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Utilization of Recent Trends in Automobiles into Textiles Structures Tires for Bradding Wires in Belt of Steel Bridge

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ABSTRACT: Tires types, including; Trimmed rubber (70% by weight), steel wire (5–30% by weight), and fluff or textile fibers (up to 15% by weight). From the aforementioned materials, rubber and steel wires are mainly recovered and used for numerous applications. Wire rope (cables) are recently used in many industrial branches such as structural cables in civil engineering and automobile tires. This paper presents the similarities and differences between the wire rope used. Many previous studies were investigated individually for each branch. This paper presents the studies to make complete comparison between the two branches. The purpose of the current study is to sufficiently review recent progress on the management of in civil engineering and automobile tires. Focusing on alternative uses of textile fibers such as additive for stress strain materials, density conglomerates production, structures wire materials reinforcement. Material and cross section of wire rope are investigated. The study concluded that the wire rope have great tensile strength and ability to carry fatigue loads.

KEYWORDS: Automobiles Tires, Steel Bridge, bradding Wires.

1. INTRODUCTION

Due to the importance of tires and metal constructions for bridges that take us to safety, which gives it the effectiveness and durability that starts from the filaments and strings with the multiplicity of raw materials (natural - industrial - transformative) in the production of ropes (spun - twisted) and cables (wire ropes). Gather and give straps high strains.

Cables, wire ropes and belts are the same object with differences in the purpose of use, cross sectional area and length. In recent years, cables have been used in many industrial and construction fields, such as bridge cables, crane cables, and elevator cables, and they have been used as a basic element to reinforcement and strengthen other products like automobile tires. First, what is the cables or wire rope and the function of using the cables in the bridges and tires. Find the diameters of wire rope of cables cross section (Core and sheath), according to ElNashar) [3] [4] [6]. In the following equation:

$$d = 4.44(\sqrt{\text{Tex count}/\text{fiber density}})\, 10^{-3} \text{ cm.} \quad (1)$$

Where: d^1, d^2=diameter of (Core and sheath) cross section. To find the (weight) of wire[1], wire[2] …etc. by the following equation:

$$W = \pi\,(d^2/4)\, L * \text{number of wire or (filament of rope) threads in cables or wire rope} = \text{gram.} \quad (2)$$

Wire rope or cables [9] are a piece of flexible, multi-wired, stranded machinery made of many precision parts. Usually, a wire rope consists of a core member, around which a number of multi wired strands are “laid” or helically bent. There are two general types of cores for wire rope - fiber core and wire core. The fiber core may be made from natural or synthetic fibers.

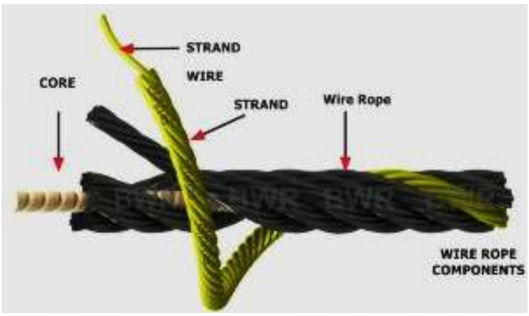
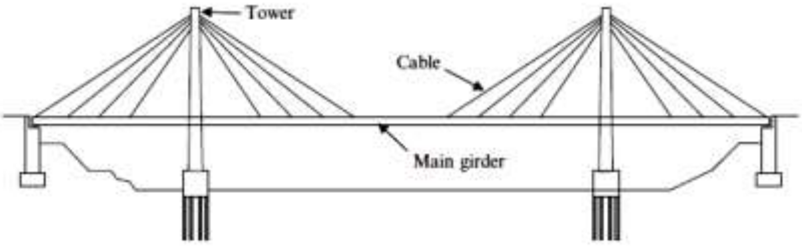
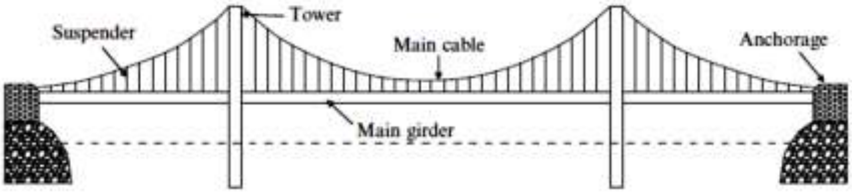


