STRATEGIA

UNLIMITED LIQUID FORGING

www.strategia.world


UNLIMITED
LIQUID
FORGING

SUMMARY

STRATEGIA

SAFETY
TOECAP

Safety toecaps, performance-oriented geometry; lightweight, ergonomic, high-performance.

CASTING
TECHNIQUE

Components and connectors that must ensure gas-tight seals of all types.

VEHICLE
PARTS

Components, suspensions, braking systems, mechanical supports, steering bases, rocker arms, engine mounts, connecting rods.

STRATEGIA

UNLIMITED
LIQUID FORGING

HIGH-PERFORMANCE ALUMINUM FORGING

A unique technique for casting light alloys which involves applying very high pressure to the material in the liquid state during the solidification phase.

PROCESSES OF FORGING
COMPARISON

CONVENTIONAL
HOT FORGING PROCESS

1) **MELTING**
   - Melting Furnace
   - Degas
   - Filter

2) **DC Cast**

3) **Ultrasonic inspection**

4) **Homogenization**

5) **EXTRUSION**
   - Scalping
   - Preheat
   - Extrusion
   - Press

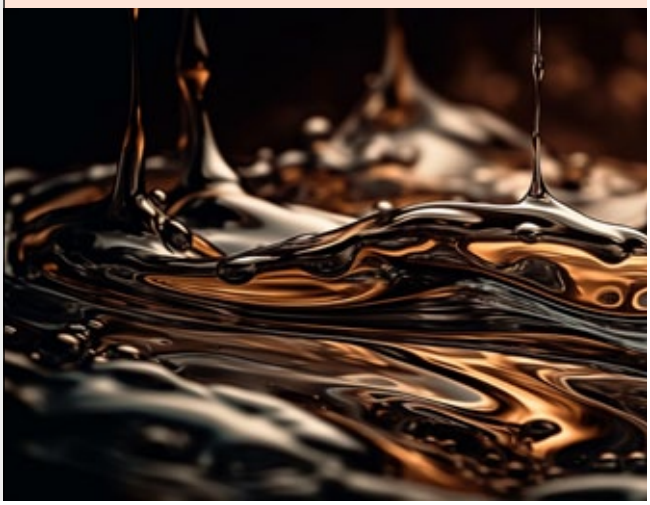
6) **Straighten & Cut**

7) **FORGING**

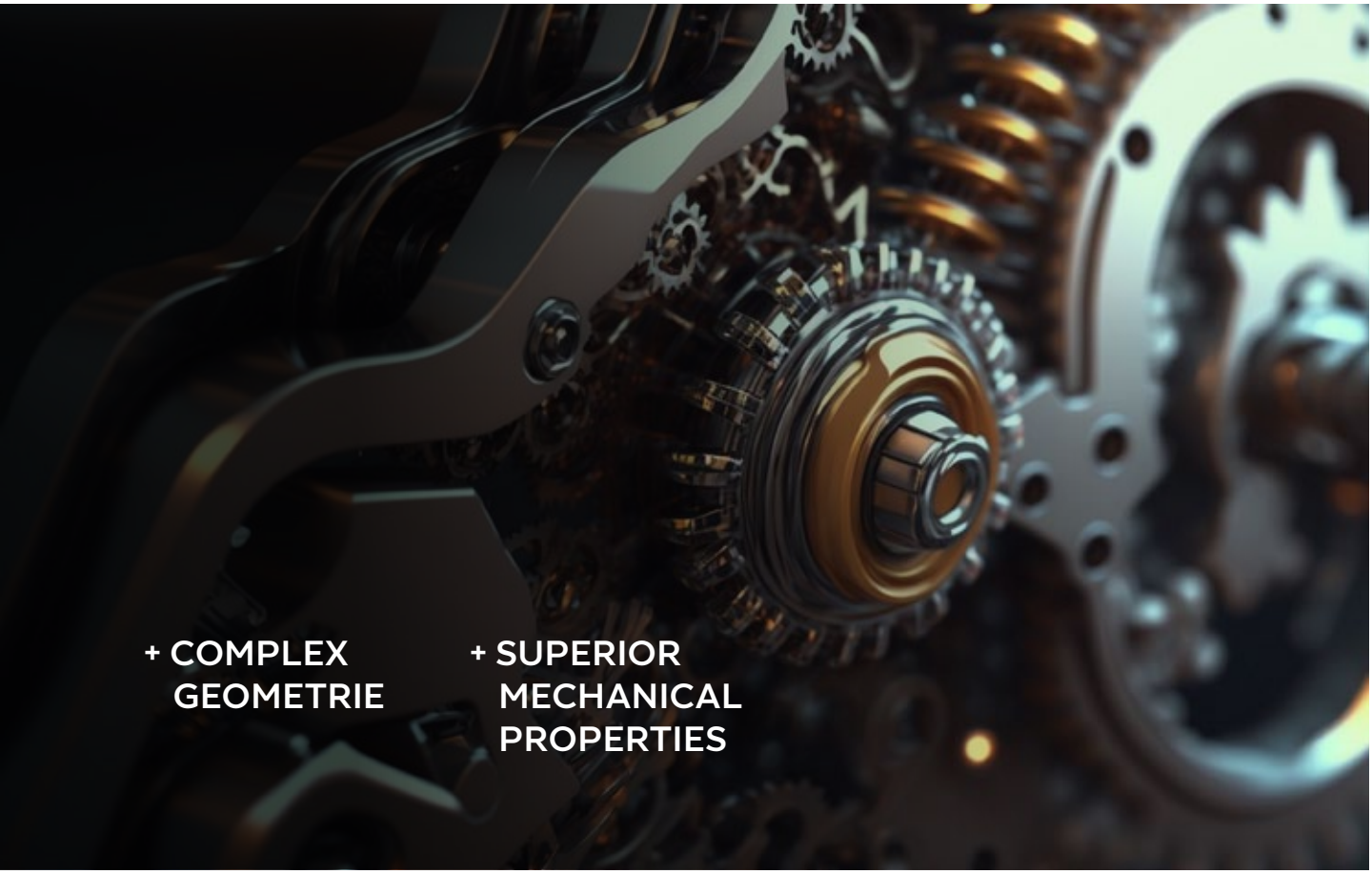
LIQUID FORGING
PROCESS

1) **MELTING**
   - Melting Furnace
   - Degas
   - Filter

2) **LIQUID FORGING**



HIGH-PERFORMANCE DESIGNS



A process that allows for **great design freedom**, as it overcomes the traditional molding limitations of competing technologies (forging, permanent mold casting, squeeze casting, etc.).

Furthermore, our special technology enables **high geometric precision** and **mechanical properties superior** to those of any other alternative casting process.

+ STRONG

+ QUALITY

+ THIN

+ PRECISION

+ VERSATILITY

+ PERFORMANCE

QUALITY
LIQUID FORGING

+ SUPERIORITY

Product density is higher than any traditional casting process (gravity or die casting) and **equivalent to forging**.

