# Standard OPTIMAT Test Specimen Proposal

## Introduction

During the kick-off meeting, a number of potential problems were identified.

In order to arrive at unambiguous conclusions regarding the fatigue properties of the reference material and the residual strength it is proposed to define one standard test specimen geometry for a large part of the test programme.

Furthermore, extra tests will be necessary for most TGs, some of which on other type specimens, such as biaxial loading, thick laminates, shear loading etc.

### *Background*

For instance, if the residual strength is tested after 10% of $N_{f,}$ no serious degradation of the static strength is to be expected. However, if the static strength is compared to that determined from dedicated static test specimens (like ISO 527-4) a 10-20% degradation may be found caused by the geometry of the test specimen.

Obviously, this leads to the need for extra static tests according to ISO/ASTM etc. in order to define the “true” static material and ply properties and have a comparison between those results and the results of static tests on the standard OPTIMAT BLADES test specimen.

## Proposed test specimen and test set-up

We propose the use of the short Risø Standard Specimen as the standard OPTIMAT BLADES test specimen. This geometry will be used on the materials specified during the kick-off meeting, namely the UniDirectional material with ±45º face layers and the MultiDirectional material for static tensile and compressive tests and fatigue tests.

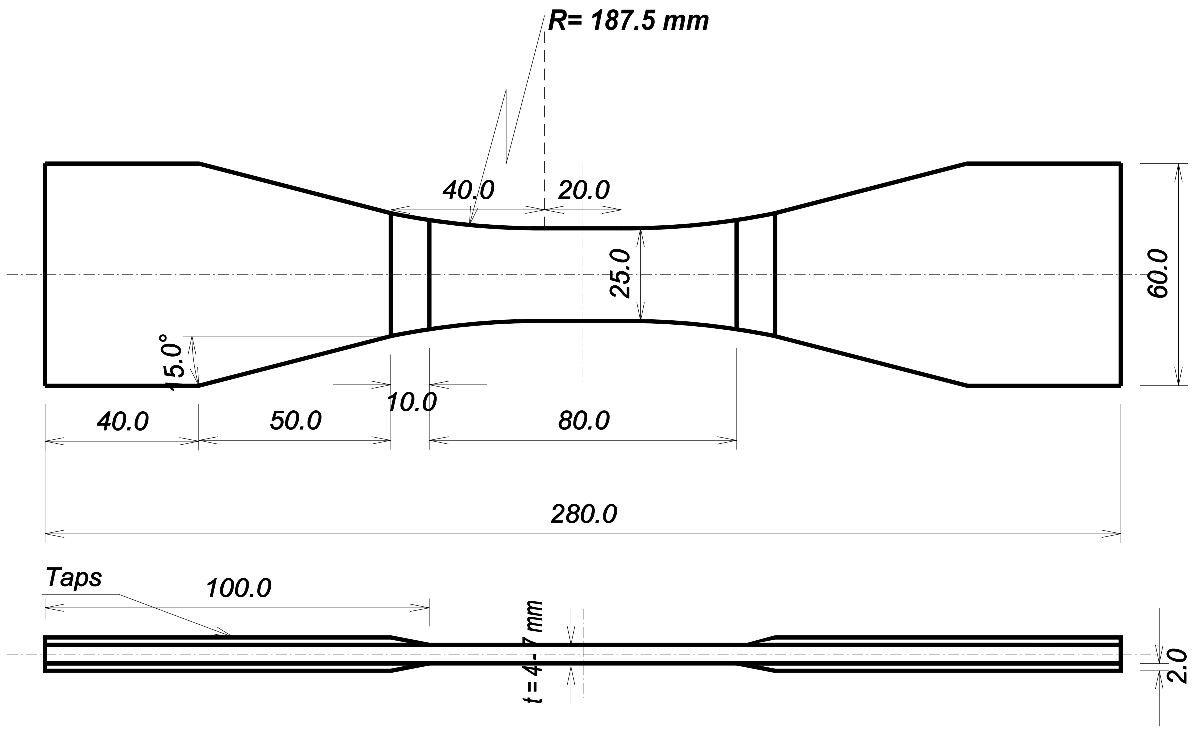


**Figure 1 OPTIMAT BLADES proposed standard test specimen (RISØ short)**

**Test set-up**
The test equipment used is similar to the simple anti-buckling guide set-up used at Risø as indicated by Povl Brondsted, see Figure 3.

