# AVD2 Wing DBT Requirements

Release 1

**Overview**

A1.5m starboard wing shall be designed and built to achieve aerodynamic, structural and actuation performance according to the specification given in this document.

The wing shall be capable of carrying a specified test load as a simplified representation of a critical manoeuvre load case. The main load bearing structure shall be a box-spar in the form of a stiffened skin construction made from aluminium alloy sheet and embedded within a foam aerofoil section. The wing plan-form shall be rectangular. The wing aerofoil section shall be prismatic but the box-spar shall taper from a given station outboard from the wing root. The wing profile shall preferably be chosen from the NACA aerofoil series and must be constant along the span (selection from other aerofoil series must be agreed on discussion with the aerodynamic advisor). Span and chord lengths must be as specified. The maximum aerofoil depth shall be between 15-20% of chord. Lower surface inspection holes must be provided in each box-spar rib-bay from bay 2 outboard (*note, there is no inspection hole in rib-bay 1*).

The leading edge shall be fixed. The trailing edge shall include a flap capable of rotation and hold at precise settings for a specified set of configurations for take-off, flight mission and landing. The flap mechanisms shall be electronically actuated and controlled.

**Aerodynamic performance requirements**

The design shall aim for the following aerodynamic attributes in each of the specified flight phases:

- Take-off - minimise $C_D - \mu C_L$ at zero incidence
- Mission phase *a* – maximum endurance - Highest $L/D$ at $C_L = 0.5$
- Mission phase *b* – dash - Lowest $C_{Do}$ at highest speed and zero lift
- Landing - Highest max lift coefficient $C_{Lmax}$ for slowest landing speed

To prove aerodynamic performance over each of the specified flight phases the wing shall be tested in a wind tunnel under a range of angles of attack at wind speeds up to 30 m/s. On-board pressure tappings and sensors shall be included along the upper and lower aerofoil near the mid span-wise position of the flap with data logging of readings for further analysis.

**Structural Performance requirements**

Stiffness: The wing deflection shall be limited to allow flap mechanism hinge-lines to operate freely up to ultimate load.

Strength: The applied stress at proof loading shall not exceed the proof strength of any part. The applied stress at ultimate loading shall not exceed the ultimate strength of any part.

Stability: The applied stress at ultimate loading shall not exceed the column buckling strength of any stiffener. Elastic panel buckling shall be allowed to occur as low as 50% of limit load provided that that bounding panel stiffeners are not compromised and that aerodynamic performance is not significantly affected.

To prove limit and ultimate performance and final failure the wing shall be tested as a cantilevered beam with load applied through a loading “wiffle” tree arrangement at the 30% chord position as the expected maximum torsional offset.

The wing root shall be fixed by specified attachments to the box-spar and false-rear-spar for wind-tunnel and structural testing.

**Mechanisms performance requirements**

The flap must be electronically actuated and capable of achieving and holding precise positions under normal flight conditions and up to the ultimate design load. Indications of actuation and achieved positions must be provided.

To prove the flap control deployment shall be demonstrated in the wind tunnel at various wind speeds and angles of attack and in the structural test up to ultimate loading.

**Design Practice**

A proof factor of 1.0 and an ultimate safety factor of 1.5 shall be used. Unless otherwise stated all ultimate reserve factors shall be greater than 1.0 with acceptable margins for uncertainties. Some panel buckling ultimate reserve factors may be less than 1.0.

**Design Consideration**

Overall, the design shall aim for the following attributes:

- Best compromise of aerodynamic performance over the specified flight phases.
- Best compromise between aerodynamic and structural efficiency.
- Use of standard materials and components.
- Ease of manufacture and assembly.
- Accuracy and quality of build.
- Ease and accuracy of mechanism operation.
- Robustness.
- Minimum cost.

