Mode coupling coefficients of curved few-mode optical fiber

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Few-mode optical fibers are one of the upcoming trends of fiber optic development. Main objective is overcoming the "non-linear Shannon limit" [1-7]. Signal distortions during transmission over such fiber are primarily due to the combined action of differential mode delay and mode coupling. The latter in turn result from irregularities in the optical fiber, randomly distributing along the length of the optical cable. The most typical irregularities of optical fiber of the delivery length of the optical cable are macro and micro bends. Therefore, the working purpose is calculation the mode coupling coefficients at the bending of a few-mode optical fiber with a bending radius significantly larger than the fiber core diameter.

The calculation of mode coupling coefficients was executed for a multimode optical fiber with a truncated parabolic refractive index profile. It is shown on Fig. 1. Well-known Gaussian approximation method and a stratification method were used as a mathematical apparatus. The curved lightguide was replaced by a straight optical fiber with an equivalent refractive index profile. The dependencies of the mode coupling coefficients of the principal mode LP_{01} with the modes LP_{11}, LP_{02}, LP_{12} and LP_{03} on the bending radius were obtained as a result of the calculations and shown on Fig. 2.

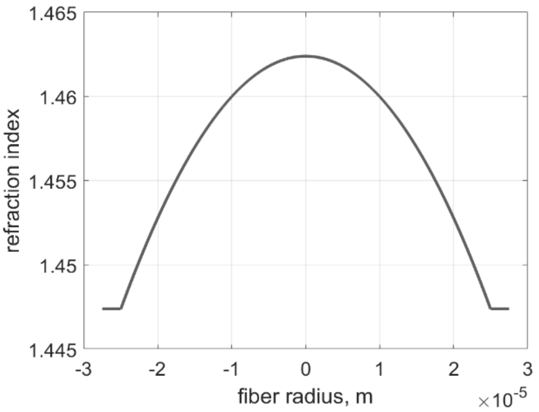

Fig. 1. Refractive index profile of the researched optical fiber under investigation.

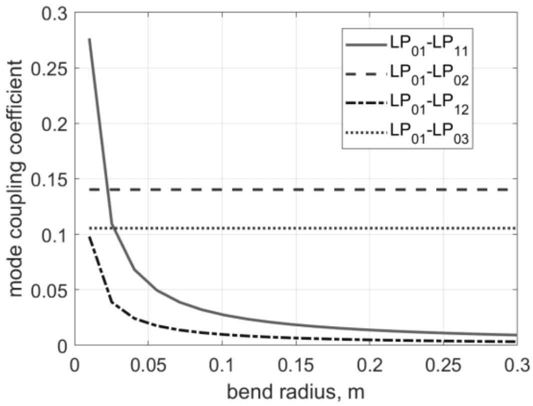

Fig. 2. Dependencies of mode coupling coefficients on bending radius of optical fiber.

The calculations showed that the mode coupling of different azimuthal orders increases sharply with a decrease on the bending radius. At the same time, the mode coupling of same azimuthal order practically does not depend on the fiber bending radius. There is no mode coupling of different azimuthal order for a perfectly straight optical fiber, but even the weak curvature of the optical fiber leads to its occurrence.

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