

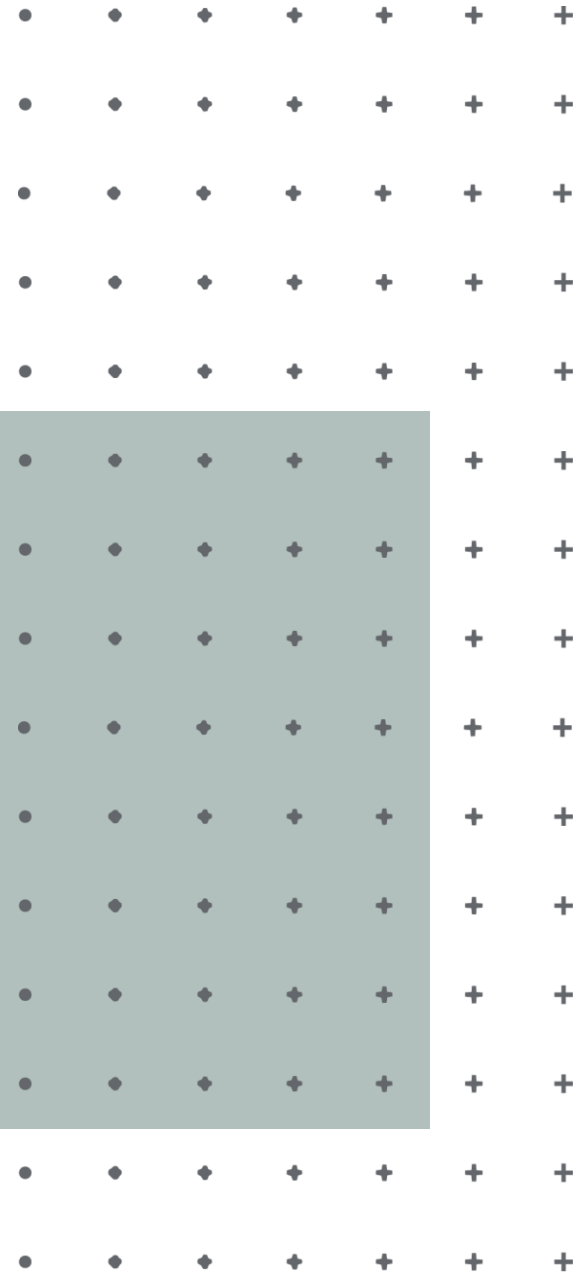


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Past and Recent Advances in Low Density SMC for Automotive Class A and Structural Applications

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Low Density SMC



OUTLINE

- **Class A 1.2 SPG Low Density**
 - Development of Current Low Density Class A SMC
 - Properties of Low Density Class A SMC
 - Status of Current Low Density Class A SMC
 - Current Usage
- **Next Steps**
 - High Mechanical Property Class A 1.25 SPG
 - 1.0 Specific Gravity Class A
- **Summary**

Development of Current Low Density Class A SMC



- **Low Density SMC mostly used in non-appearance applications**
 - Heat shields
 - Body panel supports; etc.
- **New Low Density Class A Body Panels**
 - Requirement is for a **1.2** specific gravity or lower
 - Surface aesthetics comparable to standard density (**1.9 SPG**) Class A SMC
 - **Physical Properties**
 - Must meet current low density SMC specifications
 - Better if they could meet the standard density SMC specifications

Development of Current Low Density Class A SMC



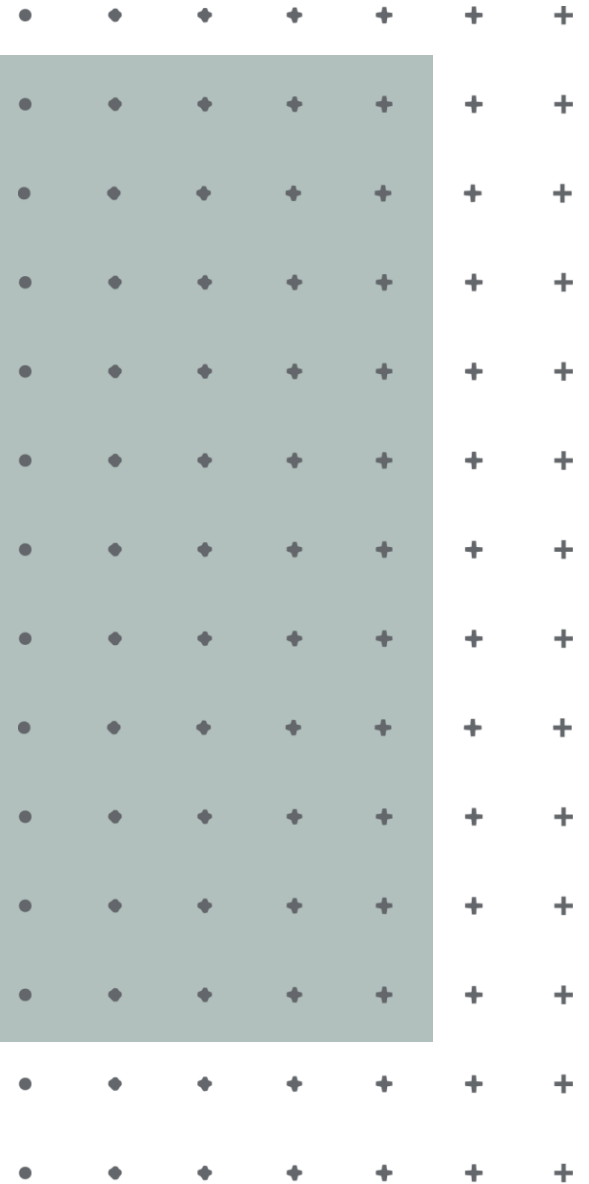
- *Achieving both required mechanical properties and Class A surface aesthetics has been a challenge.*
- *Now low density systems of 1.2 specific gravity offer comparable performance in both respects to standard density (1.9) Class A systems at up to a 46% weight savings vs steel*

Development of Current Low Density Class A SMC



- **Demand for Better Fuel Efficiency**
 - Improvement of mileage
 - Lower carbon emissions
- **High Strength Steel**
 - Low cost/readily available
 - Stampable - Fits the existing infrastructure
 - At the point of diminishing returns in terms of weight reduction
- **Aluminum**
 - Lighter but more expensive than steel
 - Stampable
 - Requires major re-tooling of the forming & assembly processes
- **Carbon Fiber**
 - Offers excellent strength/weight ratios
 - Slow process / High cost raw materials
 - Limited carbon fiber availability
 - Di-electric & repair concerns
 - Likely (future) material of construction

