BINDT WORKSHOP

‘NDT REQUIREMENTS FOR AUTOMOTIVE COMPOSITES’

30 YEARS OF COMPOSITES IN F1

APPLICATIONS OF NDT

Brian O’Rourke

Chief Composites Engineer,
Williams Grand Prix Engineering Ltd.
FW39/40 OF 2017
F1 CAR PERFORMANCE

A few general facts:-
- 690kg minimum weight (incl. driver)
- 350kph top speed (at Monza)
- 3.5g cornering, 5.5g braking, 1.5g accelerating
- 25 kN down-force at 300 km/hr, typ.

Power unit (2017):- 145 kg. min.
- 950 bhp (?) engine, 1.6 l. V6 turbo-charged limited to 15,000rpm, hybrid. Fuel 100kg., rate 100 kg/hr max.
- ERS capacity 4MJ/lap power output
- MGU-K: 50,000 rpm, 200 Nm, 2MJ/lap max, 120 kW
- MGU-H: 125,000 rpm max, unlimited power in/out
ADVANCED MATERIALS IN F1 USE

Materials are chosen to be correct for the application

The range of types used covers:

• High-spec steels
• Titanium
• Aluminium alloys
• Magnesium

• Polymeric matrix composites
• Metal matrix composites
• Carbon/carbon composites
EARLY F1 PRIMARY STRUCTURES IN COMPOSITE MATERIALS

The McLaren MP4-1 (1981)  
Hill GH1 (ex-Lola T371 1975)

WILLIAMS
FIRST WILLIAMS COMPOSITE MONOCOQUE – FW10 (1985)
CHASSIS CONSTRUCTION – COMPOSITE MATERIALS

FW07: 1979-82

FW11: 1986
CHASSIS CONSTRUCTION – COMPOSITE MATERIALS

FW07: 1979-82

FW11: 1986
FW39 OF 2017
COMPOSITE MATERIALS – EXTENT OF USE
COMPOSITE MATERIALS – EXTENT OF USE

- Front wing assembly
- Nose energy absorber
- Survival cell assembly
- Head-rest
- Engine ducting
- Engine cover
- Rear wing assembly
- Suspension
- Rear energy absorber
- Side-pods
- Side energy absorber
- Cooler ducting
- Underbody/diffuser
COMPOSITE MATERIALS APPLICATIONS

Suspension assemblies

Brake ducting
COMPOSITE MATERIALS APPLICATIONS

Front wing assembly

‘Bodywork’
‘MONOCOQUE’ CHASSIS ASSEMBLY

Hybrid sandwich assembly
CHASSIS FUNCTIONS – INERTIAL AND AERO LOADING

Loads acting on chassis structure

- Deceleration $> 5 \, 'g'$
- Acceleration $> 1.5 \, 'g'$
- Cornering $> 4 \, 'g'$
- Front wing downforce $- 5 \, kN$
- Rear wing downforce $- 5 \, kN$
- Underbody downforce $- 5 \, kN$
- ‘Bump’ cases $> 10 \, 'g'$
FIA STATIC PROOF TESTS

‘Squeeze’ loads + ‘floor push’ on all chassis built

- Roll-hoop **120 kN**
- **50 kN** (3 Positions)
- Roll-hoop **75 kN**
- **30 kN**

Stiffness criteria and no damage allowed

- **25 kN**
- **12.5 kN** Tank floor
- **250 kN** Side Impact
- **15 kN** Cockpit floor

‘Push-off’ tests on
- Nose: **40 kN**
- Rear absorber: **40 kN**
- Side absorbers: **60 kN (Lwr.) + 40 kN (Upr.) simultaneous**

10 kN = 1 tonf
FIA FRONT AND REAR IMPACT TESTS

Chassis Front Impact Test (1) - Nosebox

- **Energy**: 87 kJ
- **Speed**: 15 m/s
- **Mass**: 780 kg

**Acceptance Criteria**
- Peak ‘g’ < 20 (up to 60kJ)
- Av. ‘g’ < 40 (Overall)
- Peak ‘g’ > 60 (<3 ms at dummy)
- No damage to chassis

Rear Impact Test

- **Energy**: 47 kJ
- **Speed**: 11 m/s
- **Mass**: 780 kg

**Acceptance Criteria**
- Peak ‘g’ < 20 (up to 225mm.)
- Peak ‘g’ > 20 (< 15 ms remainder)
- Damage rear of axle line

[ 15 m/s = 54 km/hr = 33.5 m.p.h.]
CHASSIS CONSTRUCTION

Front segment

Insert

Irregular inner surface

Sandwich shell

Core splice
SANDWICH CONSTRUCTION

Where used

- Bodywork
- Nosebox
- Diffuser
- Primary structures
STRENGTH-CRITICAL BONDED JOINTS
Suspension elements: adhesively bonded joints connect the wheels to the car!

Inboard joint

Rear assembly – hot!
STRENGTH-CRITICAL BONDED JOINTS
STRENGTH-CRITICAL BONDED JOINTS
STRENGTH-CRITICAL BONDED JOINTS
NDT TECHNIQUES

Early: ‘Audiosonic’

Current: Ultrasonic Phased-Array + Real-time Radiography
ANOMALY DETECTED BY NDT - EXAMPLE

Omniscan u/s indicating void

Physical position mapped

Real-time radiograph showing void
DRIVER ROLL-OVER PROTECTION
ROLL-OVER HOOP – CT OUTPUT

Operator: Matt Parker
Piece: #04
Part name: DA-07854-N-001_A

27/01/2016
ROLL-OVER HOOP – CT OUTPUT

Operator: Matt Parker
Piece: #04
Part name: DA-07854-N-001_A

27/01/2016
ROLL-OVER HOOP – CT OUTPUT

THIS SHOWS CROSS SECTIONS 1-8

Operator: Matt Parker
Piece: #04
Part name: DA-07854-N-001_A

27/01/2016

4/12
ADVANCED MATERIALS IN F1 USE
THANKS FOR YOUR ATTENTION