PODIUM

ADVANCED TECHNOLOGIES

Suspension Components Topology Optimisation Analysis Specification

Revision 03

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1. Analysis objectives

The aim of performing topology optimisation for the components listed below is to help understand relation between part mass and stiffness in specified directions under stiffness load scenarios. Direct objective of the topology optimisation is to achieve the desired stiffness targets while minimising part mass.

Constraints of the optimisation should include:

- 2 stiffness load cases with maximum deflection of camber and toe angle,
- Manufacturing constraints – draw direction, split lines, component symmetry

2. Analysis items

The items listed below are the items to be topology optimised. The optimisation volume for each component is attached with this file in .stp format. Unless otherwise specified, the parts are supplied for LH side only, with the assumption that the mirrored geometry will e used for the opposite side of the car.

2.1. Front upright

Component is an assembly of two parts – a) upright and b) upper wishbone mount, fixed together with distancing shims, by means of 3 threaded fasteners to which several other components are attached, namely:

c) Upper wishbone
d) Lower wishbone
e) Tierod
f) Wheel hub
g) Brake calliper
d) Brake duct – attachment points neglected

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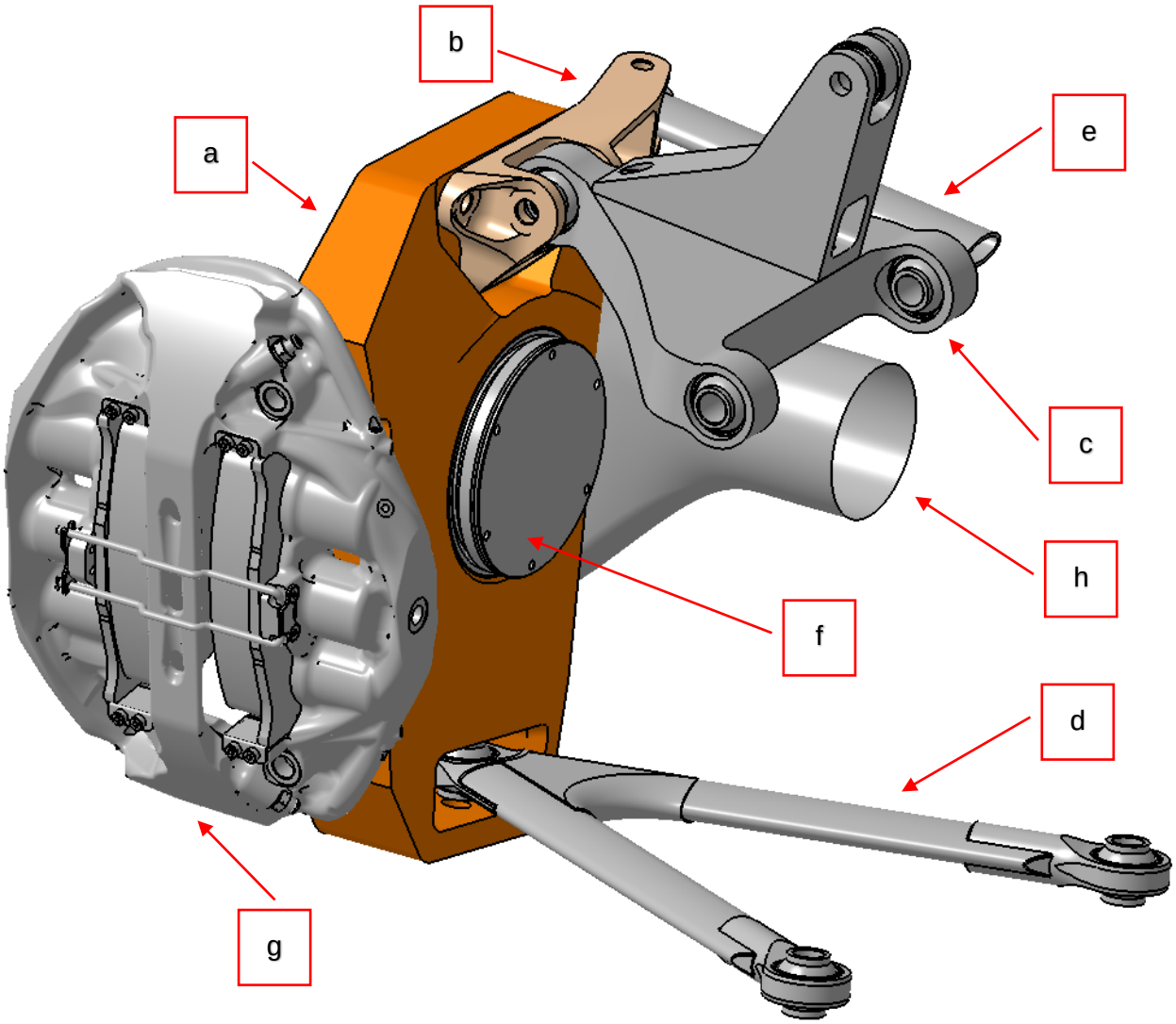