Properties of Current Class A 1.2 Low Density



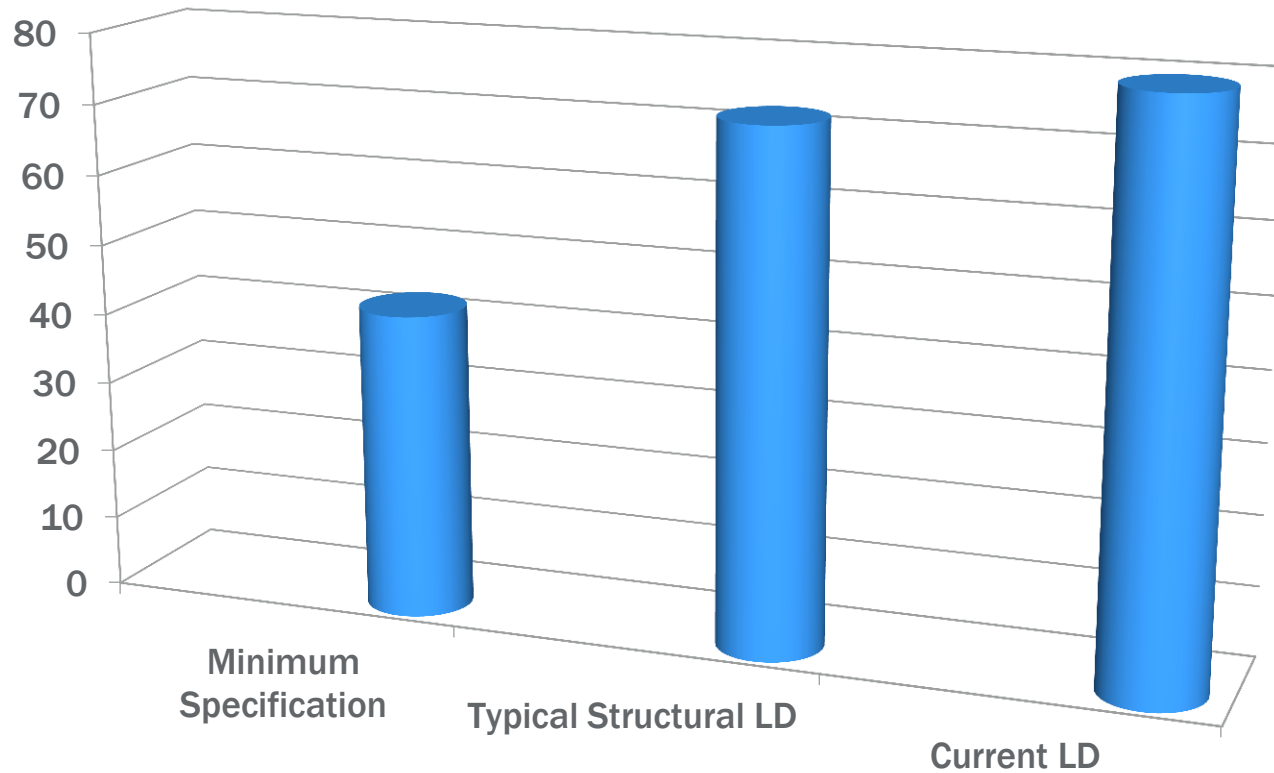
Surface Properties



Description	LORIA	OP	DOI
Typical Structural LD	104	6.4	70
Standard Density Class A 1.9 SPG	87	9.3	94
Current Class A Low Density 1.2 SPG	50	9.6	97

Mechanical Properties

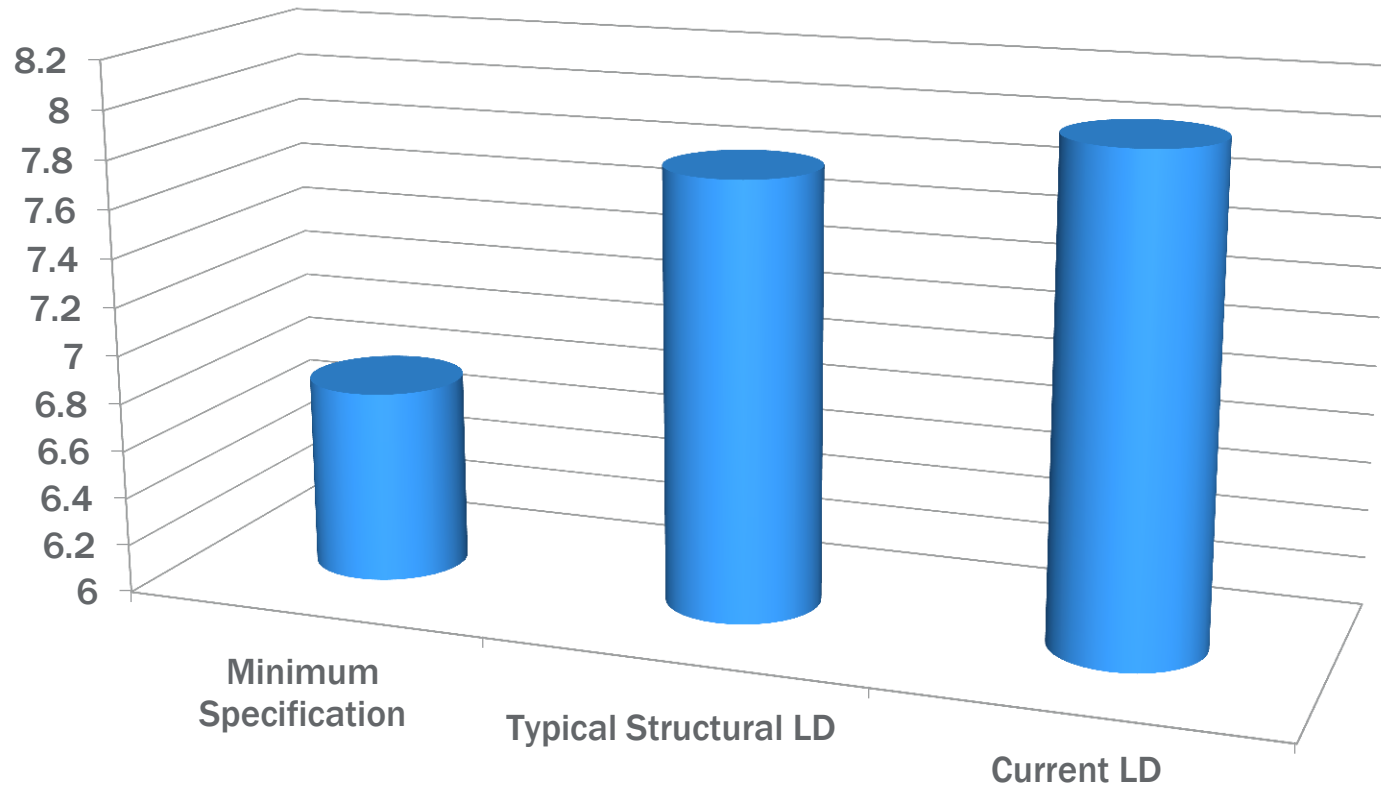
Tensile Strength (MPa)



