 0.440	29.4 ± 6.57	112 ± 2.23	180 ± 22.0

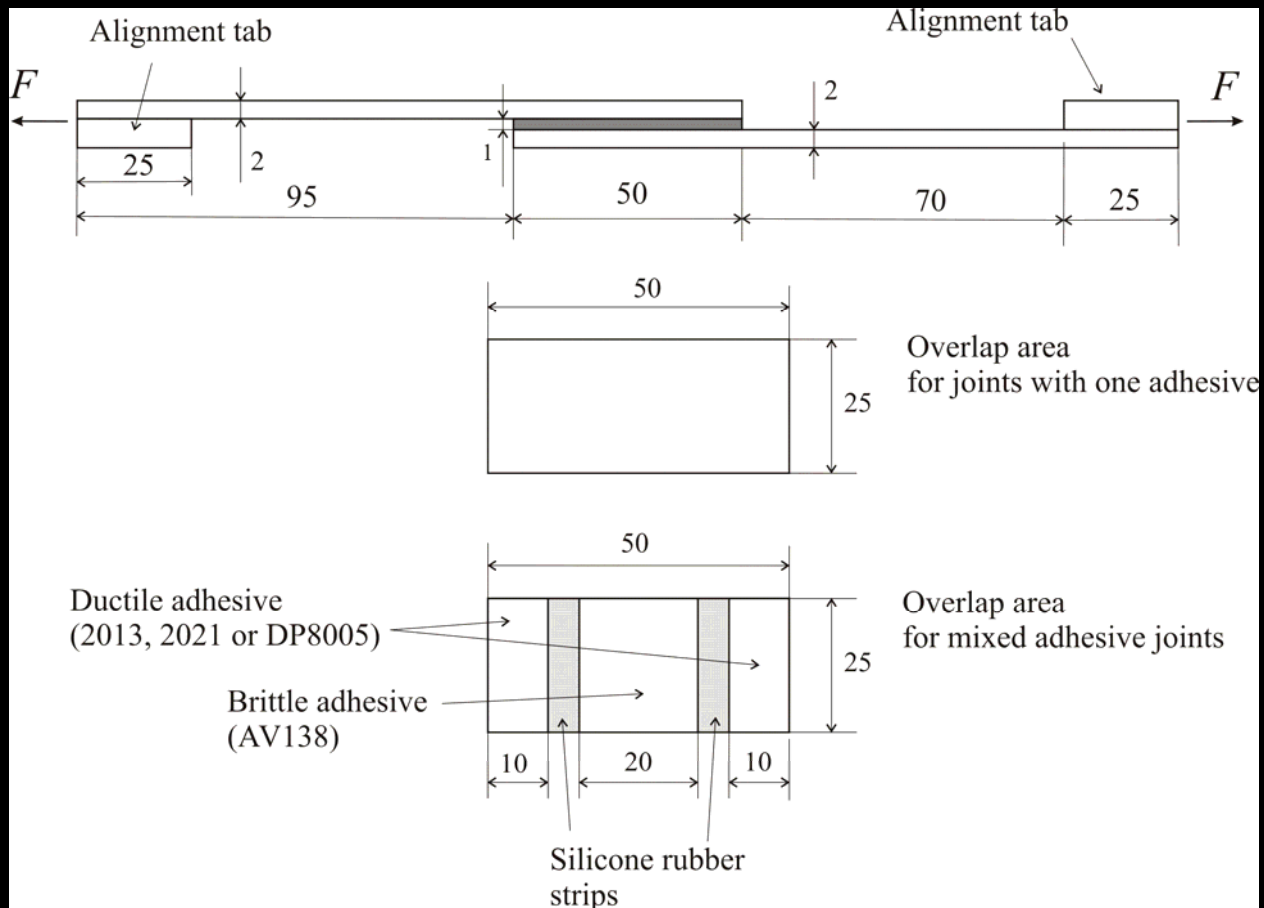
Experimental programme

- Materials (adherends)