Fig.1 Cables or wire ropes

Paper presents the wires (belts) used in the cable bridges and car's tires through previous work and studies. The properties of wires for each product investigated and drawn to make a complete comparison. In the cable bridges as reviewed by Gimsing et al [13] divided the bridges into two types, cable stayed bridges and suspension bridges as shown in the Fig. 2. The main supporting system for the bridges was the cables. The main function of the cables is to transmit the load from the bridge deck to the tower. The load is transmitted to the tower as a tension force in the cable [14] [15].



a. Cable styed bridges



b. Suspension bridges

Fig. 2 cable bridges types

Caetano [2] displayed the cables bridges. Cables are made from steel wires, typically of cylindrical shape, and with a diameter of 3–7 mm. These wires are arranged in strands and ropes. Strands can be formed from the parallel or else from the helical assembling of wires [15]. The parallel arrangement is typical of the main cables of suspension bridges (Fig. 3), while the helical arrangement is normally employed in hangers and stay cables. The simplest and most common is the seven-wire strand made from the helical winding of six 5 mm wires around a core wire (Fig. 4), with a nominal diameter of 15 mm.

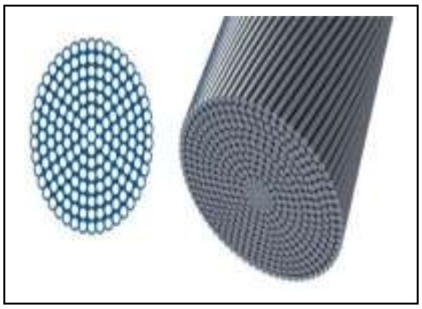


Fig. 3 Multi-wire helical strand

Fig. 4 Seven-wire strand

Tires **[1]** contain a several nine categories, depend on vehicle application. There are tires for racing vehicles, passenger vehicles, and light trucks. In such tires, a fabric reinforcement was required to strength the tires. Larger tires such as those for heavy trucks, farm and agricultural vehicles, earthmoving equipment, and large aircraft tend to contain both steel wire and fabric reinforcements. Boiocchi [11] presented the tire components as showed in Fig.5. Belts contain layers of steel wire and fabric. They limited deformation of the casing and provide rigidity to the tread region, thereby allowing improved wear and handling performance, better damage resistance and protection of the ply cords. Belts are composed of either steel wire, PET, nylon-66, or nylon-6 coated with a NR based compound.

Fig. 5 Tire components. It is seriously past that the use of cables has spread in many areas and it is indispensable that a study should be made to compare some of the uses of cables, especially in bridges and tires.

1.1 Tire Construction industry (Radial - Bias - Solid)

Tire selection is one of the most important factors for Tire life. Choosing the correct Tire specification significantly improves Tire life and reduces vehicle operational costs including Radial, Bias and Solid Tires which all offer specific benefits for different kinds of applications and machinery.

1.1.1. Radial Tires

In Figure 6 (a) "Radial tires, radial constructed Tires utilize a series of steel cords, extending from the beads and across the tread, so that the cords are laid at approximately right angles to the centre line of the tread, and parallel to each other, as well as belts directly beneath the tread. This network of cords gives the Tire strength and shape. Due to the all-steel radial construction the sidewall of a radial Tire is more flexible compared to a bias Tire resulting in a shorter, but wider footprint. This means less rolling resistance, lower fuel consumption, more grip and greater ride comfort at greater speeds. Steel radial construction has no movement between plies, which means lesser heat buildup or increased resistance to heating. Also, the belts directly under the tread ensure lesser deformation which leads to more traction and puncture resistance. Disadvantages of the radial tire include a harder ride at low speeds on rough roads and in the context of off-roading, decreased "self-cleaning" ability, a more rigid sidewall and lower grip ability at low speeds. [12]

1.1.2. Bias or Diagonal Tires

In Figure 6(b) "Bias or Diagonal Tires". A Bias Tire is made of layers of rubber-coated, plies of fabric (commonly nylon) placed at angles of approximately 30-40 degrees, with successive plies laid at opposing angles forming a crisscross pattern to which the tread is applied. This construction provides the main advantages: a smooth ride on rough surfaces with enhanced operator comfort, while also the ability to withstand higher loads. This makes these Tires especially effective for machinery in ports & terminals. On the down-side, these Tires have lower grip at high speeds, are more sensitive to overheating, have accelerated wear and higher fuel consumption. [12]