Ford LD Specification WSS-M3D188-A

Mechanical Properties

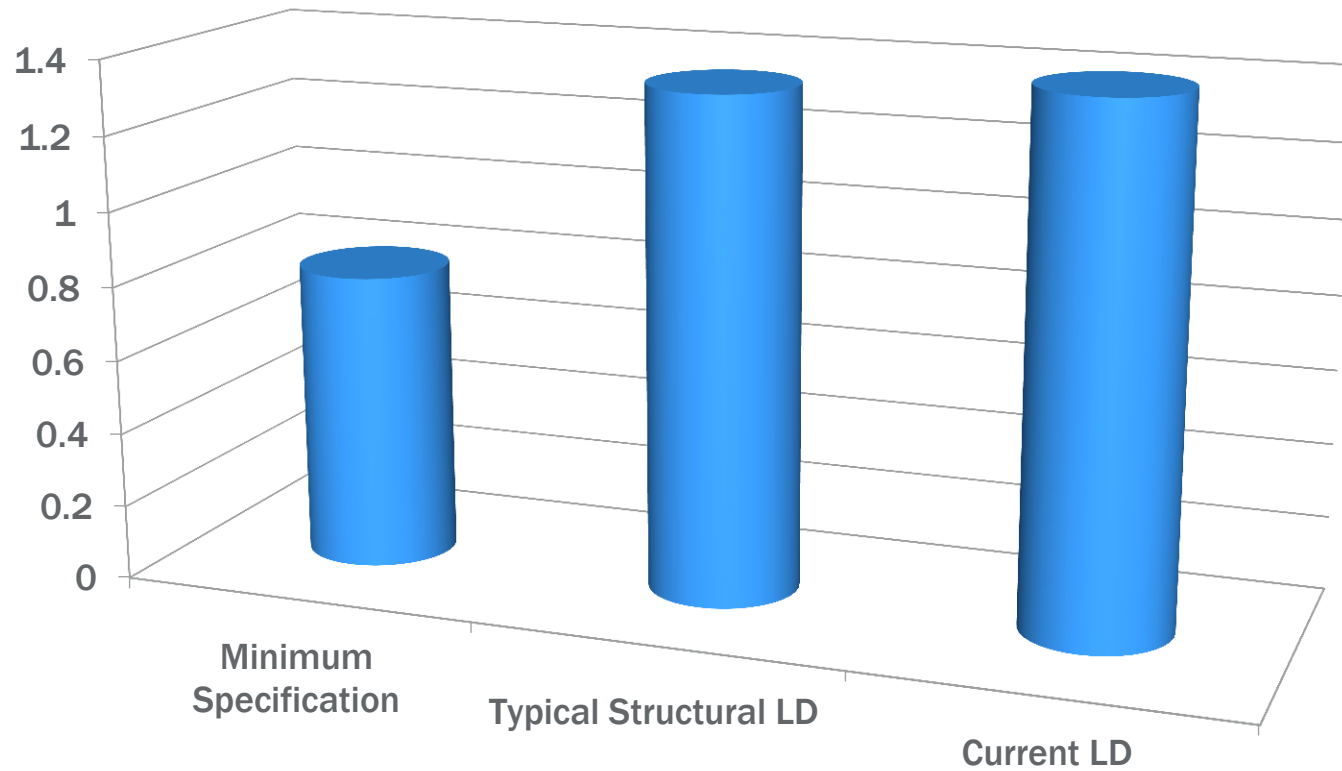
Tensile Modulus (GPa)



Ford LD Specification WSS-M3D188-A

Mechanical Properties

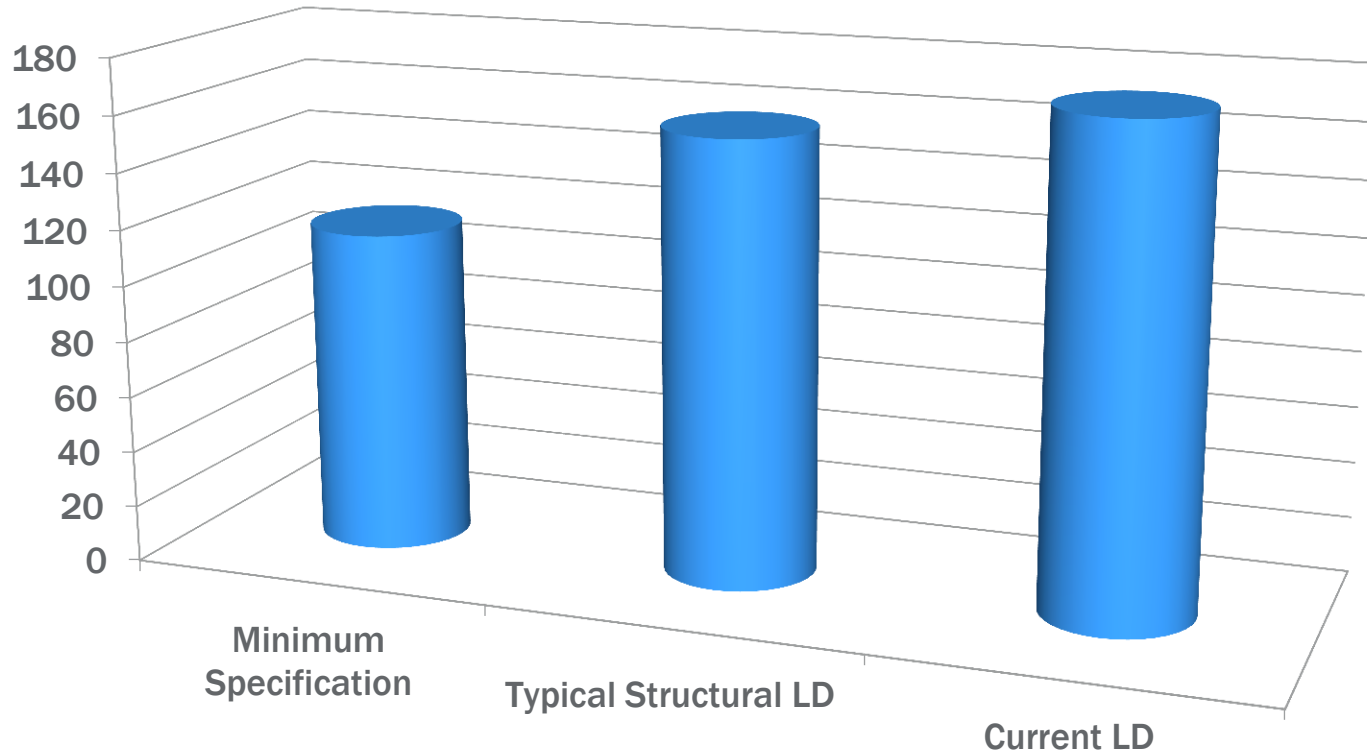
Tensile Elongation (%)