Two suggested differences are:

1) Perhaps the OPTIMAT jig ought to have adjustable grips, to eliminate movement in the loading direction during load reversal. This movement may occur if the specimen does not fit neatly into the set-up, or if clamping force is lost due to wear during the test.

2) The OPTIMAT Anti-Buckling Guide (ABG) is essentially a Risø simple ABG with a slightly larger hole to allow space for condition monitoring equipment. The movement in the transverse direction is constrained. See discussion in 0.

Povl Brondsted has expressed a willingness from Risø to provide test set-ups for the OPTIMAT BLADES partners and give drawings etc. This will enable all partners to carry out their fatigue tests in a more standardized way, thereby improving the quality and uniformity of the programme. He will provide a quotation for the set-ups.

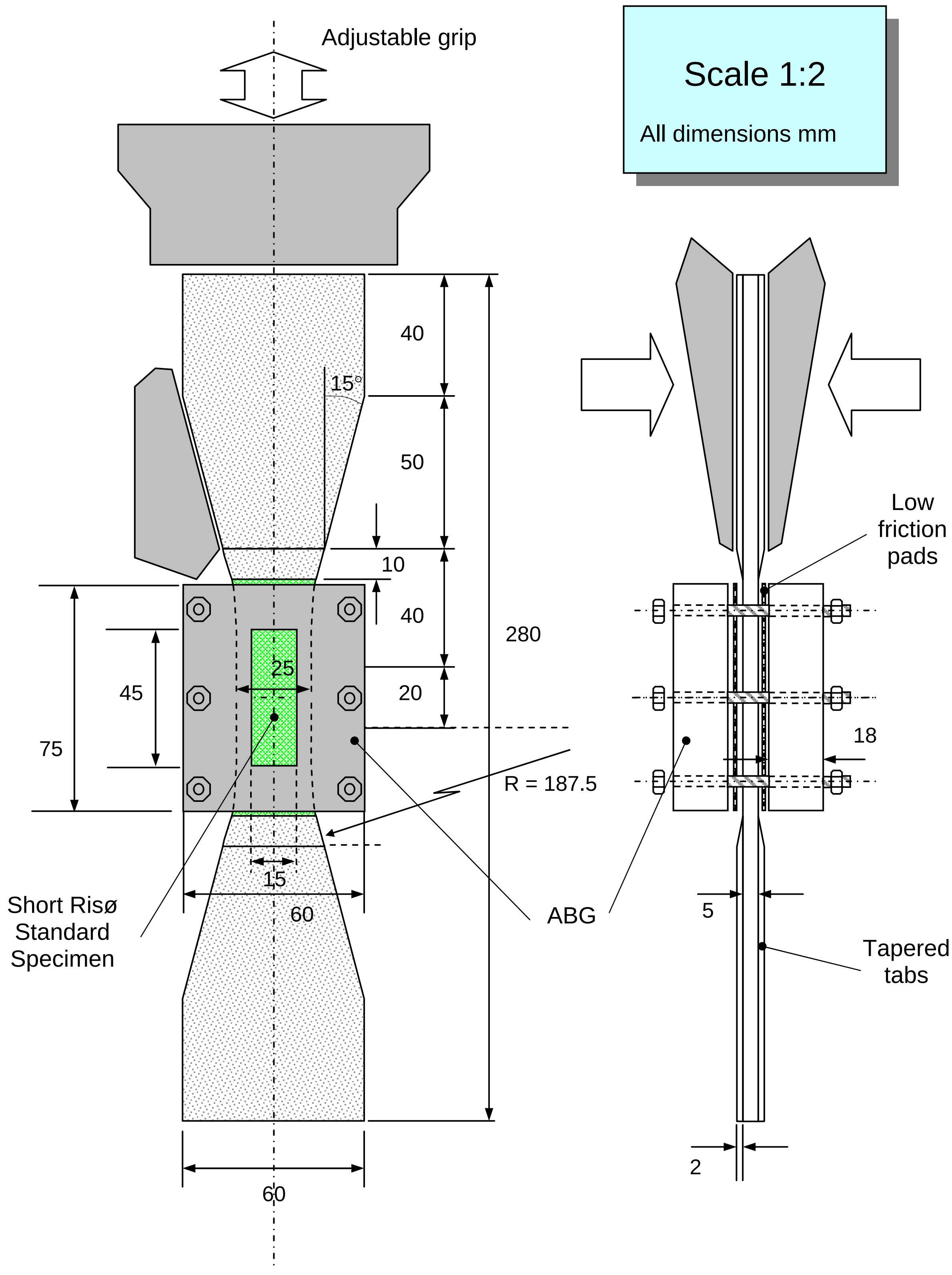


**Figure 2 Standard OPTIMAT Test Specimen Proposal**

**Discussion on Anti-buckling guide (ABG)**

Obviously, an anti-buckling guide (ABG) is necessary given the slenderness of the test specimen. Risø currently uses a simple ABG, shown in Figure 3, essentially consisting of two parts of steel clamping the plate together without holes or an advanced ABG, shown in Figure 4, which is attached to the lower end of the test bench and can move in longitudinal direction.

