Cable Testing in Tension, Twist and Bending

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ABSTRACT

A hydraulic test frame has been designed to apply the simultaneous actions of tension, twist and partial sheave bending loads on cable specimens. This paper reports on its use in evaluating a finite element program for modeling the structural behavior of cables and wire rope. Computer model and test results are compared and found to be in good agreement.

KEY WORDS: Cable; wire rope; tension; twist; bending; testing.

INTRODUCTION

This paper describes the design of a novel cable test frame and its use in providing test data needed to evaluate the cable finite element analysis computer code, CableCAD® (2009). Approximately 200 cable tests in tension, twist and bending were performed. A sample of these tests; viz., tension-twist of an electrical-mechanical cable and tension-bending of a 1x19 wire strand, are presented here. Cable specimens were tension-twist tested and a wire rope was subjected to bend-over-sheave tests to determine the bend diameter that causes wire slip.

Cable specimens were dissected to obtain accurate geometrical properties including component diameters, layer diameters, and lay lengths and directions. Material properties were obtained from manufacturers. Specimens were terminated with fittings following recommended industry practice. All specimens tested were preconditioned with a minimum of 15 tension cycles to eliminate “constructional stretch.” Peak cyclical tension values were equal to the final test values.

Test measurements include real-time data acquisition of reaction torque, cable elongation and diameter change in response to applied tension, twist and bending loads. With known geometrical and material details, computer models were created and analyzed. Model and test results are compared.

CABLE TEST FRAME

A new test frame design capable of horizontally testing specimens up to 5.6 m in length is described in Figs. 1 and 2. The test frame applies up to a 445 kN tension at one end of the test frame and a maximum 1,130 N-m torque can be input at the opposite end of the test frame. A variable diameter sheave can be integrated into the frame to induce bending. These loads can be applied separately or simultaneously. The cable test specimens are instrumented with axial and diametral extensometers and a tension-torque combination load cell measures the applied loads.

Additional design objectives included knock-down joints for ease of disassembly and shipping, use of caster wheels for transporting and positioning, centerline thrust between square compression tubes to optimize structural efficiency and keep weight low, use of hydraulic power to apply static and cyclical tension, an apparatus to apply twist to...