Ford LD Specification WSS-M3D188-A

Mechanical Properties

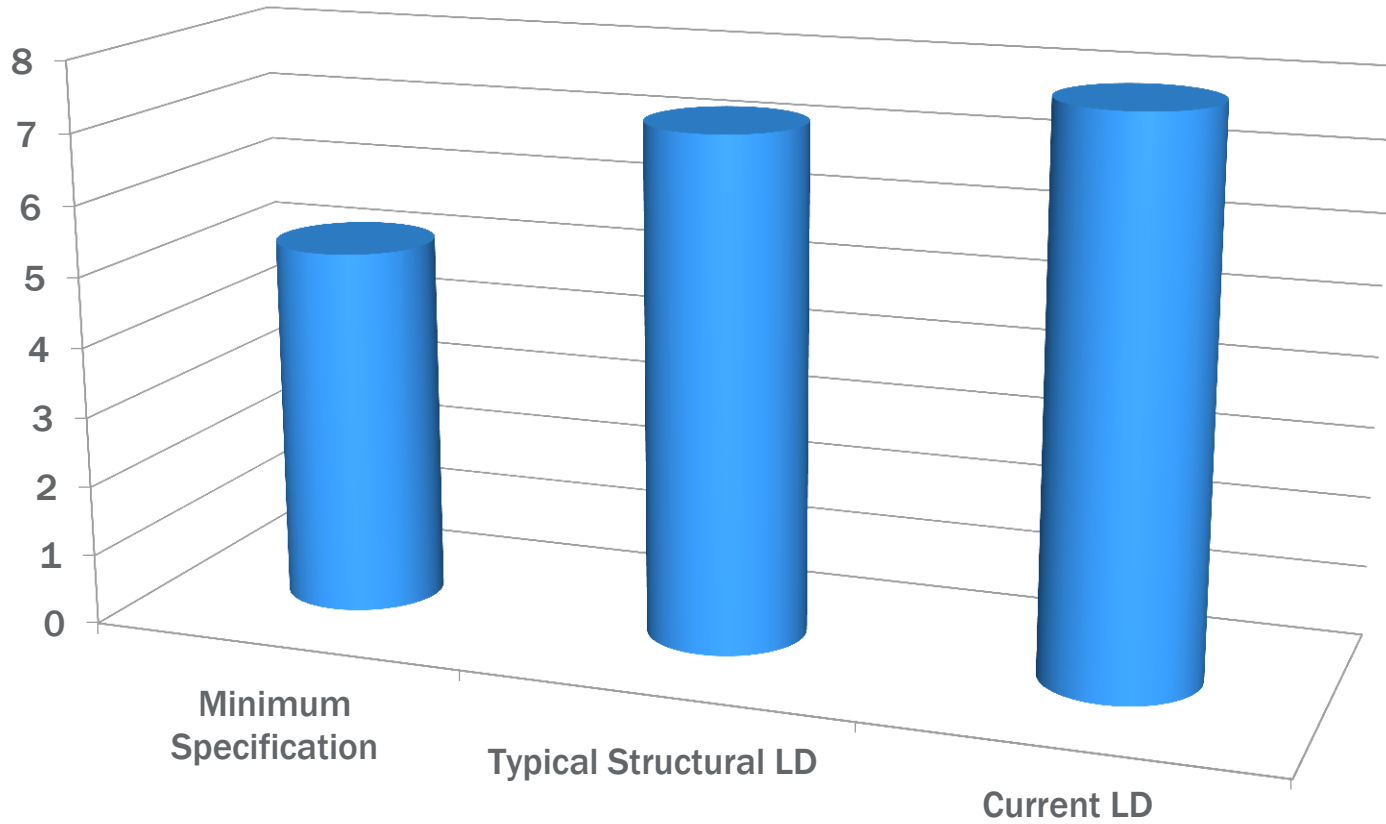
Flexural Strength: (MPa)



Ford LD Specification WSS-M3D188-A

Mechanical Properties

Flexural Modulus: (MPa)