Young's modulus E (GPa)	Tensile yield strength σ_y (MPa)	Tensile strength σ_r (MPa)	Tensile failure strain ε_f (%)
198.3 ± 11.6	1260 ± 4.5	1413 ± 4.3	20.0 ± 5.08

Experimental programme

- Geometry (single lap joints)



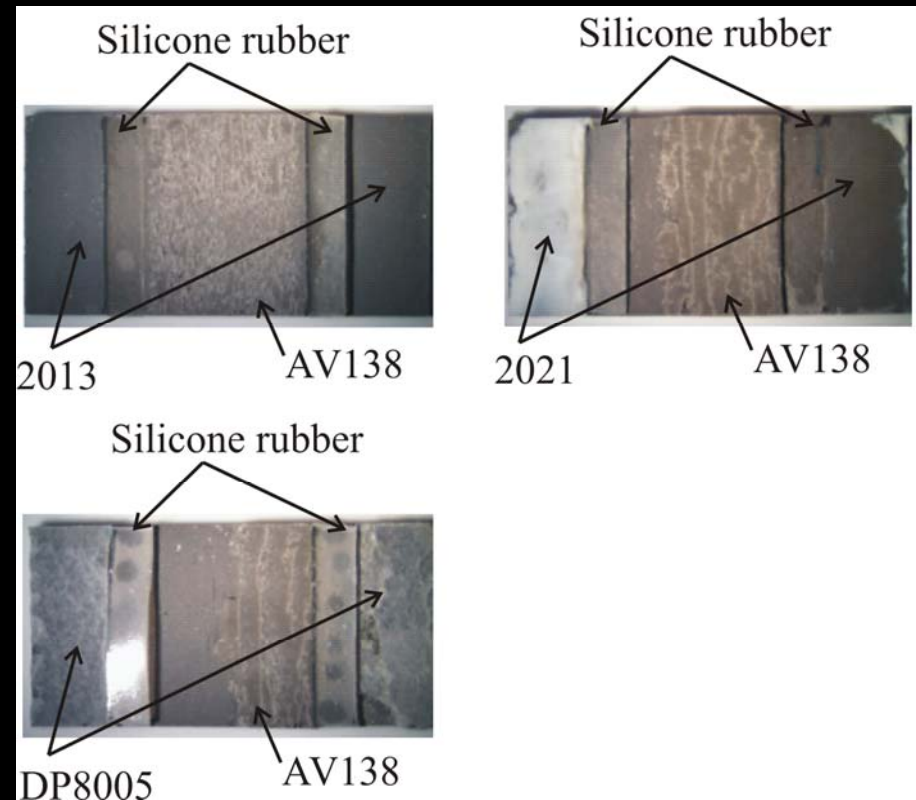
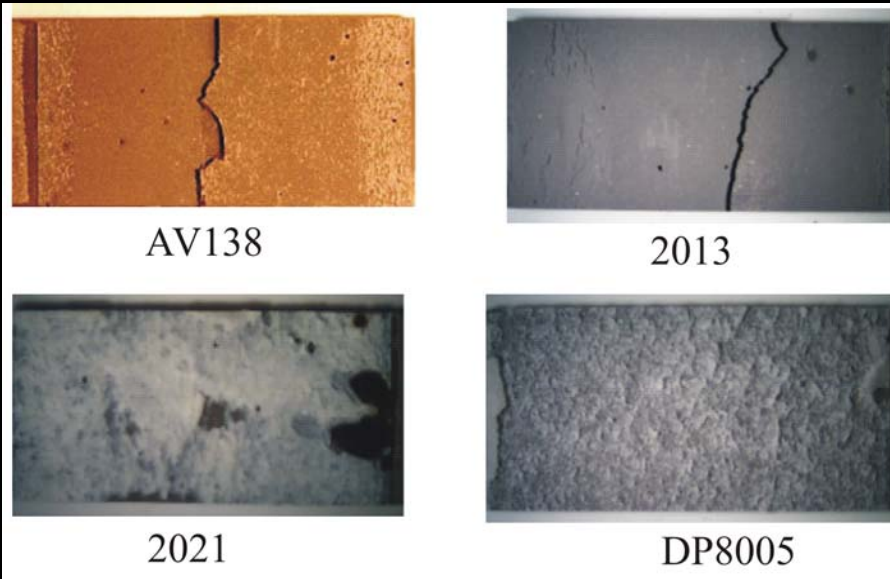
Experimental programme