+ QUALITY

The **complete release of the air** contained in the mold is ensured by the **slow entry of the metal and specially made "airs"**.

+ VERSATILITY

The **compaction of the metal during solidification** allows the **recovery of the desired shape** considering the passage from the liquid state to the solid state.

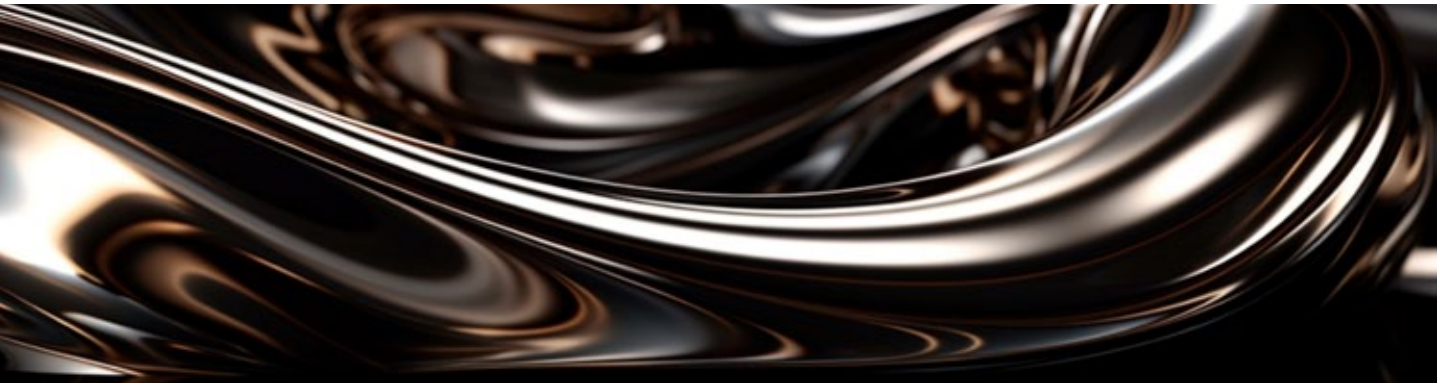
+ COMPETITIVITY

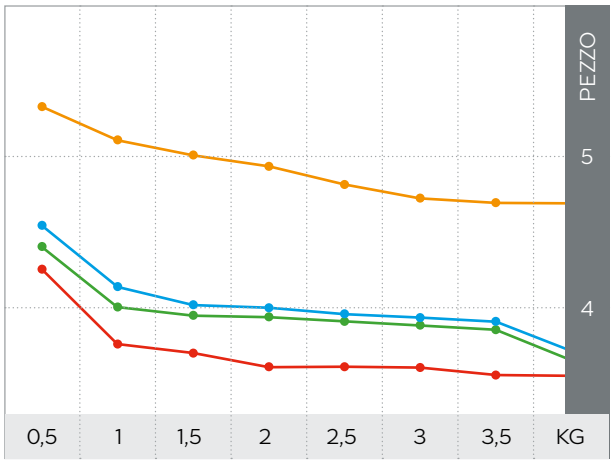
The **fully automatic production cycle** is guaranteed by the technical solutions adopted on the **machine layout**.
Cycle time much lower than Squeeze Casting (ratio 1:2.5).

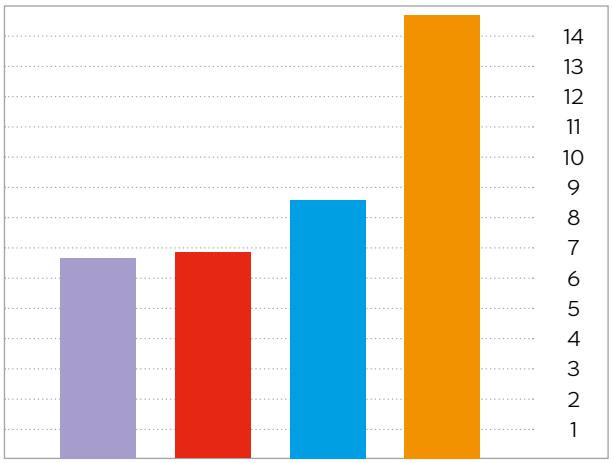
FEATURES
LIQUID FORGING

Structural integrity	Absence of porosity
Excellent micro-structure, for rapid solidification following forced cooling of the mould	Suitable for all types of light alloys, including magnesium (6082, 7075, 2014.0 A356, AlSi4.5, AlSi9, Magsimal, Silagont...)
Tighter dimensional tolerances than hot forgings	Possibility of carrying out thermal treatments
Possibility of producing pieces with inserts	Possibility of obtaining complex geometries
Possibility of creating multi-figure molds with substantial reductions in cycle time	Possibility of having different shapes in the same mould
Possibility of producing pieces weighing from 40g up to 10 kg	**THERE IS NO WASTE!** The right amount of liquid metal becomes the part

COST
LIQUID FORGING



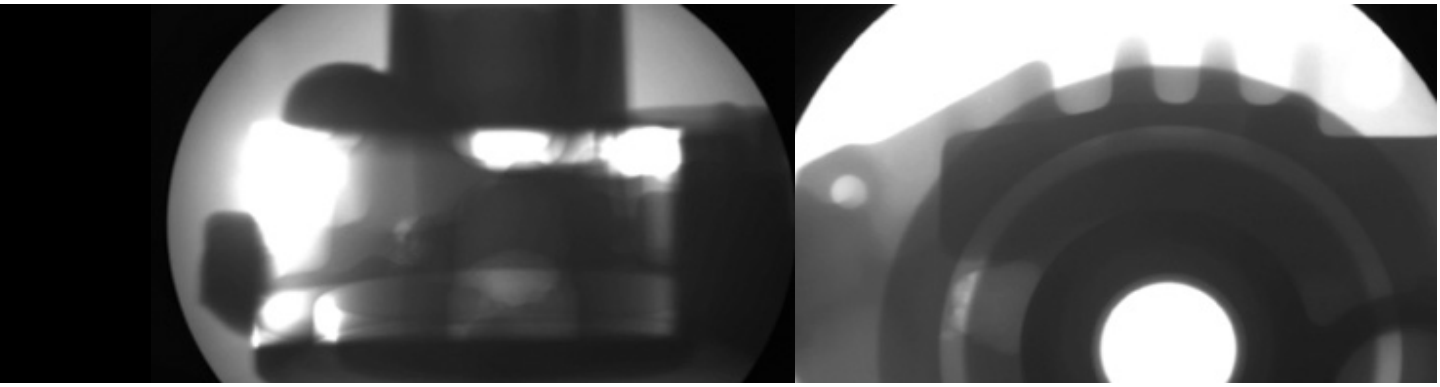




The cost of Liquid Forging is **lower** than that of gravity casting, offering **better qualitative and mechanical characteristics and higher productivity**. Cost positioned between permanent mold/gravity casting and high-pressure/ low-pressure die casting.