2.1.1. Geometrical constraints

- No component symmetry is required;
- Draw direction normal to “Plane_1”;
- Minimum wall thickness: 3 mm;

2.1.2. Material

Material intended to be used for this component is billet 6000 series aluminium in T6 condition.

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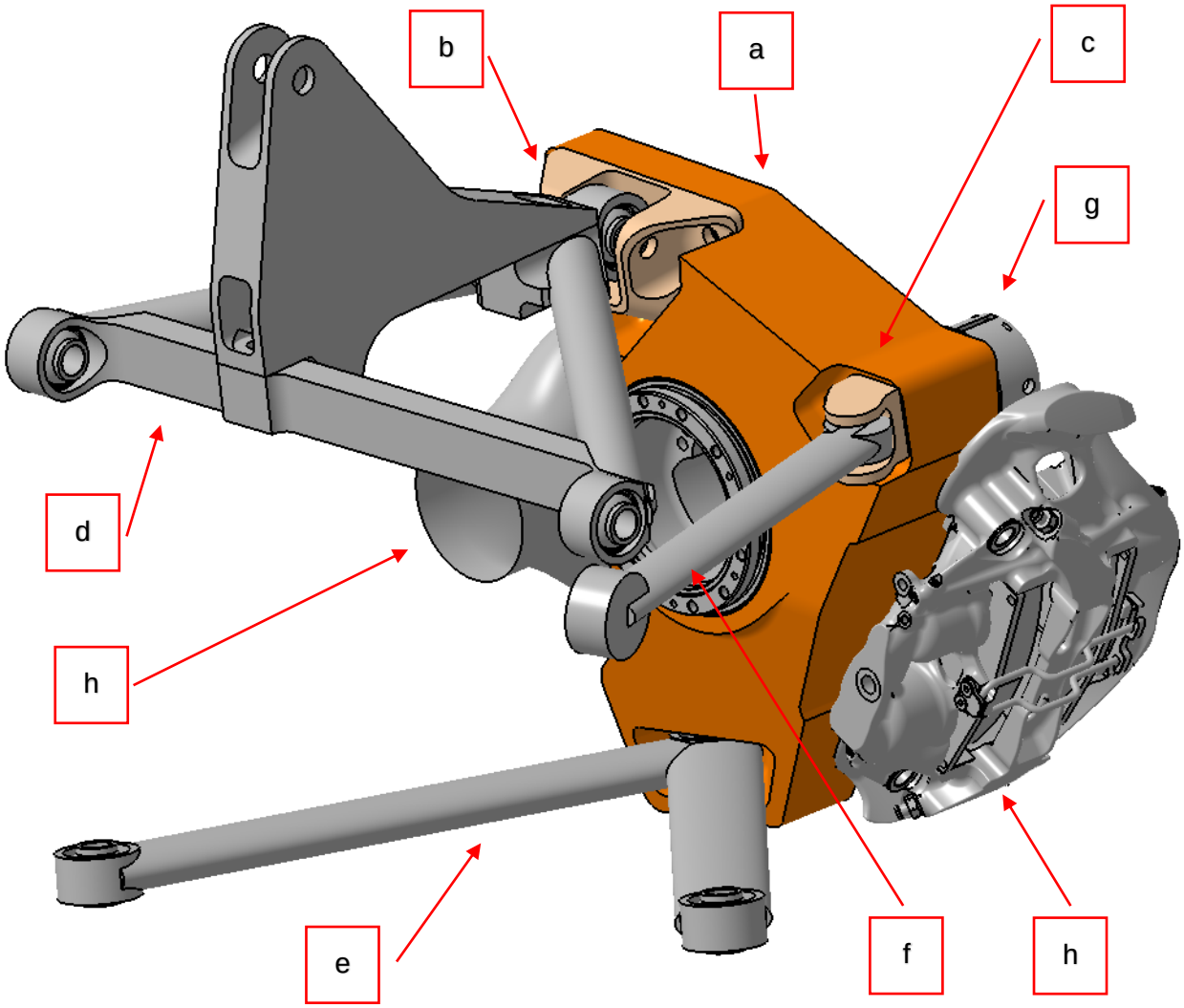
2.2. Rear upright