- **Manufacture**



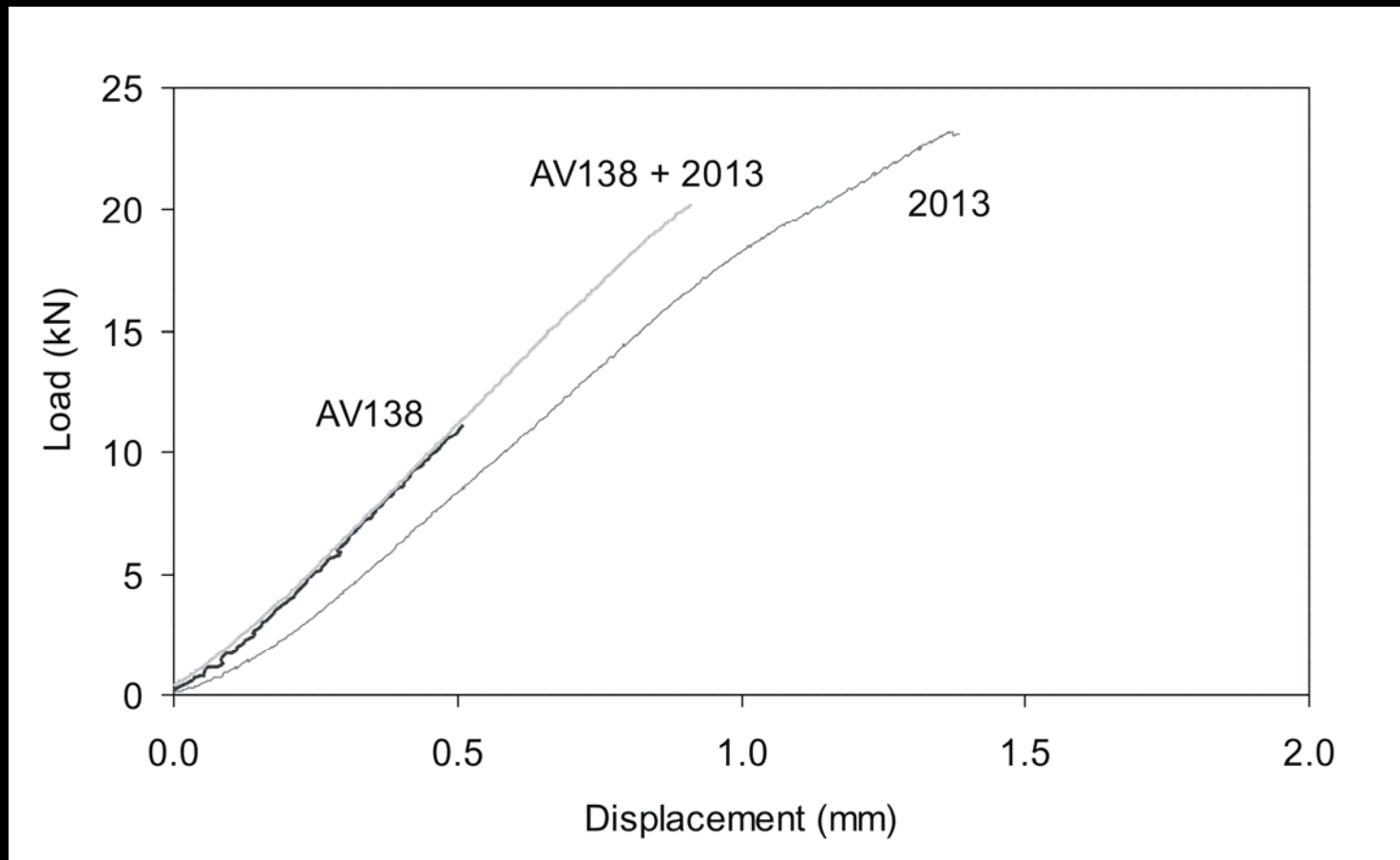
Experimental results

- Failure surfaces