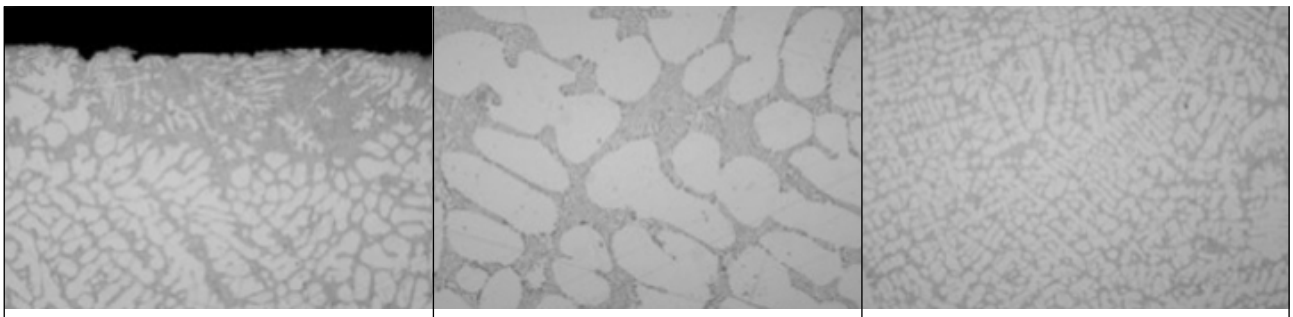
The comparison illustrates the cost in euro of the part made for Volvo in the various technologies.
Bear in mind the higher costs for Die Casting, Gravity and Low Pressure due to 100% impregnation, or a variable scrap from 6 to 20%.

TEST & MICROSCOPIC EXAMINATION



The x-ray images illustrate the compactness of the Volvo transfer case, the absence of porosity, microporosity, blowholes, cracks and crystallizations (characteristics common to the entire production batches).

LIQUID FORGING MICROSTRUCTURE



The **microstructure** at the **surface of the casting is very fine**, due to the **very rapid cooling of the liquid**.

The **interdendritic eutectic** solidification microstructure is **finely modified**..

The **heart structure** has a **high dendritism**, with average DAS values of about 18 μm, an index of **rapid cooling**.

MECHANICAL PROPERTIES

The hardness of the material is equal to 64.5 ÷ 67.5 HBW5/250, consistent with the lack of heat treatment of the alloy.

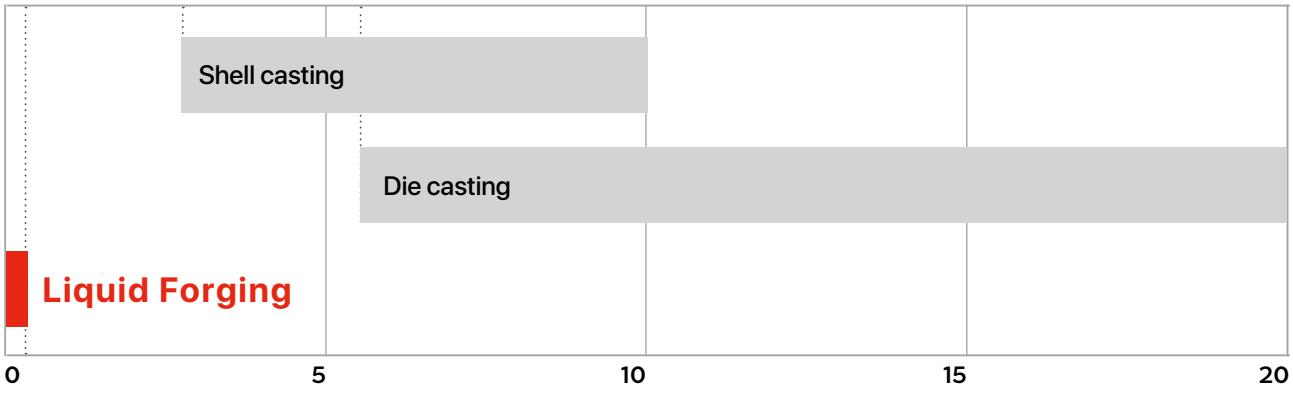
3 cylindrical specimens (L0=5xdiameter) were taken from the casting and subjected to a tensile test according to the manufacturer's standard.

The material is characterized by a minimum elongation value comparable to that envisaged for the same semi-solid cast alloy (thixoforming), according to tab. 53231.

From the casting were also made 5 test tubes of Charpy resilience without carving; the test (carried out according to tab. 50130) produced values.

PROBE	E (GPa)	Rp_{02} (MPa)	Rm (MPa)	A_5 (%)
1	38.7	97.8	208.5	10.6
2	43.5	100.4	211.6	10.0
3	47.3	97.6	223.9	19.3

PERCENTAGE OF POROSITY



PATENT

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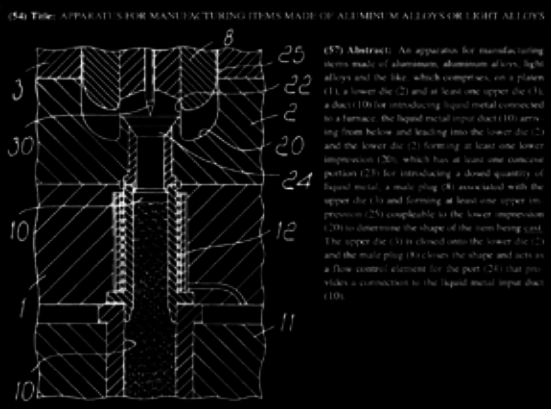


(54) Title: APPARATUS FOR MANUFACTURING ITEMS MADE OF ALUMINUM ALLOYS OR LIGHT ALLOYS

(57) Abstract: An apparatus for manufacturing items made of aluminum, aluminum alloys, light alloys and the like, which comprises, on a platen (1), a lower die (2) and at least one upper die (3), a duct (10) for introducing liquid metal connected to a furnace, the liquid metal input duct (10) serving from below and leading into the lower die (2) and the lower die (2) forming at least one lower impression (20), which has at least one eutectic portion (23) for introducing a dosed quantity of liquid metal, a male plug (8) associated with the upper die (3) and forming at least one upper impression (25) coupleable to the lower impression (20) to determine the shape of the item being cast. The upper die (3) is closed onto the lower die (2) and the male plug (8) closes the shape and acts as a flow control element for the port (24) that provides a connection to the liquid metal input duct (10).