**Documentation & Communication**

- Comms group executive summary and presentation to group tutor
- Team portfolio final report and tutor debrief

All tasks, document deliveries and presentations shall be undertaken according to the DBT schedule

*Note, these requirements are not exhaustive and further directives may be issued during the design and build stages. Please check aerodynamic, structures and mechanism actuation & control documents on Blackboard for further detailed instructions.*

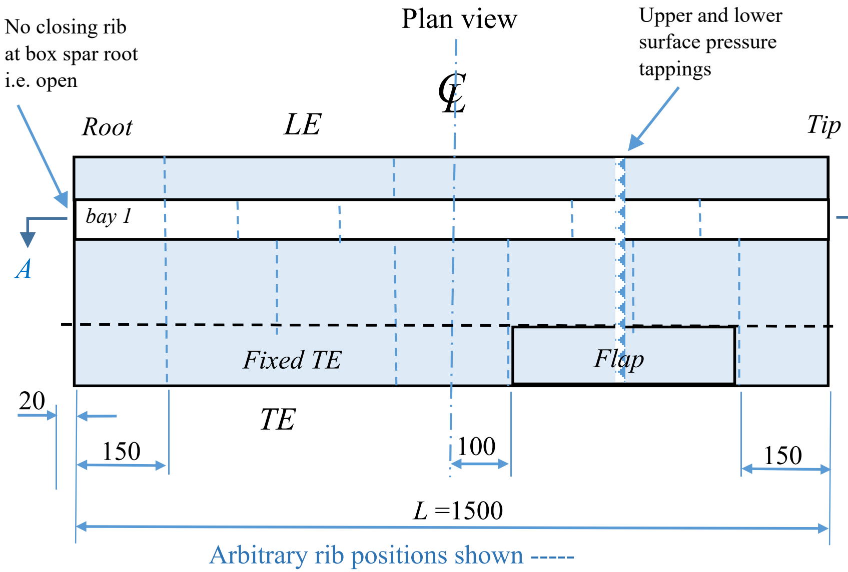
*Drg pto*

# Geometric Envelope and loading
# DRG AVD2 DBT 2017-2018 A

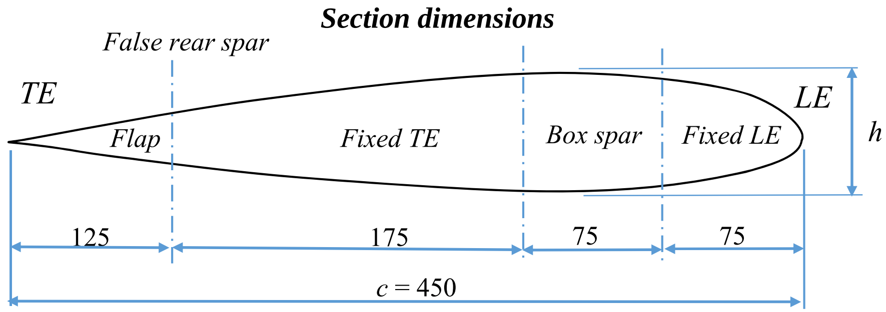
All dimensions mm (shown dimensions are fixed)