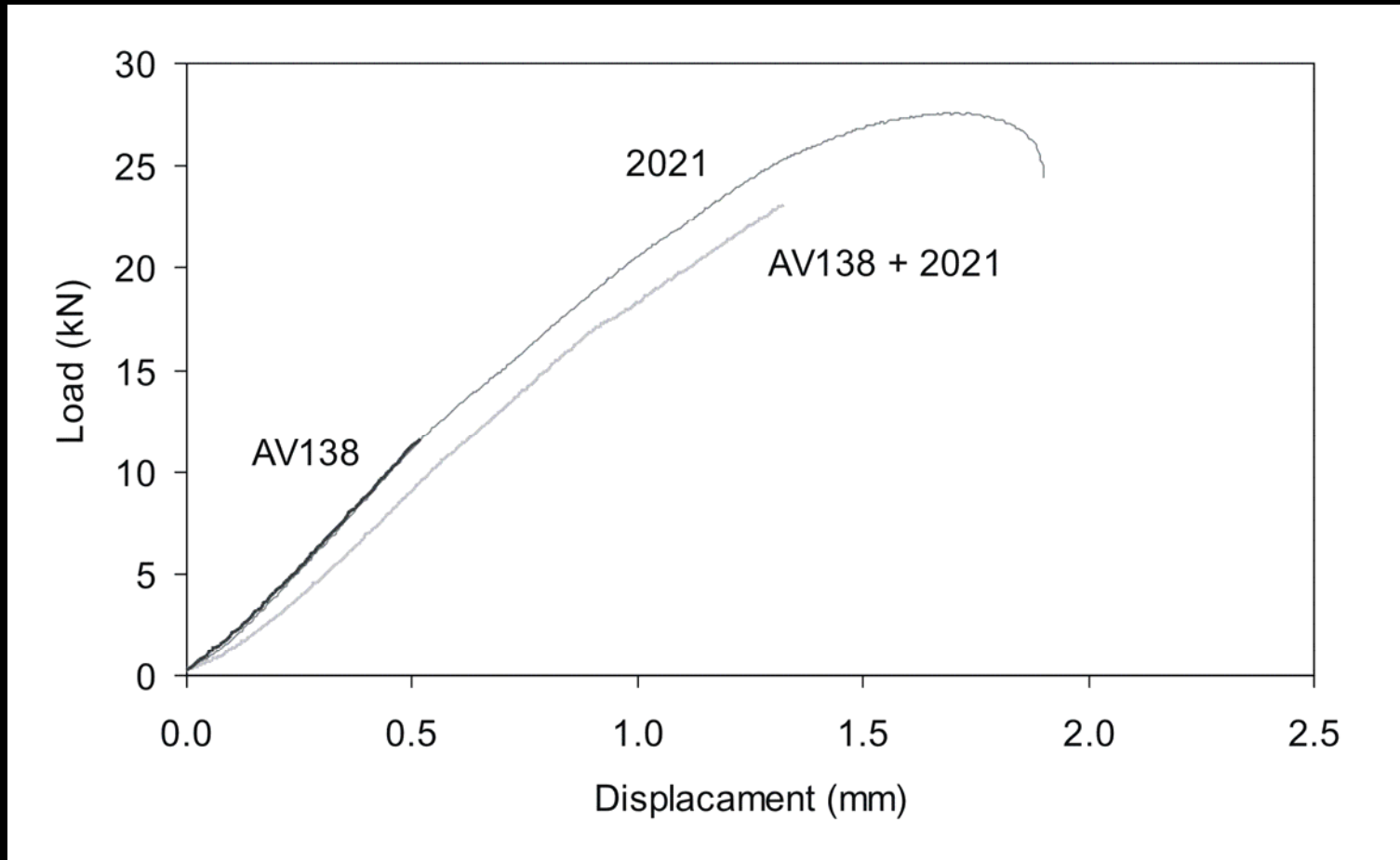
Experimental results

- Load displacement curves



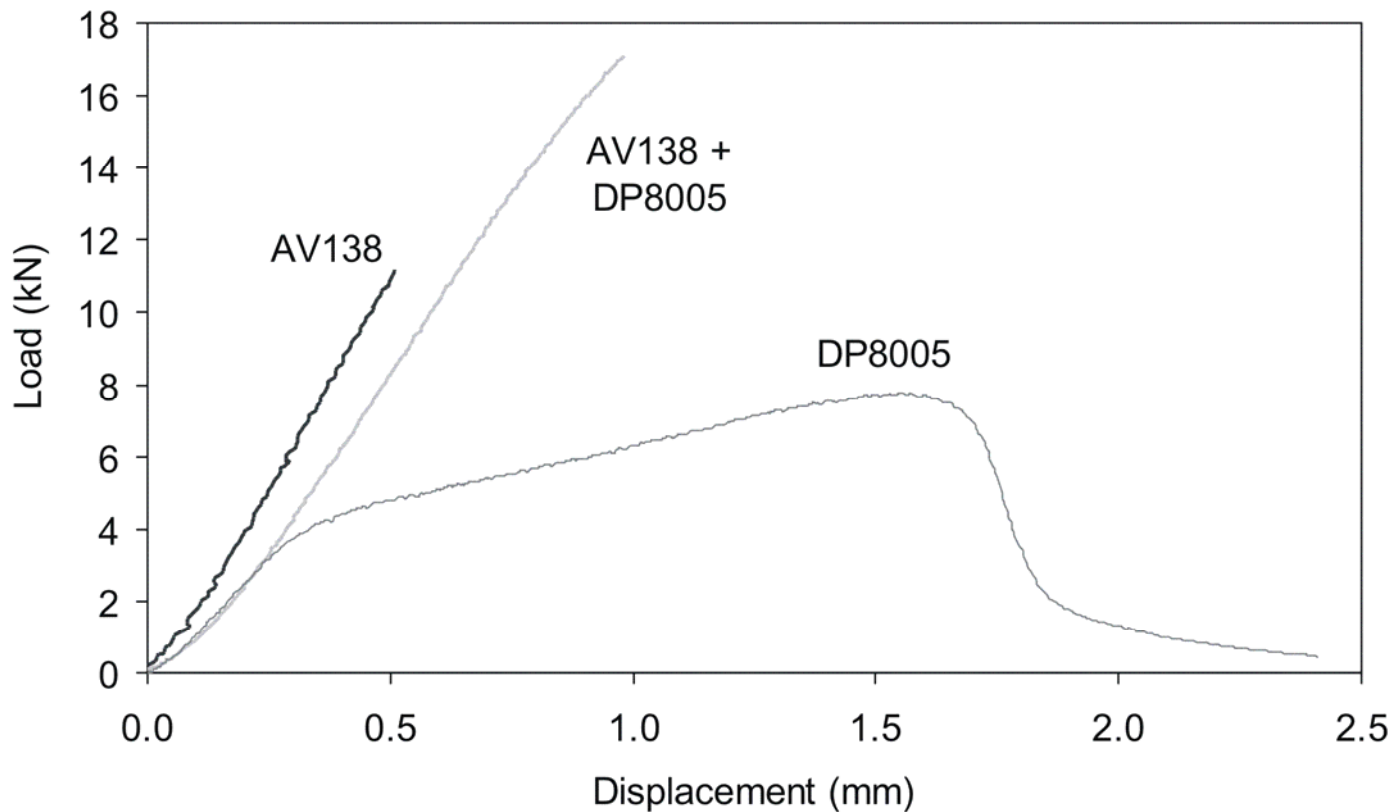