STRATEGIA

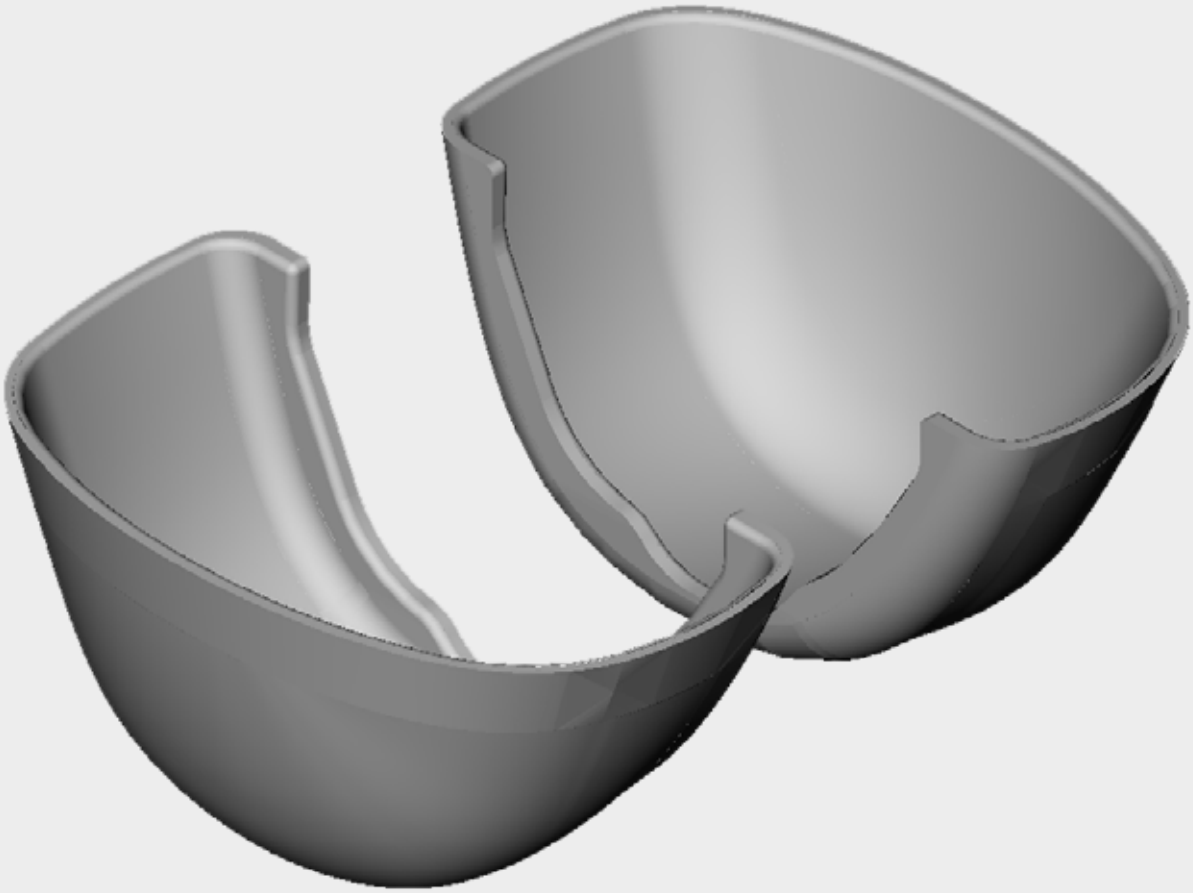
SAFETY
TOECAP

PERFORMANCE SHAPES
THE FINAL GEOMETRY

Toecaps featuring an innovative design developed using the latest technologies derived from the automotive and aerospace sectors.

A lightweight, ergonomic, and above all high-performance toe cap.

TOECAP GEOMETRY

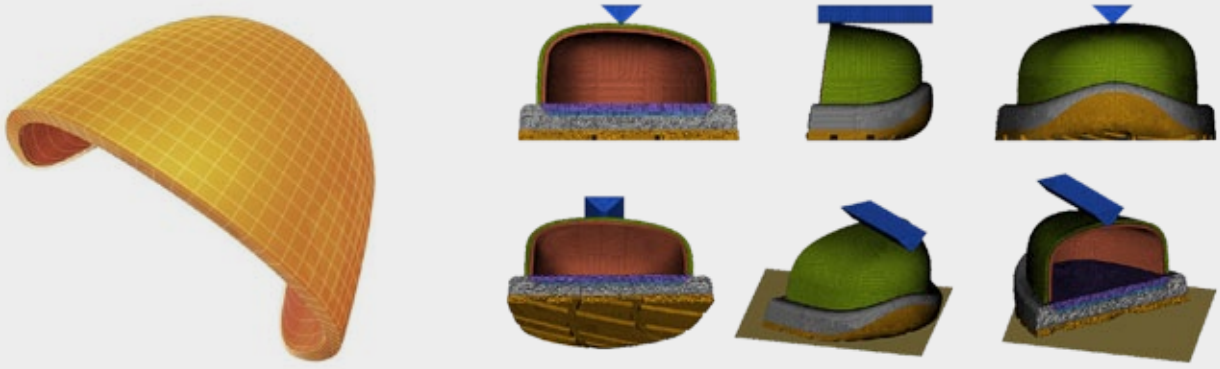


We design the toecaps using **CAD** and verify them with **FEM technology** prior to mold construction.
FEM methods optimize their shape for performance, ensuring a balanced and safe design.

We simulate the toecap's strength and, if necessary, **modify it to achieve optimal performance**.

Material is used only where required to meet the target specifications.

TECNOLOGIA FEM (Finite Element Method)



+ THIN

Using the topology and shape optimization process, areas that do not contribute to structural strength are identified.

+ LIGHT

Variable thickness distribution thanks to Liquid Forging technology.
Load-bearing sections are thicker, while secondary sections are thinner.

+ RESISTANT

The new punctual geometry is well within the prescribed limits and there is no risk of breakage.

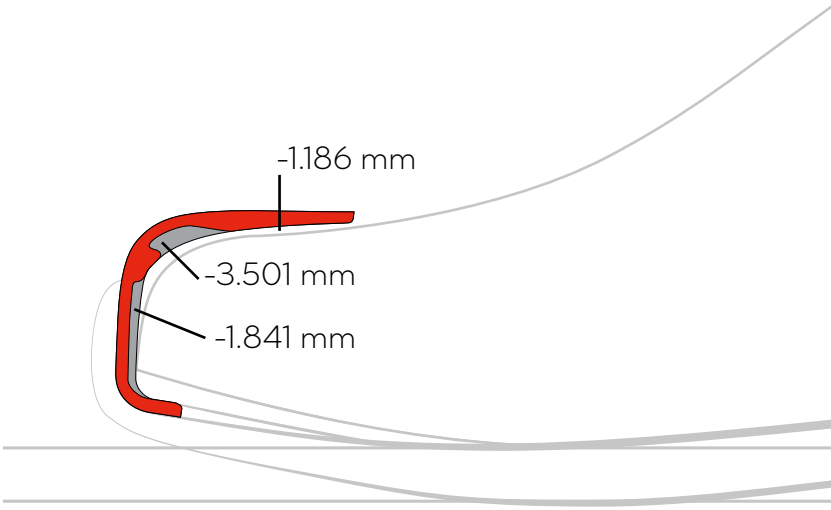
+ STRENGHT

In compliance with the required format, the material is distributed in such a way as to meet the specific constraints and objectives.