1.1.3. Solid Tires

In Figure 6 (c) "Solid Tires", Solid Tires are non-pneumatic, meaning that they are not filled with air. These Tires are used for industrial applications and suitable for forklifts, heavy-duty transport vehicles, platform trucks and other industrial vehicles. Recycling & waste companies and manufacturers who handle glass products are likely to use solids because of their resistance to puncture damage. They are extremely stable, maintenance-free and also able to handle a significantly higher weight load than pneumatic tires without the fear of blowouts. Solid Tires are especially designed for slow-moving industrial machines that require heavy lifting. [12]

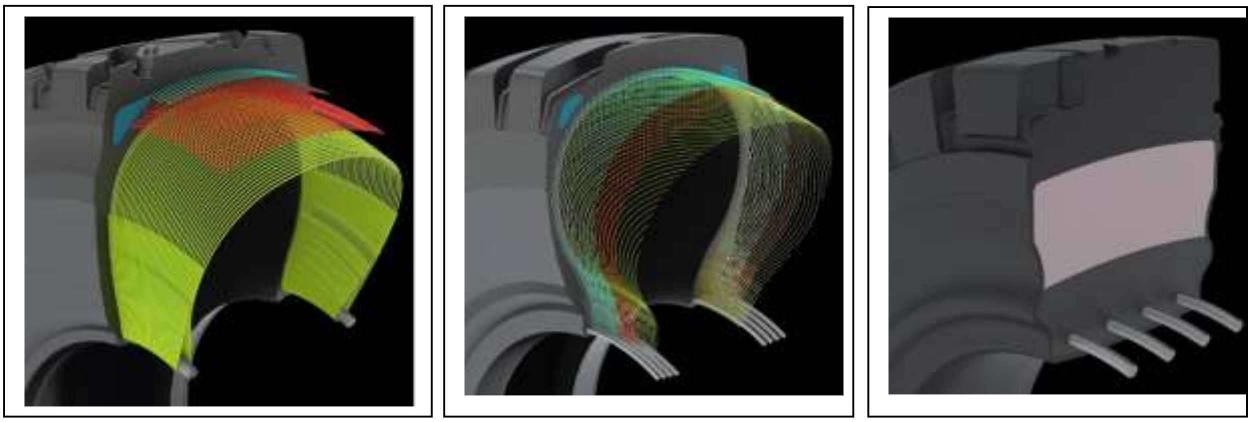


Figure 6: (a) at left "Radial Tires, (b) at middle "Bias or Diagonal Tires". And (c) at right "Solid Tires", [12]

2. COMPARISON BETWEEN WIRES IN BRIDGES CABLES AND AUTOMOBILES TIRES

In this section, the similarities and differences between the cables used in bridges and tires will be presented through previous studies. The mechanical and physical properties will be displayed. The geometric properties also will include the cross-section properties such as the shape, the area, number of wires and wire diameters. In addition, the failure modes for cables will be discussed.

2.1. The geometric properties

Gimsing et al [13], Caetano [2] were presented the properties of the information concerning major world realizations in suspension and cable stayed bridges. These include bridge spans, lengths, diameters and types of employed cables, and the country and year of construction table 1 and table 2.

Table 1. Major World Suspension Bridges: Main Cable Characteristics

Bridge Name	Location	Year	Cable Characteristics		
			Diameter (mm)	No. of strand	No. of wire x wire diameter
Akashi Kaikyo	Kobe-Naruto, Japan	1998	1122	290	127 x 5.23 mm
Xihoumen Bridge	Zheijiang, China	2009	870	1690	127 x
Great Belt East Bridge	Halsskov- Sprogoe, Denmark	1998	827	37	504 x 5.38 mm
Humber	Hull, Great Britain	1981	680		149948 x 5 mm

Table 2. Major World cable-stayed Bridges: Main Cable Characteristics

Bridge Name	Location	Year	Cable type	
Pont de Normandie	Le Havre,France	1995	Parallel wire strand	31 to 53 cables
Tatara	Onomichi- Imabari, Japan	1999	Parallel wire cable	349 wires with 7mm diameter
Stonecutters	Hong Kong, China	2009	Parallel wire strand	7 mm diameter of wires

Boiocchi **[11]**and Rodgers et al **[10]** mentioned the steel wire used in tires is of various configurations, but all are brass-coated wire strands wrapped together to give cords of different characteristics, depending on the application. Steel tire cord was manufactured with a diameter of approximately 1.2 mm. A brass plating is then added to the wire before a final drawing to 0.15–0.40 mm. the basic rule is that the description follows the manufacturing sequence, starting with the innermost strand. A full description of the cord is given by the formula:

Strand 1{(NxF)xD} + Strand 2{(NxF)xD} + Strand 3{(NxF)xD} + ……… (3)

Where N = number of strands

F = number of filaments

D = diameter of filaments (mm)

An example of a steel cord specification would therefore take the form

$$(1 \times 4) \times 0.175 + (6 \times 4) \times 0.175 + (1 \times 0.15).$$

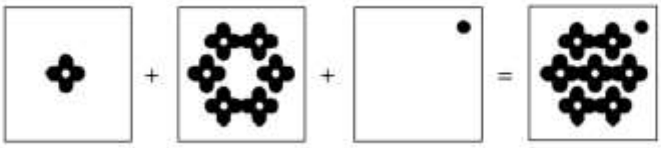


Figure 7. Steel cord specification

2.2. Mechanical and Physical properties

Steel wire is manufactured from high-quality steel, which is necessary because of the performance demands to which cables are subjected. The composition of a typical steel cord is illustrated in Table 3. The key mechanical properties governing a steel cord or wire are its tensile strength, elongation, and bending stiffness. The steel wire strength for bridges cables is significantly high, reaching values of 1570–1860 MPa. For very long spans, strengths of 1860–1960 MPa. For tires, both bead wire and steel cord are made from carbon steel that has been drawn and then coated to improve adhesion to rubber. Steel cords are now available with tensile strengths up to 3500 MPa and cords with strengths up to 4500 MPa.

Table 3. Cable Steel properties

	Unit	**Conventional cable steel in bridges (5- or 7-mm Wires)**	**Steel Tire wire**
Tensile strength	MPa	1570- 1960	3500-4500
Modulus of Elasticity	MPa	205	200
Typical Chemical Composition			
	C	0.80%	0.65%
	Si	0.20%	0.25%
	Mn	0.60%	0.65%
	Cu	0.05%	0.02%
	Ni	0.05%	
	Cr	0.05%	0.05%
	P	0.03%	
	S	0.02%	0.03%

2.3. Failure shapes

The corrosion of main cables bridges figure 7 has been the most common reason for cable failure. Corrosion can seriously shorten cable life, both by metal loss and by formation of corrosion pits in the wires. These pits act as stress-concentration points in the wires in much the same manner as do nicks. To preserve the rope for future use, it should be removed, cleaned and thoroughly lubricated.

Fig. 7

Fig. 8 a

Fig. 8 b

Fig. 9

Fatigue failure Figs 8 (a and b) of cables and strands is a common and complex problem.

Failure is typically caused by different combinations of time-variable bending and axial forces. In addition to these loads, contact stresses between wires may play an important role in the fatigue failure of cables. Smaller wires are the key to bending performance when cables are subjected to repeat loading [7]. Broken steel cords of a stabilizer (steel belt) in the common failure occurred. This failure can be happened form the impact of tire. Impact failures are analyzed by examining any damage the impact caused, such as rubber tears, fractured steel cord as in Fig.9, broken body ply cords, radial splits, propagation patterns, surface damage to the tire, and wheel deformations [14].

3. CONCLUSION AND DISCUSSION

Due to the importance of tires and metal constructions for bridges that take us to safety, which gives it the effectiveness and durability that starts from the filaments and strings with the multiplicity of raw materials (natural - industrial - transformative) [5] in the production of ropes (spun - twisted) and Cables (wire ropes). Gather and give straps high strains, a method for making textile yarns or cords of enhanced compression modulus. A multifilament low-twist yarn is coated with a liquid which can subsequently be converted to an elastic solid having a high performance's ratio, the depth of penetration of the liquid into the low-twist yarn being at least sufficient to bond together 30 percent of the filaments composing the yarn, converting the in figure 10 : braiding machine for tiers yarns into the elastic solid to form a yarn according to the paper or twisting two or more coated yarns together and converting the liquid into the elastic solid to form a cord.

Fig. 10: Braiding machine for tiers yarns

Fig. 11: Structural Rope for Bridge [15]

This paper relates to reinforcing yarns and cords and particularly to yarns and cords for reinforcing dynamic rubber goods. Textile yarns) (natural fibers- man-made - Transform fibers), and cords intended for reinforcing dynamic rubber articles, such as Tires or belts, have sufficient twist inserted to enable them to withstand severe compressive strains under conditions of abuse. The insertion of twist lowers the strength of the textile reinforcement and also it's Modulus of Elasticity and for this reason the twist inserted is a compromise between strength and/or Modulus of Elasticity and durability.