Experimental results

- Load displacement curves

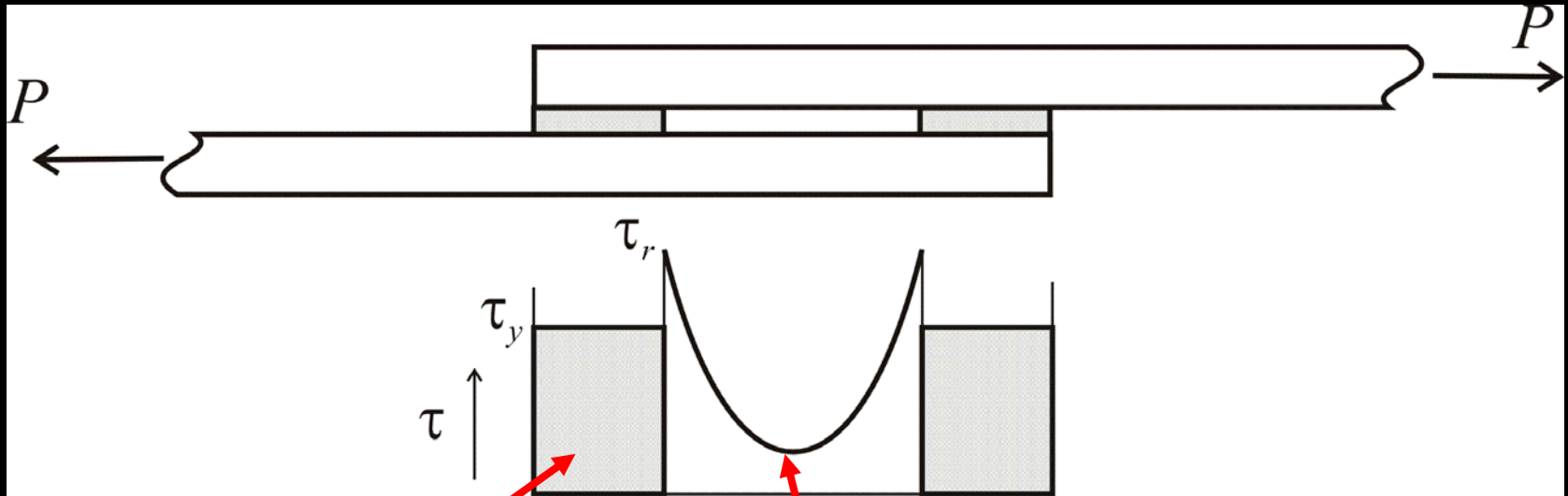


Experimental results

- Load displacement curves