WEIGHT REDUCTION

Our toecaps are **twice as light as steel** and **less bulky than plastic, yet just as strong**.

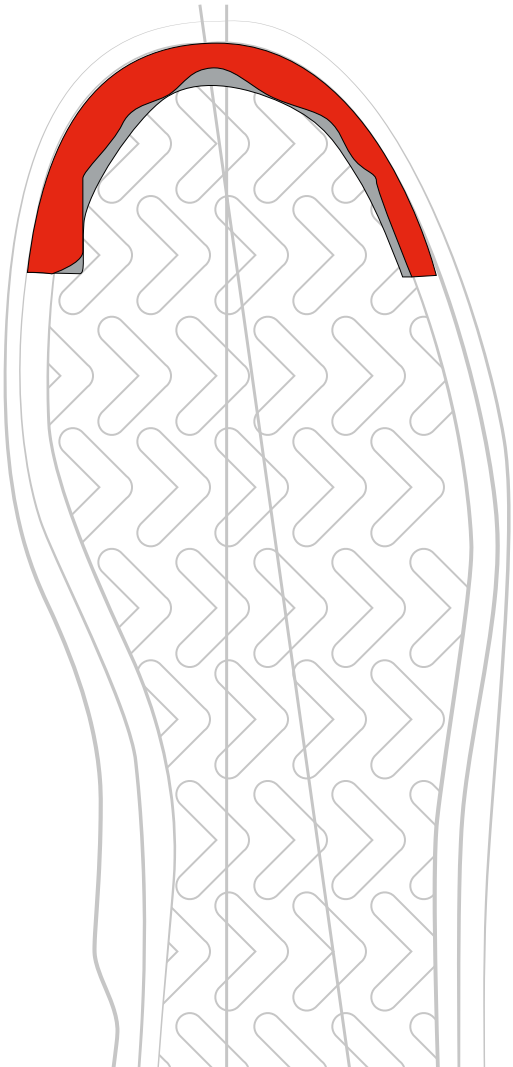
Our **lightest toecap weighs 60 grams** and our **heaviest just 68 grams.**



With an average lower weight of 8 gr it is the best compromise between weight and performance.

Our technology allows us to **use material only where necessary**;
we avoid unnecessary material costs and reduce weight.

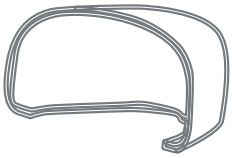
– 8 gr (-14,3 %)



We produce all of our toecaps in-house and **weigh them as soon as they are produced**. Only tips with the right weight continue in the subsequent processes because **the weight is one of the guarantees of the quality of the toecaps**.

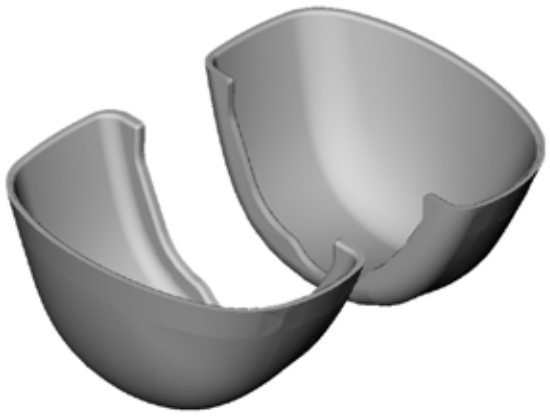
We guarantee the weight with a tolerance of +/- 3.5 grams.

MODELS AND SIZES
TOECAP



We have **4 types of ferrules and sizes from 5 to 12**, it's easy for you to choose the right ferrule with our drawings and samples. We are the only ones who also manufacture **small sizes**, ensuring that women too can have safe, lightweight shoes suitable for office wear.
The table lists the key models in our product range, along with their respective sizes and certifications.

MODELS	5	6	7	8	9	10	11	12	Type A	Type B	
AS 522S	■	■	■	■	■	■	■	■	●	●	●
AS 604R	■	■	■	■	■	■	■	■	●	●	●
A 159		■	■	■	■	■	■	■	●	●	●
AS 795		■	■	■					●	●	●
									EN ISO 22568-1:2019		CSA



TOLLERANCE

It will be easier for you to produce the shoes because our toe caps are born from the cast alloy and thus have a **stable shape with a shape tolerance of 0.1 mm** instead of 0.4 mm or even 0.7 mm of other manufacturers.

YOUR TEOCAP

If you want we can produce "YOUR" tip that will be only yours, to make shoes ever more comfortable and beautiful, because our technology allows it.

CUSTOM-MADE MODELS

Meeting our customers' needs is our primary objective; for this reason, we offer the option to customize existing geometries or develop entirely new shapes.

PROCESS CONTROL

Our process begins with sourcing the necessary raw materials (aluminum, copper, magnesium, titanium, etc.) and **preparing the alloy, which are then mixed in melting furnaces**.