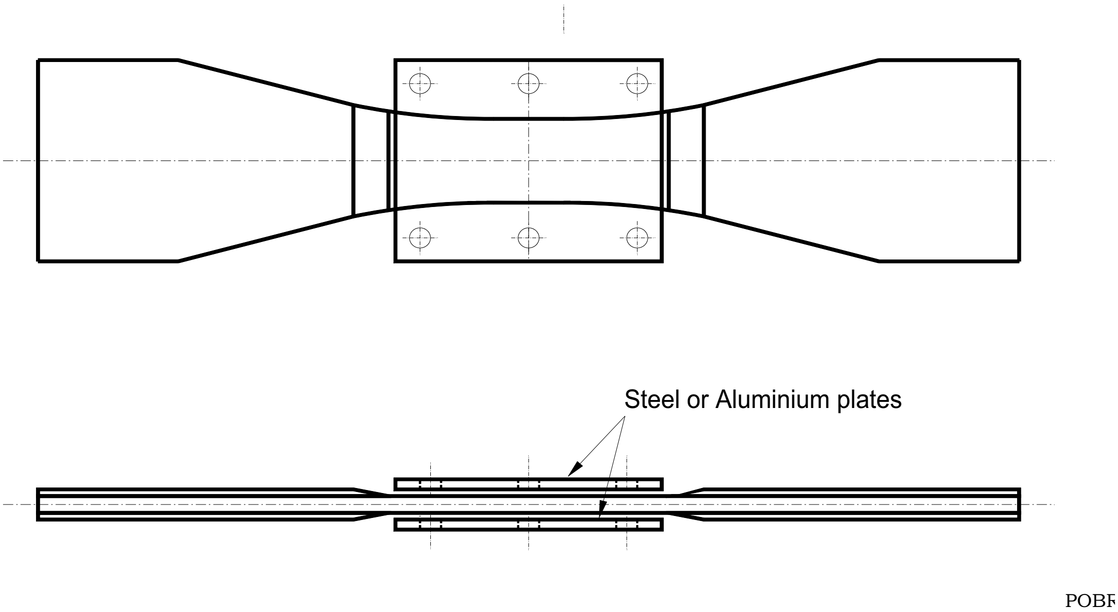


**Figure 3 RISØ simple ABG**

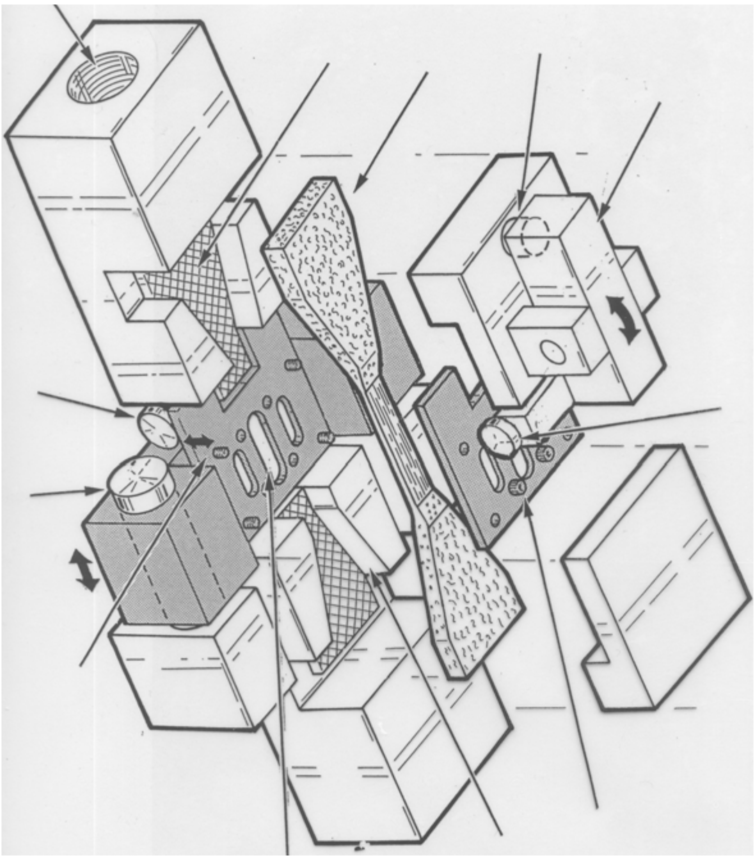

**Figure 4 RISØ advanced ABG**

Risø claims good results with both ABG, so for simplicity we might opt for the simple ABG shown in Figure 3. Unfortunately, clamping two massive steel plates on the test specimen inhibits both visual inspection and photos and many types of measurement.

Therefore, holes must be available through which to measure.
Two choices exist:

1. The edges of the specimen are free at the measurement location. In this case, it is expected that, during a fatigue test, delamination will initiate first at the specimen edges. With this ABG, an area of 25x45 mm is available on the specimen for monitoring. 45 mm is the minimum space required to apply clip gauges. The specimen is to a certain extent accessible from the side.

   However, leaving the edges unsupported and a hole of a certain length may result in insufficient protection against buckling and a smaller available height will prohibit use of clip gauges.

2. Supporting the edges would allow for a longer (but narrower hole available for measurements. See for instance Figure 4, which could be adapted for use with a simple ABG as in Figure 3. An area of 15x45 mm could be left open, see Figure 2, resulting in 5 mm wide support along the edges. For this type of ABG, the ABG must be designed in order to prevent lateral displacement, which could result in uneven support of the edges. An ABG which supports the specimen edges is expected to constrain the delamination of the edges of the test specimen.

It is proposed, that the ABG are used even in case of tensile loading, in order to have a consistent set-up across all load ratios.

Questions for the TC:
1. Is the proposed standard specimen acceptable to you?
2. Is the proposed ABG of Figure 4 with a window of 15x45 acceptable to you?
3. Risø does not support the ends of the test specimen.
   Is an adjustable test rig, where at least 1 of the 3 edges of the tabbed part is adjustable, to clamp the tabbed part of the test specimen between the edge and the triangular parts preferred, are do we follow the rigid test ends that Risø currently uses?