It is often desirable to have the highest attainable Modulus of Elasticity or stiffness in particular types of high-performance product, for under the tread of radial ply into Tires and as a warp braiding reinforcement on long-haul conveyor belts. This requirement has led to the use of small section steel cables in both these areas, though textiles are also used whenever possible because of their greater ease of handling in all over the world, with different climate and environmental conditions The moduli of some fibers such as fiberglass and high Modulus of Elasticity of rayon are adequate for high performance products provided that very low twist angles are used but this latter condition reduces the endurance potential of the fibers. as stated by to the present paper a reinforcing yarn comprises an encapsulated multifilament low-twist yarn in which the encapsulating material is an elastic solid having a high braiding ratio and penetrates the whole of the yarn outer surface to a core depth at least sufficient to bond together 45% of the man-made filaments composing the yarn

The multifilament low-twist yarn may be one of the usual textile materials, for example, rayon, nylon, polyester, poly (vinyl alcohol) and E-glass. (High Durability and tenacity), Throw as the E-glass of low-twist yarn in this specification is meant yarn having a twist factor of less than 0.038 where the twist factor of the yarn is the twist in turns per inch in the yarn divided by (Specific gravity X yarn denier) . In this case the cords are preferably twisted after the liquid has been applied to the yarns but before the liquid has been converted to the elastic solid to avoid pre-stressing the encapsulating material [7]. The cord may be made in this way by coating and cord making simultaneously using an in-line or planetary cabling machine in which the liquid coating is applied to the yarns just prior to the yarns coming together to form the cord. This method results in a symmetrically shaped cord cross-section which is very easily handled. The cords made from the encapsulated multifilament low-twist yarn have yarn helix angles of less tiers measured with respect to the cord axis.

The encapsulated multifilament low-twist yarns into tires that have enhanced resistance to compression compared with the untreated yarns. Thus, cords made from the encapsulated yarns have a higher Modulus of Elasticity than cords made from untreated yarn whilst retaining good durability. The multifilament low-twist yarns may be given an adhesive pro-treatment before encapsulation. and polyester multifilament yarns can be given a pretreatment of the blocked isocyanate type, nylon multifilament yarns can be given a similar pre-treatment and rayon as E-rayon (high tenacity of rayon) multifilament yarns may be pre-treated by inclusion of a small proportion of resorcinol in the spin finish used in their production. Poly (vinyl alcohol) yarns may also be pre-treated particularly where zinc chloride or similar treatment has been used on the filaments to increase the Modulus of Elasticity of the surface layers. A method in which the low twist yarn is of rayon, E-rayon, nylon, polyester or poly (vinyl alcohol).

A reinforcing cord comprising at least two strands twisted together in which at least one of the strands is a reinforcing yarn. A method for the manufacture of a reinforcing cord which comprises coating at least two multifilament low twist yarns with a liquid which can subsequently be converted to an elastic solid having a high core ratio, the depth of penetration into the multifilament yarn of the twist being at least sufficient to bond together 70 percent of the filaments composing the yarn, twisting the yarns together and subsequently converting the twist into the elastic solid. A method in which the core ratio of the elastic solid is measured at tensile strains, a method in which the low twist yarns are of rayon, E-Rayon, nylon, polyester or poly (vinyl alcohol).

Due to the importance of tires and metal constructions for bridges that take us to safety theory is supported by the observation that prior art placement of a pair of cross-oriented The insertion of longitudinal braids in addition to transverse braids (weft) to reinforce the tire gasket belt for cars, such as salvaged of Textile, breakers between the carcass plies of a radial ply tire, and of a single breaker between the carcass plies of a bias ply tire,

A bias ply tire incorporates a pair of oppositely oriented nonwoven breakers between two successive body plies in the region underlying the crown region of the tread layer. The breakers are inserted prior to shaping and curing. In a four-ply tire, one such pair of breakers preferably is inserted between the first and second, that is, the innermost, body plies, and another such pair of breakers may similarly be inserted between the third and fourth, that is, the outermost, body plies. Also, a third such pair of breakers may be inserted between the second and third body plies if further improved results are desired. The cord directions of each successive layer, whether a body ply or a breaker, may alternate relative to the longitudinal center line of the tire crown or the cords of successive coating layers of breaker and body ply may be in the same general direction relative to the longitudinal center line of the tire crown. The result is an improvement in stability, owing to a lower cord angle in the crown region, without any sacrifice of ride softness, owing to a higher cord angle in the sidewall region.