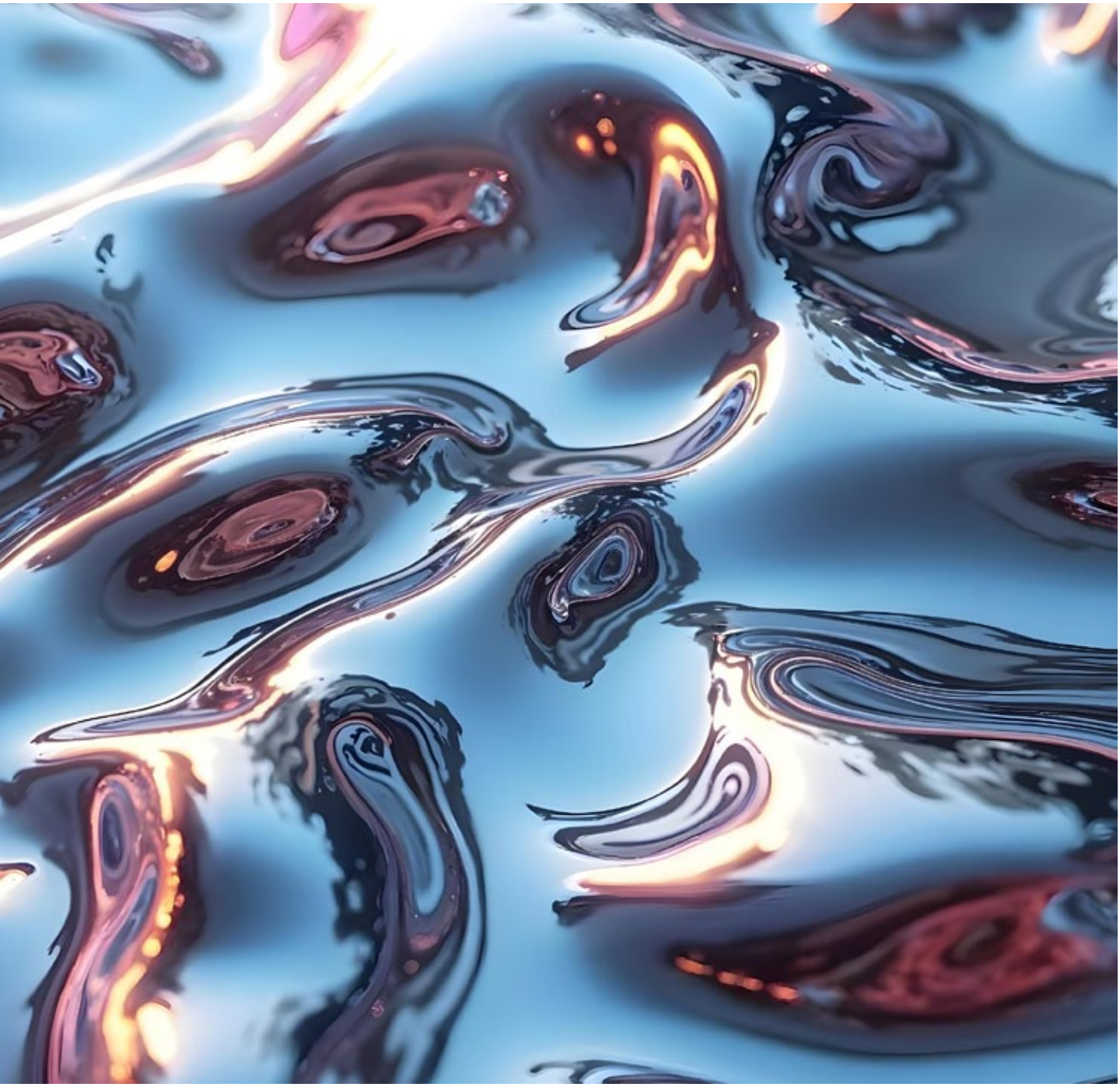
The molten metal is subsequently **injected into specialized molds** mounted on presses; these impart the **desired geometry and shape the component under high pressure**, thereby **enhancing its mechanical properties**.

OUR MOLDS

We manufacture the molds in-house using high-quality steel and test them directly in production to verify their output capacity.

Once a production run is complete, our specialized staff inspects, cleans, and if necessary refurbishes them.

PRIMARY ALUMINUM
ALLOY



We **internally produce the aluminum alloy** only with **primary aluminium**. We chemically analyze every batch of aluminum alloy produced in our laboratory. Of course we **keep the analysis data for many years**.

AVIONAL

Aluminum is **three times lighter than steel and less bulky than plastic**.

It is a very **tough metal** with **excellent corrosion resistance**.

RECYCLING

We prepare our alloy in-house using **the best primary aluminum plus 35% to 45% recycled aluminum**.

INSPECTIONS
AND CERTIFICATIONS

All our models are certified according to the **EN 12568:2010** and **ISO 22568:2022** standards by the **CIMAC** center specialized in footwear application materials.

EN 12568:2010

ISO 22568:2022

CIMAC
WE TEST
WE CERTIFY

CONTROLLO PUNTALI

Before packing, we **check all toecap** with expert personnel.

This is why **our outgoing reject rate is almost nil**.

+ CONTROL

+ PRECISION

+ PRODUCTIVITY

- WASTE

- WASTAGE

- MATERIAL

PRODUCT TRACEABILITY

We **keep the tested and destroyed tips for over 2 years**, finally we compile a **report with the results** that we archive.

Using the **QR code on the packaging**, we will tell you **which alloy batch was used to make the tip**, **when it was manufactured**, and - most importantly - **the results of the crash tests**.

TOECAP SHIPMENTS

We also have the necessary experience to **ship toecap worldwide** because we are already doing it.

In a short time and at the latest within 36 hours we agree with you the date of shipment of the material. **We also plan deliveries over 3 months in advance**.

If you have a need we will answer you immediately, if you have a problem we will help you solve it.

STRATEGIA

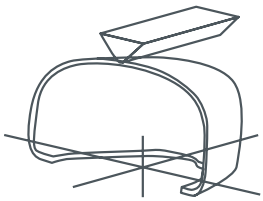
STRESS
TEST

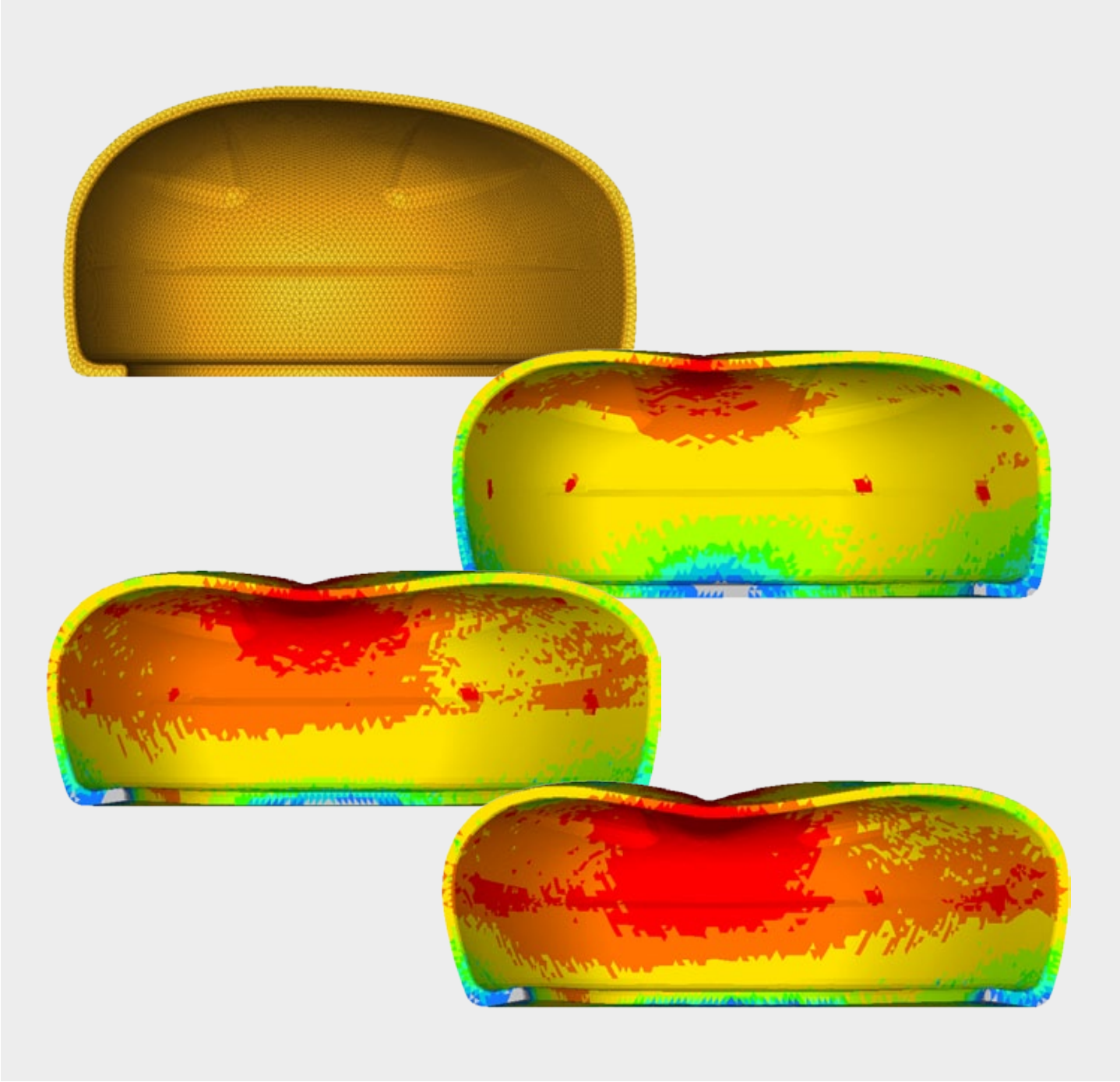
VIRTUAL SIMULATION
PHYSICAL VERIFICATION