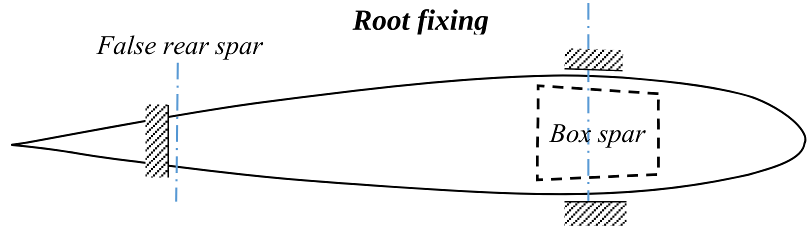
No scale

Plan View

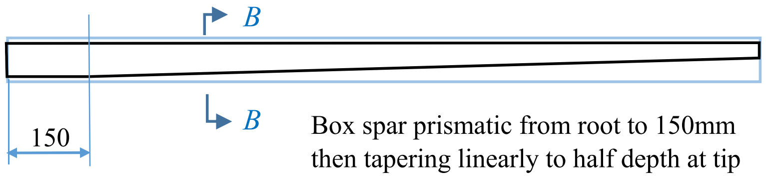



Wing section views

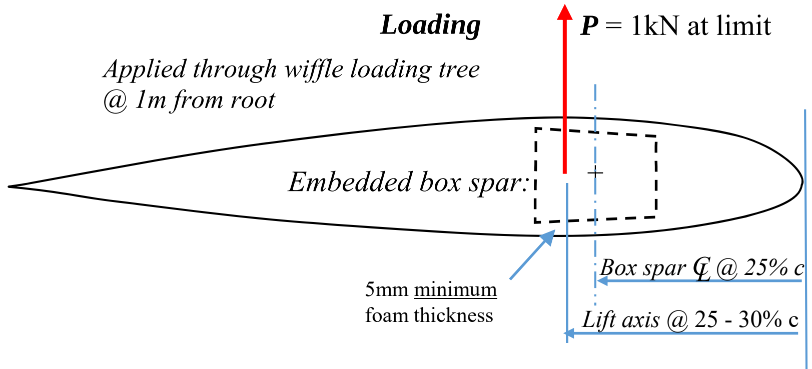



View on *A-A* showing box spar side view

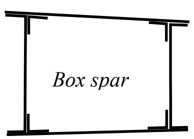


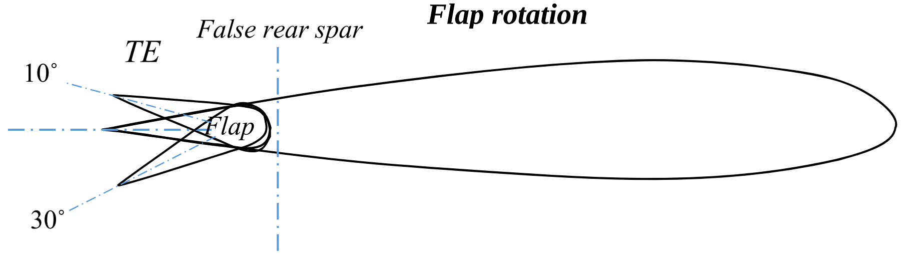

Box spar prismatic from root to 150mm then tapering linearly to half depth at tip




Inspection holes in lower skin at the middle of each rib bay but **not** in rib bay1 at the root