Ford LD Specification WSS-M3D188-A

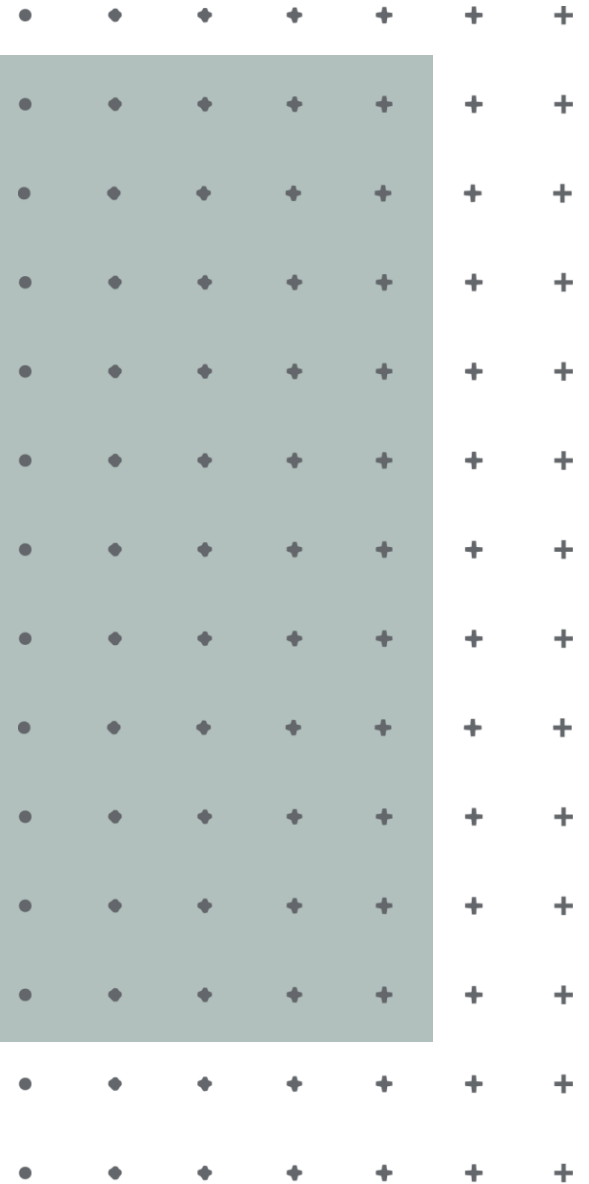
Other Properties



Structural Low Density Properties*	Typical Structural LD	Current 1.2 SPG Class A LD
Specific Gravity (1.0-1.4) (ISO 1183, Method A)	1.19	1.19
Water Absorption (max 1.3%) No blisters	1.14	0.58
Glass Fiber Content (33-45%) By weight	38	38

*Ford LD Specification WSS-M3D188-A

Status of the Current Class A 1.2 Low Density



Current Usage of Class A Low Density SMC



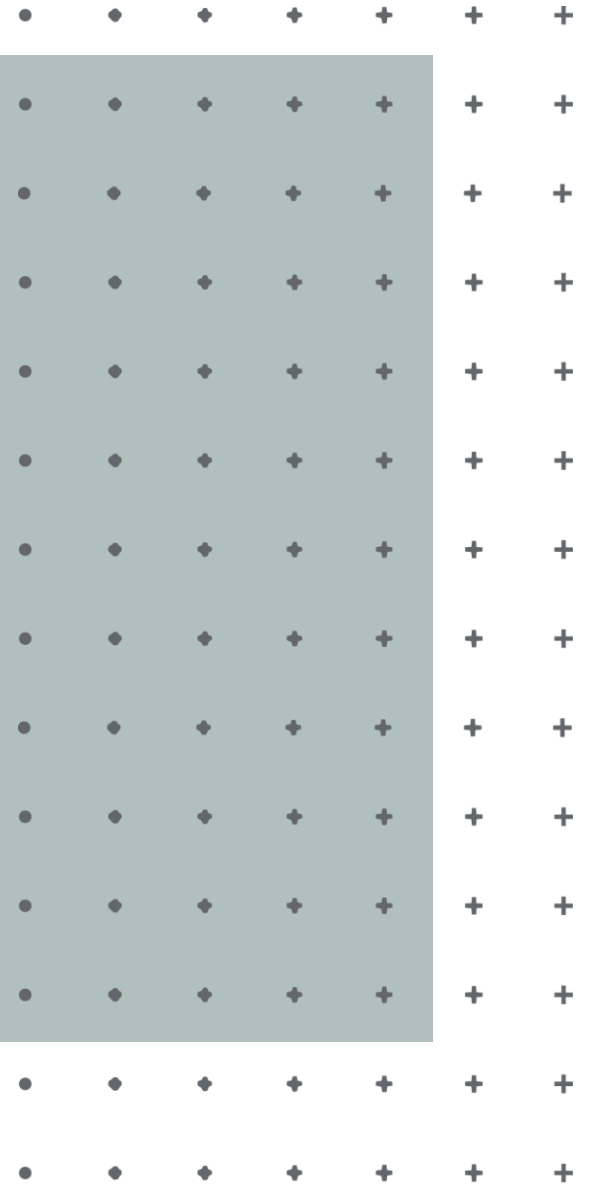
- This material is currently in production on the GM C7 Corvette and has been so for over a year.
- It has been pointed out that the material processes very well.
- Molding of the low density 1.2 SPG Class A goes very well with minimal if any paint pops.
- Customers are very happy with the over all performance of the system.

Status of Class A Low Density SMC



- *It has now been approved at two other OEMS.*
- *The low density 1.2 SPG Class A SMC is targeted for a new production application with a major OEM later this year.*

Opportunities for Low Density SMC



Opportunities



- **Explore the boundaries of the current 1.2 SPG system.**
 - **Current progress on improving the mechanical properties of the current system.**
 - **Studies are in progress to analyze the effects of lowering the specific gravity for Class A to 1.0 SPG.**

Higher Mechanical Property Class A LD SMC Progress



- **Modifications to the 1.2 SPG system has yielded:**
 - A Higher strength Class A SMC
 - System was ELPO bake tested and passed.
 - Good dimensional control – can be used in an “inner” structural application as well.
 - SPG now 1.25