To shorten the development time for the toecap, we use a virtual simulator, but only repeated crash tests on the pre-production units will validate the design.


BOOTS
CK

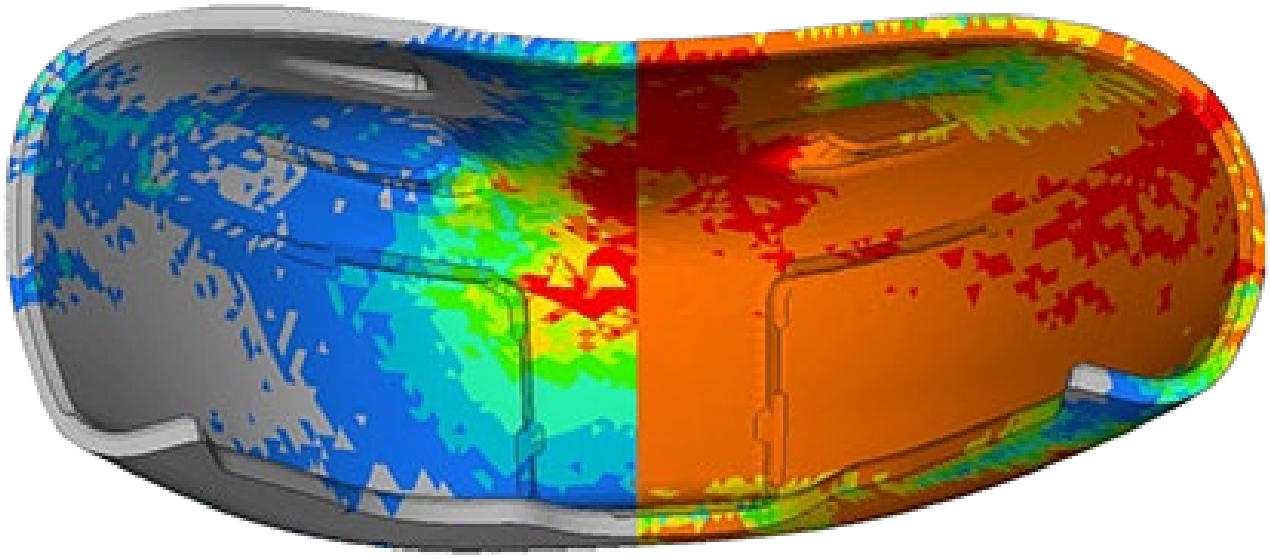
CRASH TEST
VIRTUAL 3D





Through our virtual crash tests, we can **verify the performance of the toecap before it is manufactured**.

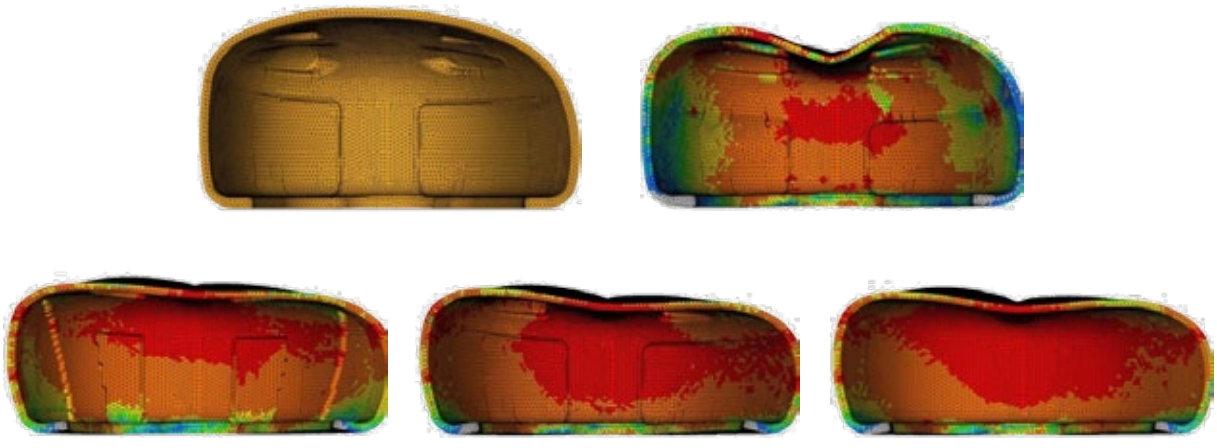
Using our **topology optimization methodologies**, we define the **perfect geometry**.