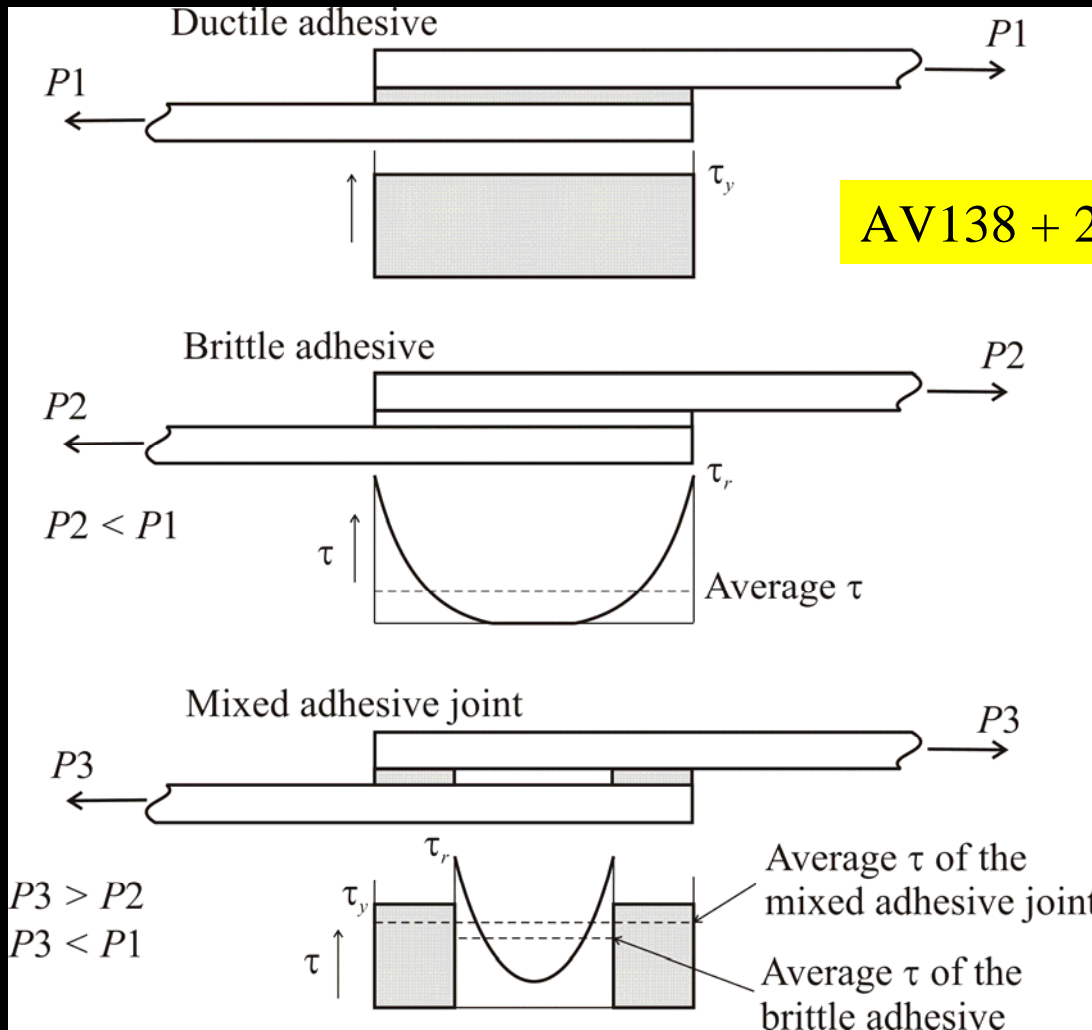


Joint strength prediction



$$P = \left(\tau_y \cdot b \cdot l \right)_{\text{ductile}} + \left(\tau_r \frac{2bl \sinh(\lambda l)}{\lambda l [1 + \cosh(\lambda l)]} \right)_{\text{brittle}}$$