Higher Mechanical Property Class A LD SMC Progress

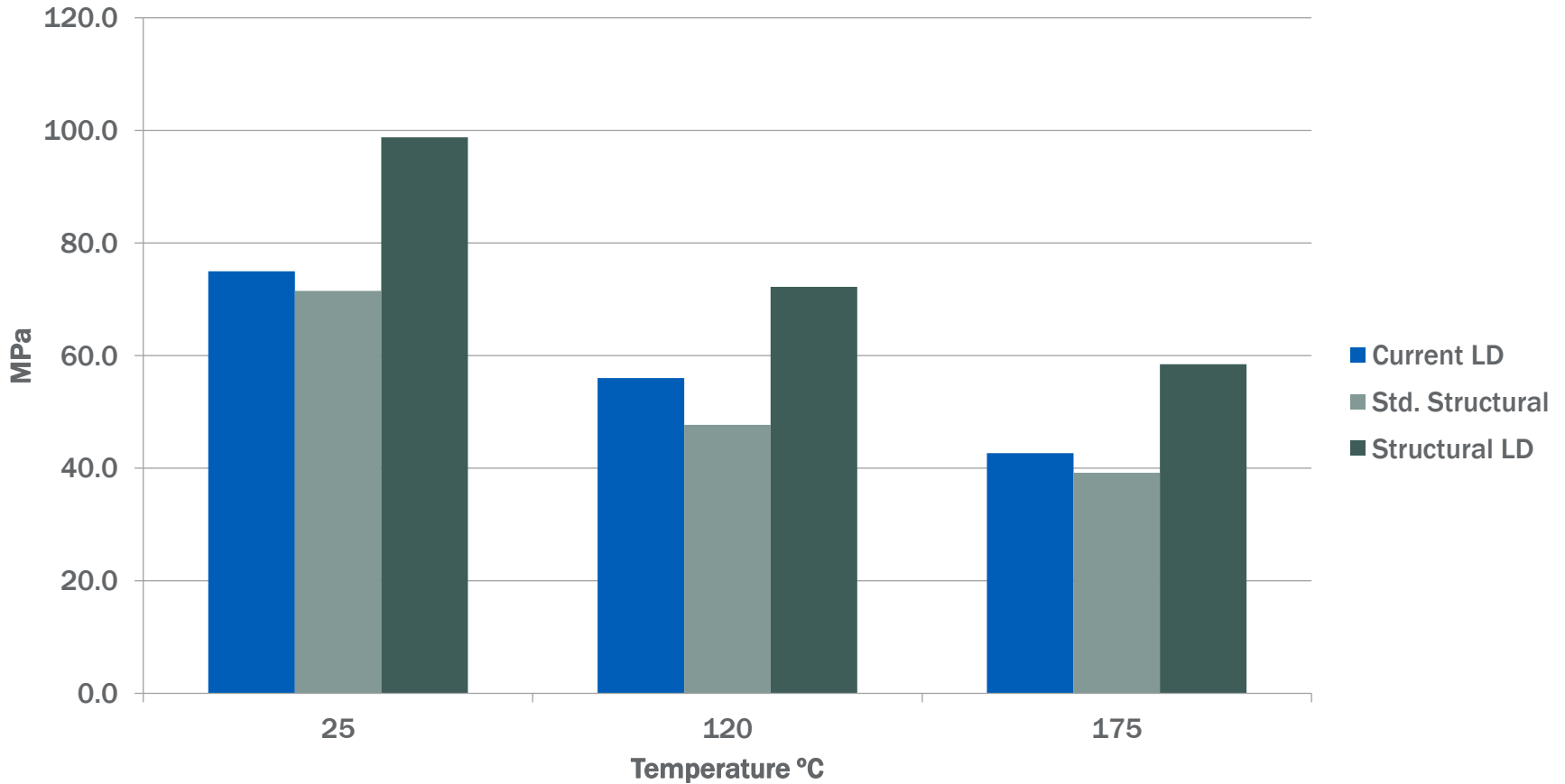


- **High Temperature Performance**

- *A key point to keep in mind is the concern for the loss of tensile modulus during high temperature painting.*
- *Even though tensile modulus is important at room temperature, it is also important through high temperature painting cycles.*

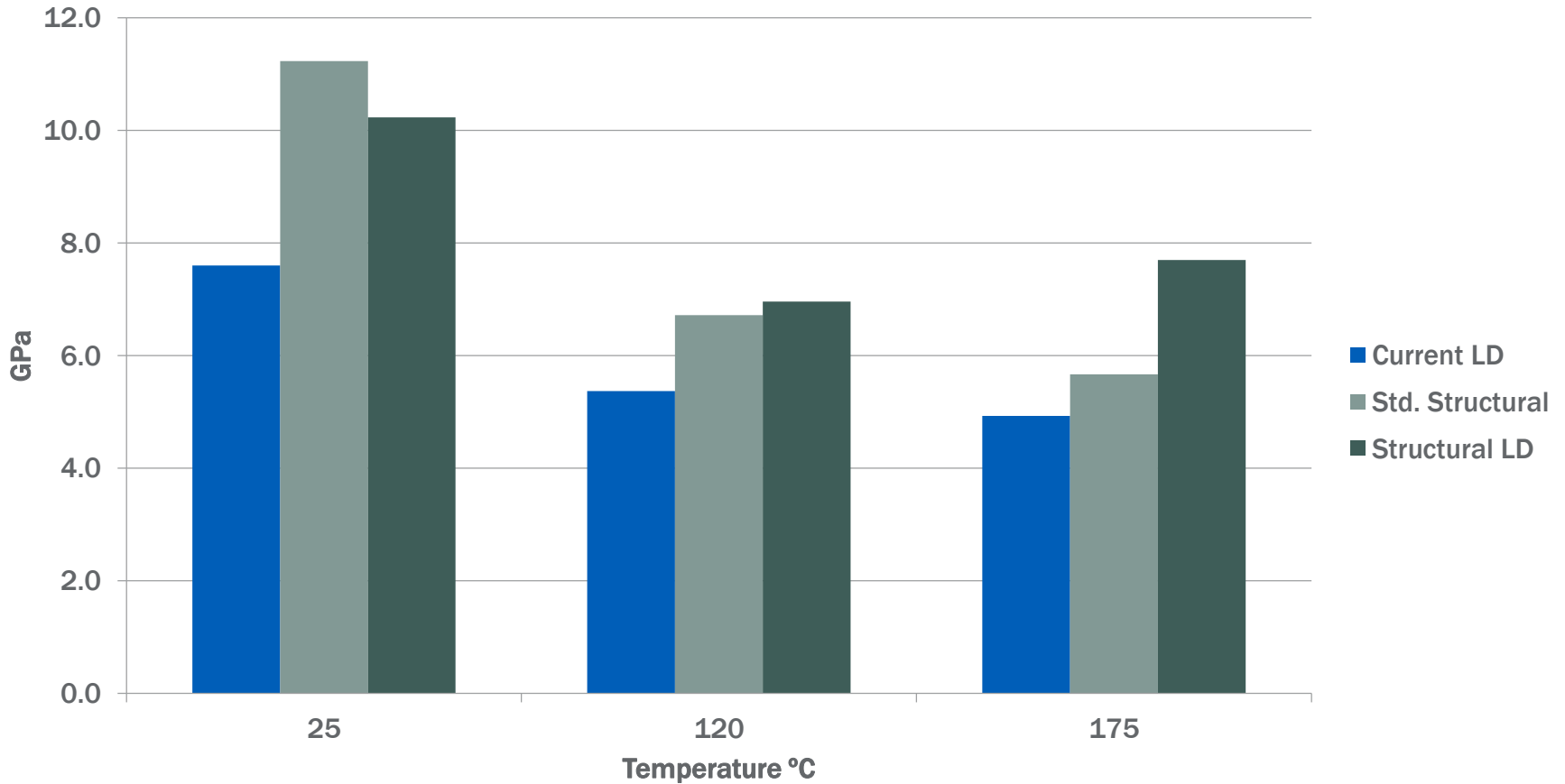
Higher Mechanical Property Low Density

Tensile Strength (MPa)