Component is an assembly of three parts – a) upright, b) upper wishbone mount and c) tierod mount – fixed together with distancing shims, by means of 4 threaded fasteners to which several other components are attached, namely:

e) Upper wishbone
f) Lower wishbone
g) Tierod
h) Wheel hub
i) Brake calliper
j) Brake duct – attachment points neglected



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2.2.1. Geometrical constraints

- No component symmetry is required;
- Draw direction normal to “Plane_1”;
- Minimum wall thickness: 3 mm;

2.2.2. Material

Material intended to be used for this component is billet 6000 series aluminium in T6 condition.

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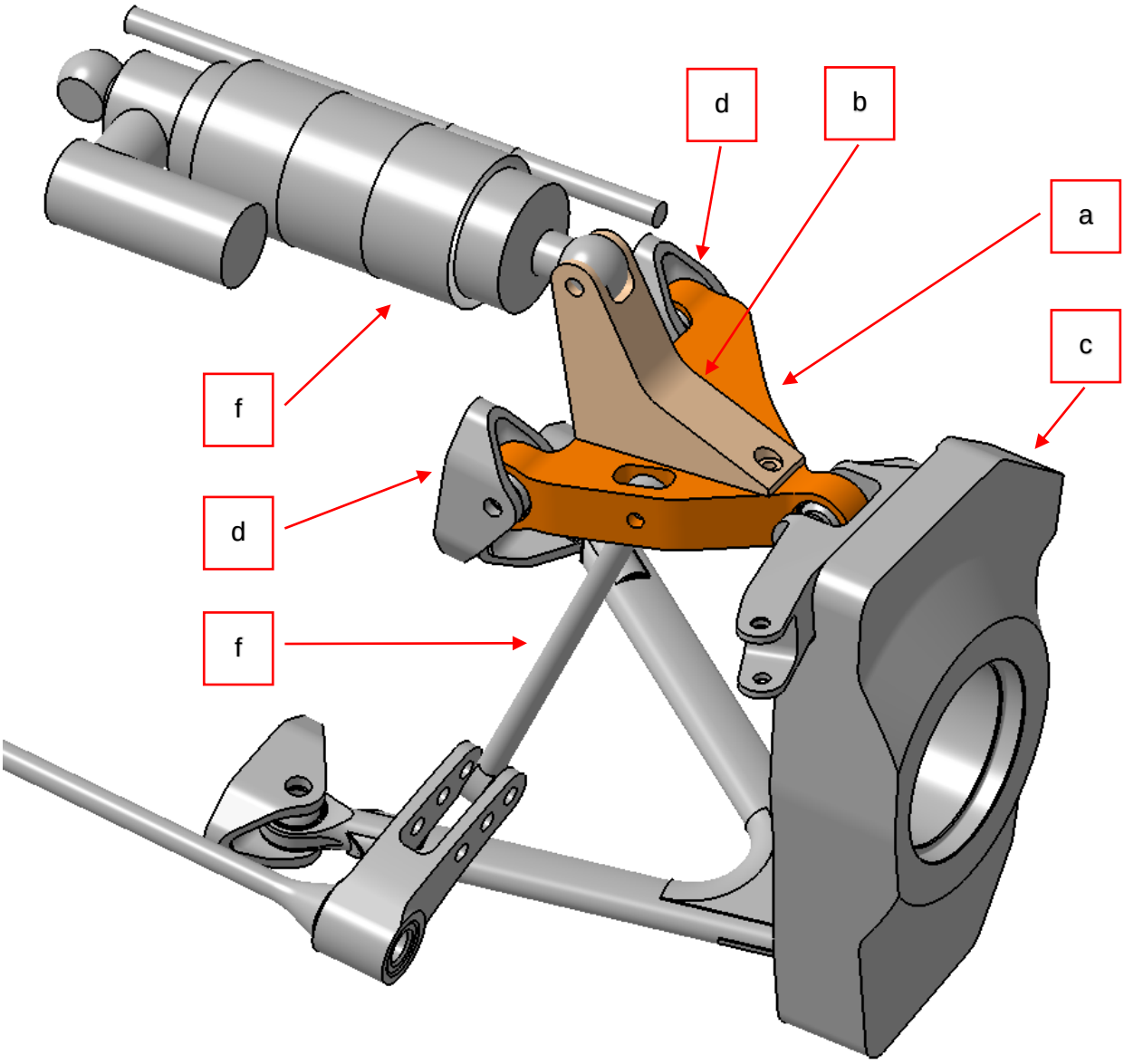
2.3. Front upper wishbone