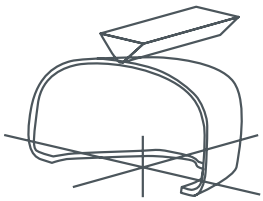
PLASTIC DEFORMATION MAPPING
OF THE SECTION

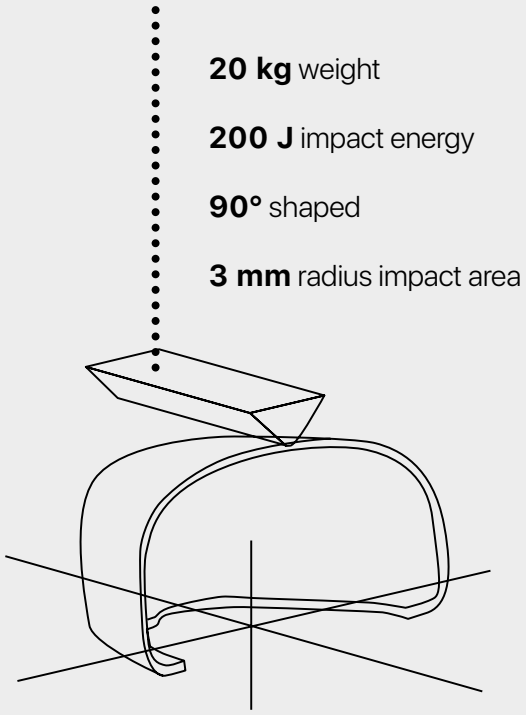
During the Virtual Crash Test the **plastic deformation is only superficial**.

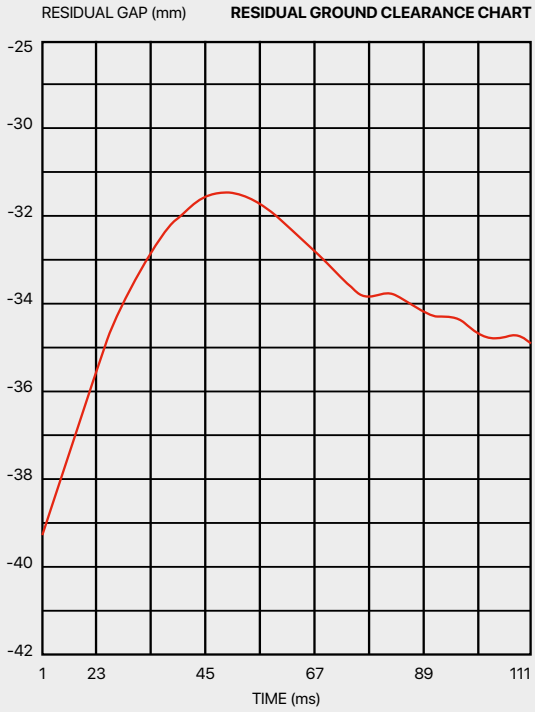
Von Mises strength criterion mapping.



CRASH TEST
PHYSICS SIMULATION







ALUMINUM AVIONAL

Density **2.72 g/cm3**

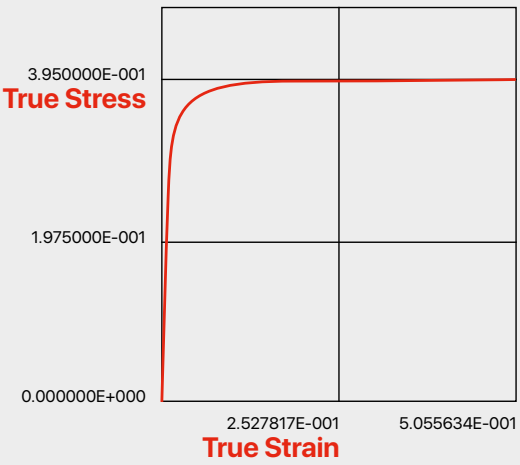
Tensile Strength, **Ultimate 395 Mpa**

Tensile Strength, **Yield 230 Mpa**

Elongation at Break **14 %**

Modulus of Elasticity **71.0 Gpa**

Poissons Ratio **0.330**



The simulation was carried out in compliance with the **European legislation**; the tip was positioned tangent to a 90° test fixture.

This impactor weighs 20 kg and is a wedge positioned at 90° shaped with a 3mm radius in the impact zone.
It is released from a height of 1 m with an impact energy of 200 J.

TEST RESULTS

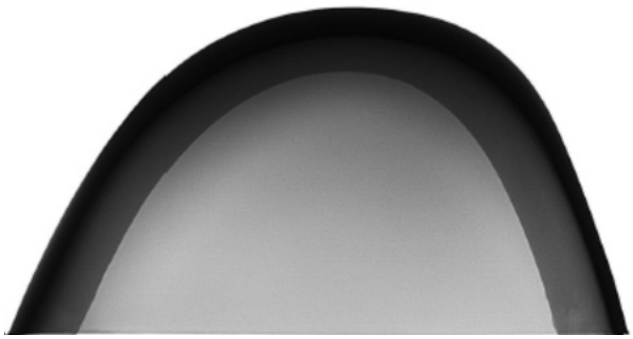
TOECAP TYPE	WEIGHT	RESIDUAL CLEARANCE	TARGET	NONE RISK OF BREAK
AS 604R/9	68 gr	31,5 mm	21,5 mm	✓

TOECAP TESTING

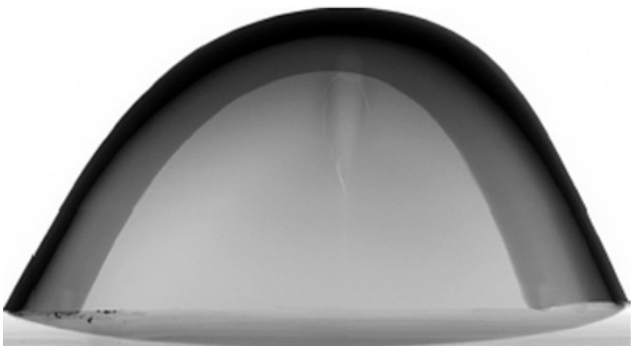
For your safety and ours, **we destroy over 15,000 pairs of toecaps annually** with technological testing.

We **test the finished product** in the company: for each production batch, we subject **80 pairs of toecaps for each size** to the 200 Joule crash test.

TOECAP ANALYSIS

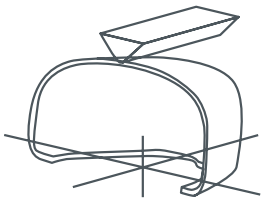


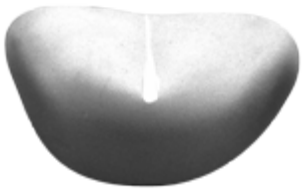
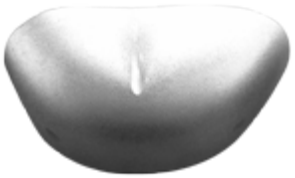
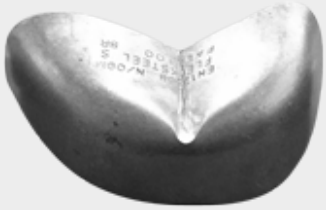
Toecap pre-crash test



Toecap post-crash test

CRASH TEST RESULTS



MODEL TOECAP	**AS 604R**	**AS 522S**
STRATEGIA TOECAP RESIDUAL CLEARANCE	 **31,5 mm** 	 **29,5 mm** 
OTHER TOECAP RESIDUAL CLEARANCE	 **26,0 mm** 	 **23,0 mm** 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