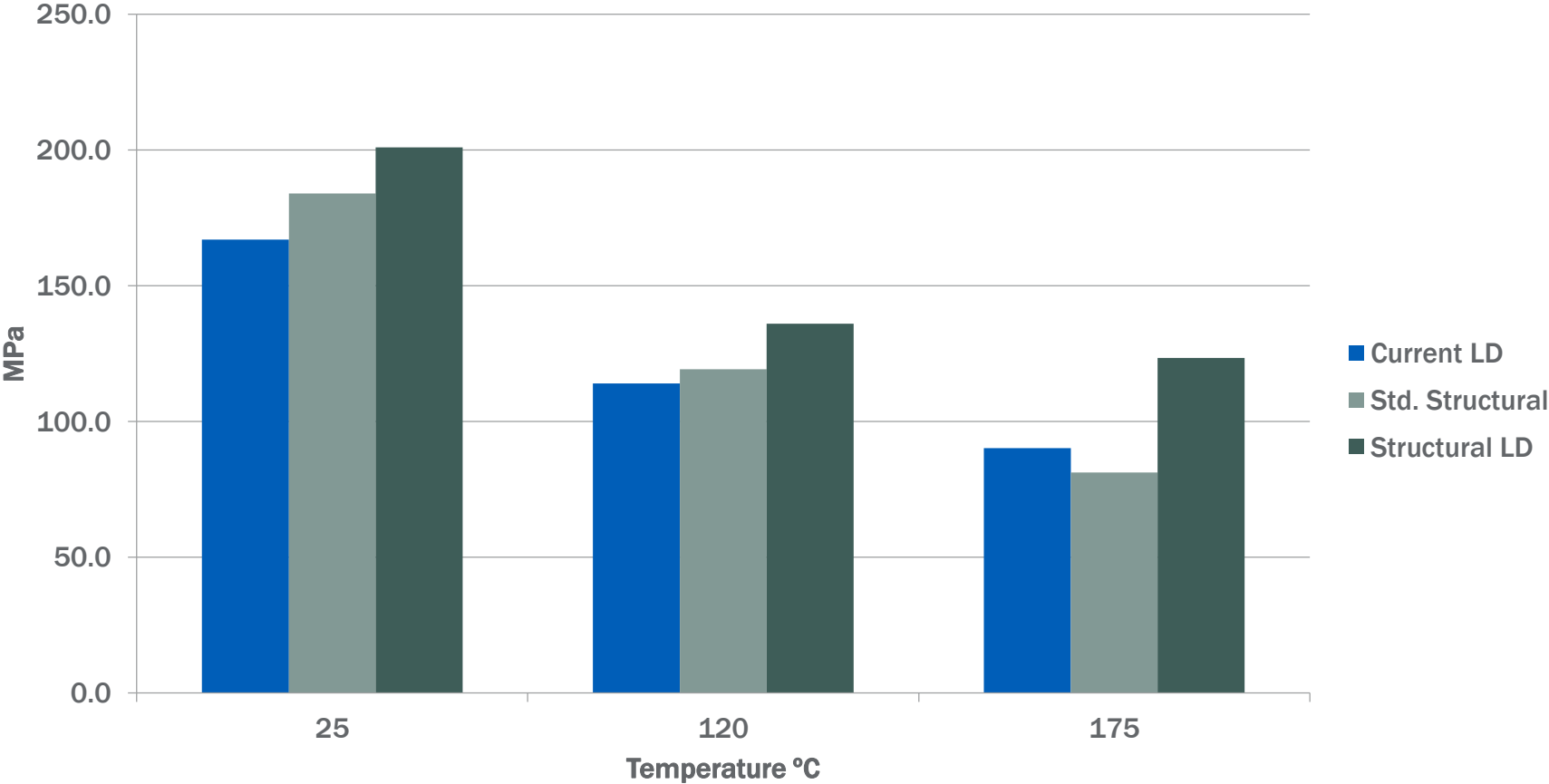
Higher Mechanical Property Low Density

Tensile Modulus (GPa)



