World Applied Sciences Journal 6 (8): 1028-1032, 2009
ISSN 1818-4952

Bending and Shearing Properties of Wheat Stem of Alvand Variety

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Abstract: Shearing stress of wheat stalk was measured for four moisture content levels (15, 25, 35 and 45%, w.b.), three cutting heights (100, 200 and 300 mm), two types of cutting knives, smooth and serrated edge and three blades oblique angle (0, 15 and 30 deg.). The results of data analysis showed that the shearing stress of wheat stems decreased as the moisture content decreased. The shearing force of stems, decreased as the cutting height of stalk increased, because of a reduction in stalk diameter. Shearing stress was lower by using smooth edge knife, because of less friction than serrated one. The blade oblique angle of 30 degree showed the least shearing stress. The average of shearing stress varied between 3.25 and 3.86 MPa. Bending stress and modulus of elasticity increased as the moisture content decreased and decreased as the cutting height of stem increased. The average of bending stress varied between 17.74-26.77 MPa and modulus of elasticity varied between 3.13-3.75 Gpa.

Key words: Wheat · Shearing stress · Bending stress · Modulus of elasticity

INTRODUCTION

Increasing interest in harvesting and commercial use f wheat straw has prompted the need for engineering ata on straw properties. Most studies on the mechanical roperties of plants have been done during their evelopment using failure criteria (force, stress and nergy) and the Young's modulus [1, 2]. The physical roperties of the cellular material are important for cutting, mpression, tension, bending, density and friction [3, 4]. rsson [5] reviewed several studies on the cutting eed and concluded that cutting power is only slightly fected by cutting speed between 1.72-5.2 m s^{-1}. ajumdar and Dutta [6] studied the required shearing ergy for two varieties of rice and a variety of wheat in tting speeds of 2.53 and 4.5 m s^{-1} and edge angle of and 40 degrees, by using a Pendulum type impact earing device. Analysis of the data showed that the fects of crop type and edge angles on shearing energy re significant. Ince *et al.* [7] stated that it was cessary to determining the stem physic-mechanical perties such as bending and shearing stress and rgy requirements for suitable knife design and rational parameters. Measurement of the shearing ngth of six varieties of wheat straw by O'Dogherty *et* [8] showed mean values in the range of 5.4-8.5 MPa. Kushwaha *et al.* [9] reported mean values of shearing strength of wheat straw from 8.6 to 13 MPa with some dependence on moisture content. Other workers have measured the energy require to shear materials. Mcrandal and McNulty [10] evaluated the shearing strength of grasses stem with quasi-static shear test. They studied the effect of shearing velocity, at 15, 28 and 41 mm min^{-1}, bevel angle, at 10, 30 and 45 degree and diameter of stems. They found that shearing velocity and bevel angle did not have significant effects on shearing strength but their interaction had significant effect at 5% probability level. Prasad and Gupta [11] determined the shearing force and energy for cutting maize stem. They resulted that maximum shearing strength and shearing energy in the direct shear test were observed to decrease with the shearing velocity. Sakharov *et al.* [12] reported that the required force to cut the stretched stalks was 50% less than that of unbent stalks. Chen *et al.* [13] found that the average values of the maximum force and the total cutting energy for hemp were 243 N and 2.1 J, respectively. Chattopadhyay and Pandey [14] determined the bending stress for sorghum stalk as 40.53 and 45.65 MPa at the seed stage and forage stage, respectively. Ince *et al.* [7] determined the bending stress and Young's modulus for sunflower stalk as 37.7 to 62.09 MPa and 1251.28 to 2210.89 MPa, respectively. There are a few studies on

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