Component is an assembly consisting of two separate parts – a) upper wishbone and b) damper mount – fixed together with two threaded fasteners, which is connected with several other components, namely:

c) Upright via upper wishbone mount
d) Inboard mounts
e) ARB Droplink
f) Damper-Spring unit



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2.3.1. Geometrical constraints

- Upper wishbone part symmetry around “Plane_1” is required;
- Upper wishbone draw direction normal to “Plane_1”;
- Damper attachment part symmetry around “Plane_2” is required;
- Damper attachment draw direction normal to “Plane_2”;
- Minimum Wall thickness: 3 mm;

2.3.2. Material

Material intended to be used for this component is billet 6000 series aluminium in T6 condition.

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3. Analysis constraints

Suspension model should be constrained from displacement but not rotation on the following points:

- Upper and Lower control arms inner points (chassis side)
- Inner damper connection point to chassis
- Tierod chassis side point

Target compliance is defined for the complete corner assembly. The aim is to achieve optimised assembly components that are characterised by even compliance contribution; therefore, the individual component compliance should be defined during a pre-study simulation.

All elements not being subject to analysis should be replaced by rigid elements.

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3.1. Lateral acceleration stiffness

3.1.1. Loads

Apply following loads to Contact Patch

Load	Front	Rear
Force X [N]	54	-1743
Force Y [N]	9574	8724
Force Z [N]	6423	7034
Moment X [Nm]	0	0
Moment Y [Nm]	0	0
Moment Z [Nm]	258	344

Apply following loads to ARB Droplink attachment on UCA

Load	Front	Rear
Force X [N]	-296	74
Force Y [N]	693	-153
Force Z [N]	-2316	1124

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3.1.2. Displacement constraints

The following maximum displacements should be used for the optimization runs.

Camber angle:

Angular displacement around longitudinal axis of wheel measured at wheel hub, calculated from Y direction displacements of skeleton hub points – “wheel centre” and “tyre contact patch”.

(X rotation of Wheel Center ref. frame)

	Front [deg]	Rear [deg]
Camber “x2.0”	0.10	0.10
Camber “x4.0”	0.20	0.20

Caster angle:

Angular displacement around longitudinal axis of wheel measured at wheel hub, calculated from X direction displacements of skeleton hub points – “wheel centre” and “tyre contact patch”.

(Y rotation of Wheel Center ref. frame)

	Front [deg]	Rear [deg]
Caster	0.10	0.10

Toe angle:

Angular displacement around vertical axis of wheel measured at wheel hub, calculated from X direction displacements of skeleton hub points – “wheel centre” and “hub centre”.