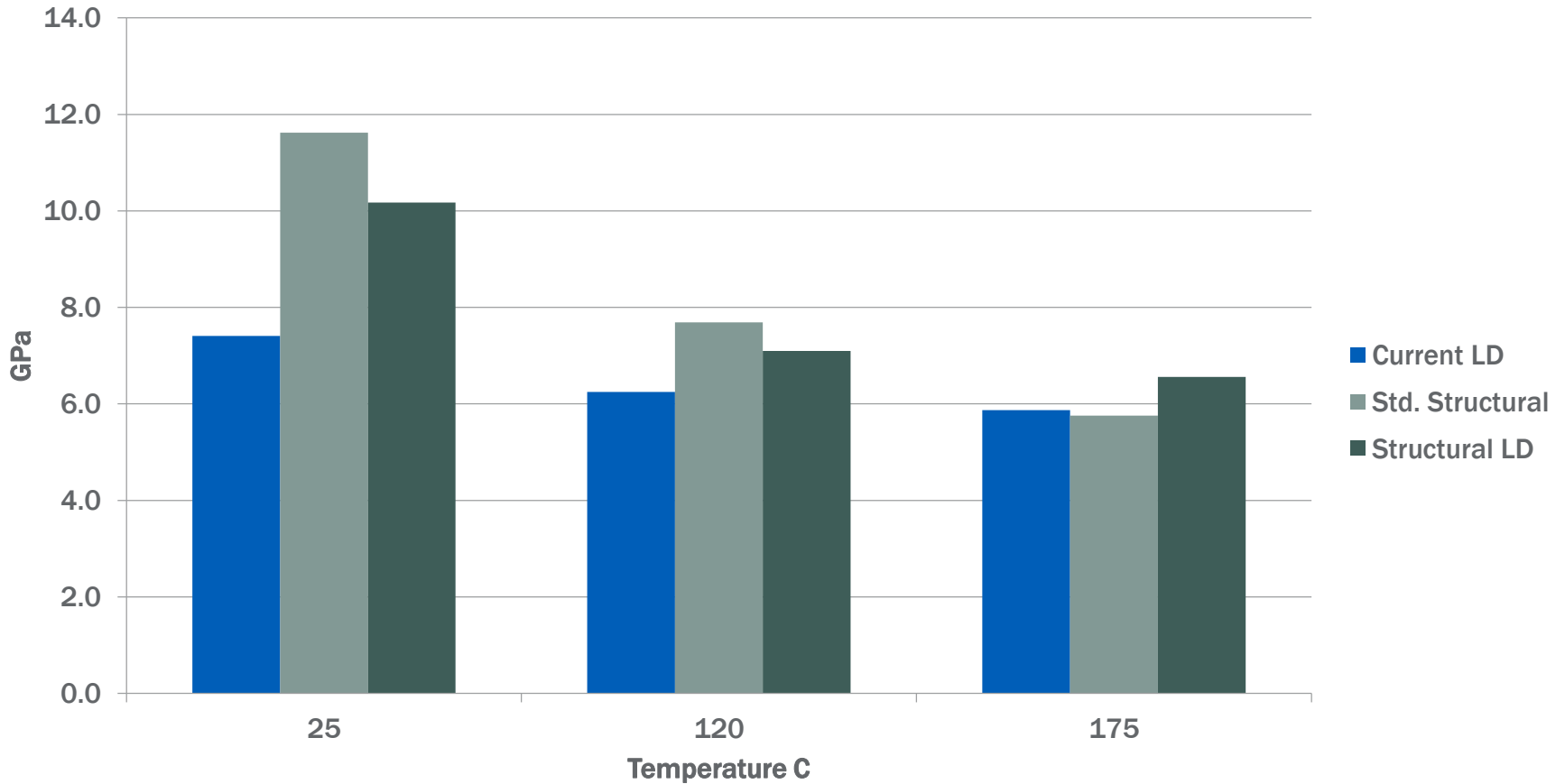
Higher Mechanical Property Low Density

Flex Strength (MPa)



Higher Mechanical Property Low Density

Flex Modulus (GPa)



Surface Properties



Description	LORIA	OP	DOI
Typical Structural LD	104	6.4	70
Current Low Density Class A – 1.2 SPG	50	9.6	97
Higher Property Class A Low Density – 1.25 SPG	56	9.3	94



Mechanical Properties

Structural Low Density Properties*	Higher Property Class A LD
Specific Gravity (1.0-1.4)	1.28
Water Absorption, max. 1.3% no blisters	0.6
Glass Fiber Content (33-45%) by weight	47.7

*Ford LD Specification WSS-M3D188-A



Ultra Low Density Class A: Surface Characteristics

Description	LORIA	O P	DOI
ULD Class A	51	9.5	96
Latest ULD Class A	57	9.3	95
Current 1.2 SPG LD Class A	50	9.6	97

Ultra Low Density Class A: Mechanical Properties



Structural Low Density Properties*	ULD Class A	Latest ULD Class A
Tensile Strength at Break, min. 42 MPa	50	55
Tensile Modulus at Break, min. 6.8 MPa	6.5	6.2
Tensile Elongation, min. 0.8%	1.08	1.19
Flexural Strength, min. 115 MPa	109	n/a
Flexural Modulus, min. 5.2 GPa	6.0	n/a

*Ford LD Specification WSS-M3D188-A



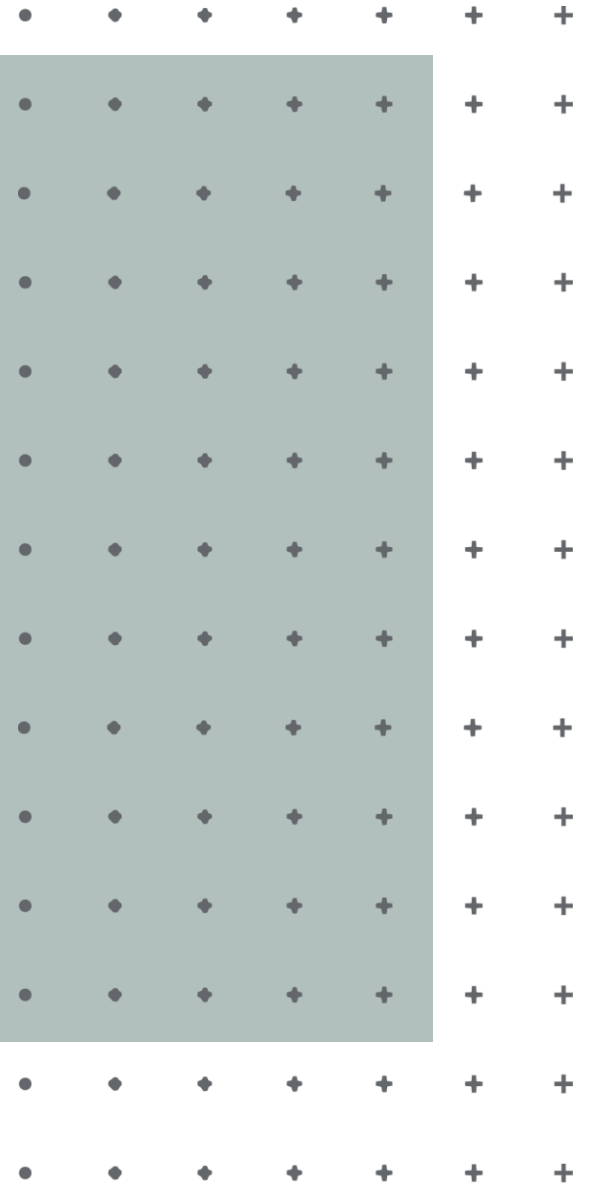
Ultra Low Density Class A:

Mechanical and Physical Properties

Structural Low Density Properties*	ULD Class A	Latest ULD Class A
Specific Gravity (1.0-1.4)	0.99	0.98
Water Absorption, max. 1.3% no blisters	0.92	0.91
Glass Fiber Content (33-45%) by weight	38.4	39.4

*Ford LD Specification WSS-M3D188-A

Low Density SMC: Summary



Summary



- **The AOC Low Density resin systems displayed –**
 - Mechanical Property results that were favorable to the Ford Low Density Structural Specification for Mechanical Properties WSS-M3D188-A
 - Some were superior to the surface characteristics shown for a standard density Class A system.
- **AOC now has a Class A resin system that is currently in production on the Chevrolet Corvette. The Class A system has also been qualified at Ford and Chrysler. Other OEMS are in the process of qualifying the Class A system as well.**

Summary



- We believe that the work done affords automotive OEMs the opportunity to immediately reduce the weights of Class “A” closure panels without having to change their manufacturing and assembly processes.
- These materials provide a cost competitive alternative to aluminum and carbon fiber composites and are readily available.
- Additional benefits include: greater design freedom, parts consolidation, lower tooling cost, dent/damage & corrosion resistance and excellent surface aesthetics.
- We are currently focusing on improving the Ultra Low Density versions for mechanical properties.

Thank You
Questions?



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