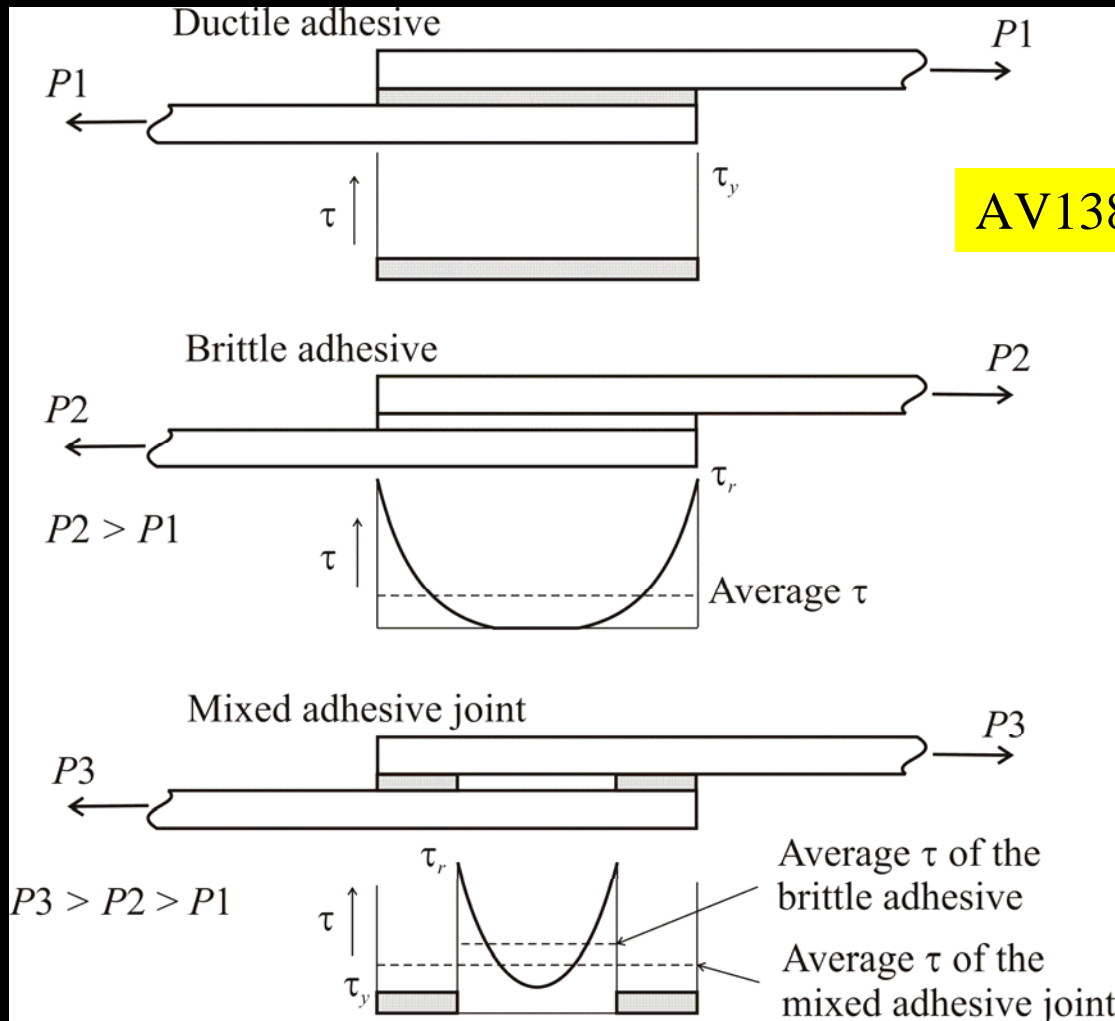
Joint strength prediction



AV138 + 2013 or AV138 + 2021

Joint strength prediction

AV138 + DP8005



Joint strength prediction

Adhesive(s)	Failure load			
	Experimental	Predicted		
		Volkersen	Global yielding	Volker. + global yield.*
AV138 (brittle)	11.3 ± 0.26	16.6	31.3	
2013 (ductile)	23.4 ± 1.32	15.0	26.3	
2021 (ductile)	28.1 ± .60	16.8	23.0	
DP8005 (very ductile)	7.8 ± 0.90	9.0	6.6	
AV138 + 2013	20.5 ± 0.70			22.6
AV138 + 2021	24.0 ± 0.84			21.3
AV138 + DP8005	17.2 ± 0.15			14.7

* Volkersen for adhesive AV138 and global yielding for the ductile adhesives

Conclusions

1. Mixed adhesive joints are relatively easy to manufacture using a silicone rubber strip as a separator between the adhesives.
2. Mixed adhesive joints give, in all cases studied, a higher joint strength than a joint with the brittle adhesive alone.
3. If the ductile adhesive has a joint strength lower than that of the brittle adhesive, a mixed adhesive joint with both adhesives gives a joint strength higher than the joint strength of the adhesives used individually. This synergetic effect can be explained by the shear stress distribution of the adhesive at failure.