(Z rotation of Wheel Center ref. frame – Toe-out at front, Toe-in at rear)

	Front [deg]	Rear [deg]
Toe “x0.5”	0.00 to 0.05	-0.05 to 0.00
Toe “x1.0”	0.00 to 0.10	-0.10 to 0.00
Toe “x1.5”	0.00 to 0.15	-0.15 to 0.00

Wheel Centre displacements:

Maximum displacement from nominal position of wheel centre point.

	X [mm]	Y [mm]	Z [mm]
Wheel centre	0.35	0.30	1.30

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ARB Droplink attachment displacement:

Front:

Maximum magnitude of displacement from nominal position of ARB Droplink relative to UCA should be below 0.50 mm.

Rear:

Maximum magnitude of displacement from nominal position of ARB Droplink relative to UCA should be below 0.25 mm.

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3.2. Longitudinal acceleration stiffness

3.2.1. Loads

Apply following loads to Contact Patch (see warning below table).

Load	Front (Braking)	Rear (Acceleration)
Force X [N]	12932	-7748
Force Y [N]	374	277
Force Z	7488	5612
Moment X [Nm]	0	0
Moment Y [Nm]	0	0
Moment Z [Nm]	770	-87

Warning: For Rear (Acceleration) load-case, apply X component to the Wheel Center point, to avoid Y moment on the upright that is induced by the transmission shaft.

3.2.2. Displacement constraints

The following maximum displacements should be used for the optimization runs.

Camber angle:

Angular displacement around longitudinal axis of wheel measured at wheel hub, calculated from Y direction displacements of skeleton hub points – “wheel centre” and “tyre contact patch”.

(X rotation of Wheel Center ref. frame)

	Front	Rear
Camber “x2”	0.10	0.10
Camber “x4”	0.20	0.20

Caster angle:

Angular displacement around longitudinal axis of wheel measured at wheel hub, calculated from X direction displacements of skeleton hub points – “wheel centre” and “tyre contact patch”.

(Y rotation of Wheel Center ref. frame)

	Front [deg]	Rear [deg]
Caster	0.50	0.50

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Toe angle:

Angular displacement around vertical axis of wheel measured at wheel hub, calculated from X direction displacements of skeleton hub points – “wheel centre” and “hub centre”.

(Z rotation of Wheel Center ref. frame – Toe-out at front, Toe-in at rear)

	Front [deg]	Rear [deg]
Toe “x0.5”	0.00 to 0.05	-0.05 to 0.00
Toe “x1”	0.00 to 0.10	-0.10 to 0.00
Toe “x1.5”	0.00 to 0.15	-0.15 to 0.00

Wheel Centre displacements:

Maximum displacement from nominal position of wheel centre point.

	X [mm]	Y [mm]	Z [mm]
Wheel centre	0.80	0.40	1.50

Caliper CoP displacement:

Maximum magnitude of displacement from nominal position of Brake Caliper CoP relative to upright should be below 0.90 mm.

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4. Results delivery

4.1. Timeframe

The delivery of the results in digital format is expected before 24/05/2019.

4.2. Expected results

Report describing output of the initial analysis should include:

- Part mass in form of table and graph, for given max deflection of camber (2 values) and toe angle (3 values), under stiffness load cases. In total, 6 results respecting each of the constraints combination are expected. It is preferable that the optimisation is run for the extreme combinations to gauge whether the combinations will indicate remarkable solutions.

	Camber 1	**Camber 2**
Toe 1	Mass 11	Mass 12
Toe 2	Mass 21	Mass 22
Toe 3	Mass 31	Mass 32

- Maximum deflection contribution of each component of the assembly.
- Geometry visualisation for each point of table, preferably in 3D neutral format.

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APPENDIX A Revision History

R01 – original file

R02 – Additional constraints of caster angle and wheel centre displacements added. Clarified definition of angle measurement definition.

R03 – Added constraints of Brake Caliper CoP and ARB Droplink attachment.

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