By using the ElNashar equation through which it is easy to calculate the diameters of strings, ropes and wires used in the architectural constructions of metal frames and bridges, predicting and calculating the functionally required weights and sizes. In accordance with the actual reality. Due to the importance of tires and metal constructions for bridges that take us to safety, this field needs an industrial revolution and more applied research in: Determining production specifications for fibers, strings, and braided ropes, tires, metal constructions, and bridges for what you need from heavy work.

-Determining the specifications of the design and the structural formation, the tires, especially cars, are a structural and architectural design that needs engineering studies.

-Determining the specifications of the structural design and formation, the bridges are a structural and architectural design that needs engineering studies. Especially the wires, Bradding Wires in Belt of Steel Bridge integration of design specifications and structural formation, tires, especially cars, are an architectural design, which is represented in (Radial/Bias/Solid), with the aim of enhancing the characteristics of functional performance.

REFERENCES

1. Brendan Rodgers and Walter Waddell (2013), the Science and Technology of Rubber. Tire Engineering, Chapter 14, ExxonMobil Chemical Company, Houston, TX, Fourth Edition. Elsevier Inc. USA.
2. E. Caetano and M. Vibest, (2016) Innovative Bridge Design Handbook. 2016 Elsevier, Inc.http://dx.doi.org/10.1016/B978-0-12-800058-8.00021-9
3. Elsayed ELNashar (1995) Msc. Entitled "Effect of warp-ends densities distributions on some esthetical and physical properties of multi- layers woven fabric". Faculty of applied arts, University of Helwan, Cairo, Egypt.
4. Elsayed ELNashar, [2005]"Volume Porosity and Permeability in Multi-Layer Woven Fabrics" Autex Research journal, Poland, December 2005. http://www.autexrj.org/No4-2005/PDF/0103.pdf http://www.autexrj.com/cms/zalaczone_pliki/4-05-4.pdf

5. Elsayed ELNashar , Metwaly F.A., Barkat M.M.,"Influence of the Bulky Woven Fabrics on Thermal Insulation Properties of Clothing ". The X International Workshop "Physics of Fibrous Materials: Structure, Properties, Science Intensive Technologies and Materials" (SMARTEX-2007) that take place in the Ivanovo State Textile Academy (Russia) from 29th to 30 May, 2007. http://www.igta.ru/files/smartex/smartex2007.pdf
6. Elsayed ELNashar, [2005]"Volume Porosity and Permeability in Multi-Layer Woven Fabrics" Autex Research journal, Poland, December 2005. http://www.autexrj.org/No4-2005/PDF/0103.pdf http://www.autexrj.com/cms/zalaczone_pliki/4-05-4.pdf
7. Gent, Alan Neville and Walter, Joseph D., "Pneumatic Tire" (2006). Mechanical Engineering Faculty Research. 854. http://ideaexchange.uakron.edu/mechanical_ideas/854.
8. HSI. Index, (2021) SECTION INDEX, Complete Contractor and Industrial Supplier • Sling and Rigging Specialist Since 1930, retrived online at www.hanessupply.com," 1930.
9. John G. Sommer (2009) "Engineered Rubber Products - Introduction to Design, Manufacture and Testing, Hanser Publications, USA.
10. M. Boiocchi and G. Matrascia, (2013) "Pneumatic Tire," Road Off-Road Veh. Syst. Dyn. Handbook. pp. 657–695.
11. Magna Tires Group - Premium Quality (2021) "Tire Construction Differences: Radial / Bias / Solid" retrieved at, https://magnaTires.com/Tire-construction-differences-radial-bias-solid/
12. N. J. Gimsing and C. T. Georgakis, (2012)"Cable Supported Bridges Concept and Design", Third Edition. This edition first published 2012, John Wiley & Sons, Ltd.
13. Sreenivas Alampalli and William J. Moreau, (2016)" Inspection, Evaluation and Maintenance of Suspension Bridges Case Studies, CRC Press, Taylor & Francis Group 6000 Broken Sound Parkway NW, Suite 300 Boca Raton, FL 33487-2742.
14. TOKYO ROPE MFG. CO., LTD. (2021) Tokyo Rope is the leading company of structural cable systems. Retrieved at: http://www.tokyorope.co.jp/