

SYMPOSIUM ON TIRE CORD, 1972-1982

Preface

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INTRODUCTION

Over five thousand years ago the Sumerians invented the wheel. As the centuries passed, the wheel was continually refined. Then, in 1845, Robert William Thomson was granted a patent in England on an "air tube device," the forerunner of the modern pneumatic tire. This invention lay unused until the end of the nineteenth century. The pneumatic tire was "reinvented" in 1888 and began to achieve wide application. After nearly a century of use, tires have made possible the evolution of a sophisticated, personal transportation system.

But what is a tire? Geometrically, a tire is a torus. Mechanically, a tire is a flexible membrane pressure container. Structurally, a tire is a high-performance composite. Chemically, a tire consists of materials from long-chain macromolecules.

Functions of a Pneumatic Tire. Fundamental to a discussion of tires is a description of the basic functions of a pneumatic tire. These may be summarized as follows: (1) load-carrying capacity; (2) cushioning ability; (3) transmit driving and braking torque; (4) produce cornering force; (5) provide flotation; (6) provide dimensional stability; (7) resist abrasion; (8) provide steering response; (9) have low rolling resistance; (10) be durable and safe. All of these functions, essential to a system of locomotion, have never been satisfactorily fulfilled except by a pneumatic tire. This is basically due to the deformability and dampening characteristics of the tire structure.

Basic Tire Types. Three basic types of tires are in use today (Fig. 1). First is the bias angle or cross-ply tire. In this construction, the reinforcing cords extend diagonally across the tire from bead to bead. The bias angle of the cord path to the centerline of the tire is generally in the range of 30 to 40 degrees. The cords run in opposite directions in each successive layer (or ply) of reinforcing material, resulting in a cross-ply pattern. This has been a standard tire construction for years.

Second is the radial tire. In this tire, the plies of reinforcing cords extend transversely from bead to bead. On top of the plies (under the tread) is an inextensible belt composed of several layers of cords. The belt cords

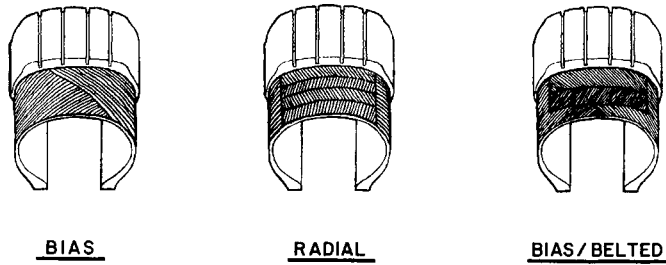


Fig. 1.

are low angle (10 to 30 degrees) and act to restrict the carcass plies. Radial tires made their commercial appearance in the late 1940's and first became popular in Europe.

The third design is the bias-belted tire, which consists of a bias angle carcass with a circumferentially restricting belt. In the bias-belted tire, the carcass angle is generally maintained between 25 and 45 degrees and the belt angle, between 20 and 35 degrees. In addition, the angle of the belt is at least 5 degrees lower than the angle of the carcass. This tire is the latest of the basic tire types and was commercially introduced in 1967.

TIRE-REINFORCING SYSTEMS

A tire is a cord/rubber composite. The tire composite is in the form of a network of cord structures arranged in a parallel configuration and imbedded in a rubber matrix. The cord reinforces the rubber much as steel strengthens concrete. However, tire cords are very unique materials of construction due to their extremely high fatigue resistance. Tire cords give the tire shape, size stability, bruise resistance, fatigue resistance, and load-carrying capacity.

The stringent demands of tire service have limited the types of cords suitable for tires to six. The first pneumatic tires were reinforced with cotton, a cellulose. In the early days, the cotton fabric was square woven. One of the important advances in tire development occurred about 1920, when cord replaced square-woven fabric. The use of plies of cord added tremendous durability and resiliency to the tire. Cotton continued to be the only tire fiber until 1937, when steel was introduced into tires in Europe. In 1938 rayon, a regenerated cellulose, was introduced. In 1942, nylon became available for military tires and in 1947 was introduced to the motor-ing public. In 1955, wire made an appearance in the U.S.A. In 1962, polyester was introduced. Then, in 1967, fiber glass joined this select group.

More than one billion pounds of tire cord are used throughout the world each year. Tire cord consumption can be characterized by individual life cycles (Fig. 2). It can be noted that tire cord usage has been characterized by a rising, peaking, and declining pattern. In 1935, only cotton was in use in tires. Cotton passed through stages of growth, maturity, and

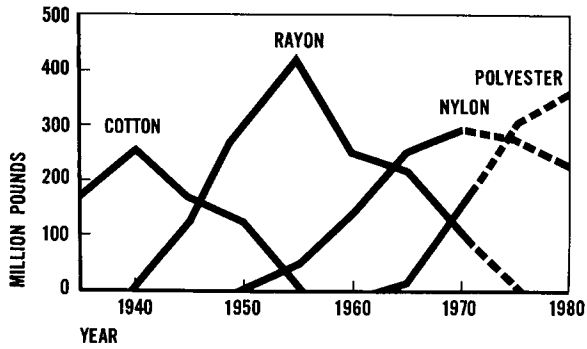


Fig. 2. United States tire cord usage.

decline, finally phasing out completely. Rayon was introduced in 1938 and is in the stages of decline today. Nylon was commercialized in 1947 and has reached maturity. Polyester is in a growth stage. Similar cycles can be constructed for fiber glass and wire cord.

Each basic tire type requires specific cord physical properties. In addition, cords for carcass and belt application require a different balance of properties. A discussion of current tire cord applications and trends for the next decade is the subject of this symposium.