View on *B-B* showing box-spar section view

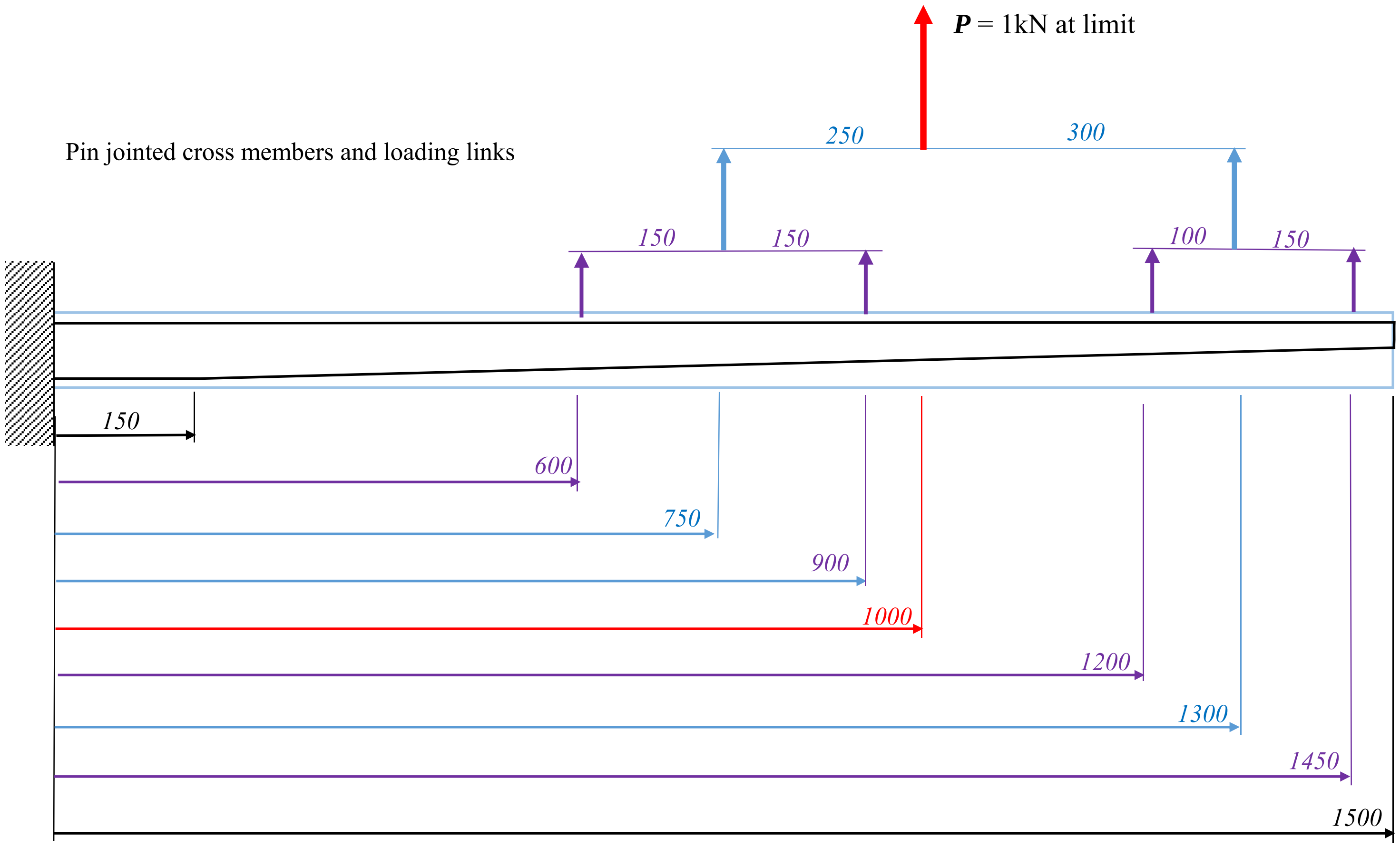


# Loading wiffle tree

# DRG AVD2 DBT 2017-2018 B

All dimensions mm (shown dimensions are fixed)



**DRG Notes:**

|Materials:

Clad aluminium alloy sheet 2014A-T3, nominal thicknesses: 0.4, 0.5, 0.6, 0.7, 0.9, 1.0mm shall be used for main box spar items, forward and aft ribs and false rear spar (FRS).

Styrofoam shall be used to create aero profile outside box-spar.

Items and assembly

Flange widths (spar and angles) shall be 15mm width.

Ribs must be included in the box spar to maintain the aero profile and to stabilise panels and booms. *There shall be no rib at the root end of the spar-box to allow post-delivery fitting of root joints.*

Ribs must be provided forward and aft of the box spar along with a false rear spar made from minimum gauge (0.4mm).

20mm diameter inspection holes shall be provided in the lower skin of each rib bay from rib bay 2 outboard (*not rib bay 1*).

Pressure tappings shall be provided along the chord of the wing near the mid flap position.

Jigs and tooling shall be used to facilitate fabrication and assembly.

Ally joints shall be made from 1/8" rivets. Styrofoam joints shall be made with epoxy adhesive.

The root attachment shall be by upper and lower fittings to the box-spar and one fitting at the extended false-rear-spar. The box-spar upper and lower surfaces shall be clear of Styrofoam within 150mm from the root. The root joint will be fitted for you – you must leave skins blank in the root joint region.

The foam shall be bonded to minimum gauge ribs on each side and to the false rear spar. Attachments to the box spar shall be at the spar cap regions only.

Rivet free areas will be specified in rib bay 1 as required for post-delivery fitting of root joint fixtures.

Test

One load case shall be considered and idealised according to the test configuration in drg. AVD2 DBT 2017-18 B, where the limit load value of $P$ shall be 1kN.

Control cables shall be of sufficient length to operate flaps remotely outside the wind tunnel and at a safe distance during structural testing.

*These notes are not exhaustive. Further notes may be provided.*