

LIGO-T030252-00-K

Buckling of ribbon fibres as used in the suspension of gravitational wave detectors

When a ribbon fibre is loaded it extends and if perfect in dimension and alignment the stress and strain are uniform across the ribbon at any point.

Buckling in such a system takes place if the stress distribution is such that the strain reverses sign at one or other edge of the ribbon. This might happen if the alignment is such that the ribbon has to be bent in the plane of its larger flat surface in order to be attached.

Now consider a possible ribbon for advanced LIGO. The cross-section chosen is 1.1 mm by 0.1mm.

Each ribbon is under a 10 kg (100 N) load and its extension is got from

$$F = [EA/L]. \text{ extension}$$

For a 60 cm long ribbon, extension = 7.5mm

Now, at worst alignment mistakes might be considered to lead to a bend in the ribbon corresponding to a difference in length of the two sides of 2mm.

Given that the overall extension is significantly greater than this, the stress will not go to zero anywhere and thus buckling should not occur.

In fact at the construction phase buckling is a more serious problem and to avoid it jigs which allow much better alignment than mentioned above will be used.

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