International Journal of Engineering Science 83 (2014) 85–94

Contents lists available at ScienceDirect

International Journal of Engineering Science

journal homepage: www.elsevier.com/locate/ijengsci

Elastic stability of a compressed cantilever beam on an elastic foundation, with application to a dual-coated fiber-optic connector

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ARTICLE INFO

Article history:
Received 11 February 2014
Received in revised form 6 June 2014
Accepted 10 June 2014
Available online 19 July 2014

Keywords:
Elastic stability
Optical connectors
Design for reliability

ABSTRACT

A simple, easy-to-use and physically meaningful predictive analytical (mathematical) model is developed for the evaluation of the critical (Euler) force for a cantilever beam supported by an elastic foundation, with application to a dual-coated fiber-optic connector. The obtained results can be used in the stress analysis and physical (mechanical) design of such connectors. These results can be used also beyond the optical engineering field, when there is a need to evaluate the elastic stability of a cantilever beam supported by an elastic foundation.

1. Introduction

Fiber connectors are widely used in optical engineering. In the analysis that follows a simple and easy-to-use analytical model is developed for the evaluation of the elastic stability of a connector. The schematics of the addressed problem is shown in Fig. 1. A structural element in a dual-coated optical fiber connector module is shown in Figs. 2 and 3. The element consists of a 125 μm dia silica fiber coated by a dual-coated acrylic system. The system, in its turn, consists of a low modulus primary coating and a high modulus secondary coating. The coating system is applied (cured) at an elevated temperature, and the connector is subsequently cooled down to a low (room, operation, testing) temperature. The thermal contraction mismatch between the high expansion secondary coating and the low expansion glass fiber materials results in an "internal" thermally induced compressive force in the fiber. The major compression comes, however, from the "external" mechanical loading, when the stripped off end portion of the connector experiences, in actual operation conditions, significant compressive force. This force is supposed to be high enough to produce an appreciable pressure on the fiber tip, but should not be higher than necessary, to avoid elevated post-buckling deformations, if any. The ability to determine the critical (Euler) force for such a connector is of obvious practical importance. Accordingly, the objective of the analysis is to develop a simple and physically meaningful predictive model for the evaluation of this force.

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http://dx.doi.org/10.1016/j.ijengsci.2014.06.005
0020-7225/© 2014 Published by Elsevier Ltd.

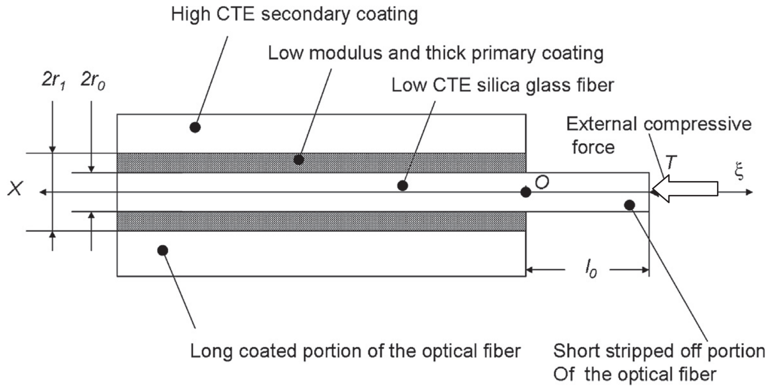

Fig. 1. Dual coated optical fiber with a stripped off coating at its end.

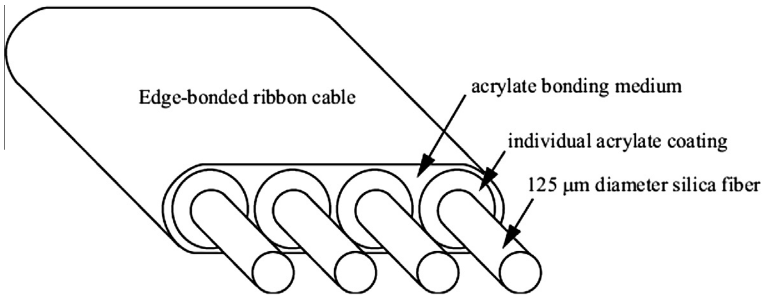

Fig. 2. Dual-coated fiber-optic connector package.

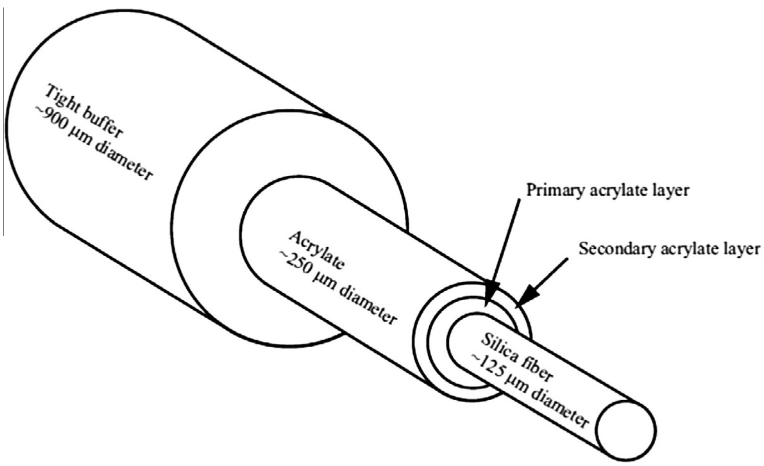

Fig. 3. Typical structural element of a dual-coated fiber-optic connector package: a dual-coated optical fiber with the stripped-off end portion.

2. Analysis

2.1. Assumptions

The following assumptions are used in this analysis:

1. The engineering theory of beams, including those supported by a continuous elastic foundation (Suhir, 1991; Timoshenko & Gere, 1988), can be applied in the problem in question;