Asian Review of Mechanical Engineering
ISSN: 2249 - 6289 Vol. 5 No. 1, 2016, pp. 40-45

Need for Supreme Prominence to the Development of Railways

***B.S.Brar[1] and A. P. K. Brar[2]**
[1]Department of Applied Sciences, Baba Farid College of Engineering & Technology, Bathinda, Punjab, India
[2]Senior-Physiotherapist, Gupta Hospital, Bathinda, Punjab, India
E-mail: hodas.bfcet@yahoo.in, amanbrar221@ymail.com

Abstract - There is need to facilitate the enhancement of capacity in human-beings to develop pro-people and pro-national technologies, production-systems, and management models. In our country, there should be more stress on promotion of labour-intensive enterprises so as to increase the employment opportunities and to solve the wide-spread and serious problem of unemployment. The nature and direction of our industrial production should be to fulfill real national and peoples' needs. The technologies should be such that these utilise and develop local resources and expertise. This will certainly facilitate our movement on the path of having and establishing the self-reliance in our country. To satisfy all the necessities, production-processes are necessary. For this, development of productive-forces (means of production plus human-resources) is a must. To develop productive-forces, the development of productive-relations is also necessary. Development of productive-forces and productive-relations is what constitutes the development of economic-base of the country. Infra-structure is necessary for economic development of the nation. Transportation is an important aspect of infra-structure. The development of transportation is vital not only for economic development of the country and the people, but also for the development of the country and the people in social and cultural spheres. There are four basic modes of transport viz. roadways, railways, waterways, and airways. Every mode of transport has relative advantages and disadvantages. In case of waterways and airways, the vehicle and load has to move through fluids. In case of fluids, there is viscous dragging force due to viscosity of the fluid which is infact internal-fraction between layers of the moving fluid. It is quantified by concept of co-efficient of viscosity. Whenever a small spherical body moves through a viscous fluid, then layers of the fluid which touch the body, are dragged along with the body, while the layers of the fluid away from the body remain at rest. Hence a relative motion between different layers of the fluid is developed. As a result, a backward dragging force comes into play. This viscous-dragging force is in addition to the viscous-drag which is inherent in the fluid motion. Moreover, when a body moves through the fluid, then there is also the presence of external-friction between the surface of the body and the "surface" of the fluid taking fluid as a bulk quantity. Therefore, when a body moves through a fluid, then the body has to struggle against three opposing forces: viscous-dragging force inherent in the fluid, viscous-dragging force due to the motion of the body through the fluid, viscous-dragging force due to external friction (air-friction), and all these three opposing forces reinforce one-another to become a formidable opposing force. Role of viscosity concerning motion of fluids is more determined by a relatively new concept of "Kinematic Viscosity" rather than the concept "Co-efficient of Viscosity". We see that kinematic viscosity for air is greater than that of water, so more power will be required for the vehicle and the load to move through air than through water. It is a common estimation that the energy requirement to carry unit load per unit distance in case of railways is one-fourth to one-sixth of the energy requirement for roadways. The basic point is that co-efficient of friction between steel-and-steel surfaces in case of railways is far less than co-efficient of friction between rubber-and-concrete surfaces. In case of railways and roadways, the role of the phenomenon of elasticity is also important. Hooke's Law states that within elastic limit, the extension produced in a wire is directly proportional to the load applied. Co-efficient of elasticity or modulus of elasticity of the material of the body is the ratio of the stress and the corresponding strain produced, within elastic limit. All the three kinds of modulus of elasticity of steel are large, also it has other good properties like being flexible and being comparatively cheap. Also co-efficient of friction for steel-steel surfaces is small. These factors combined lead to the selection of steel in railways. Of the modes of transportation of roadways and railways, supreme stress should be on the development of railways, as less force is required to move trains, leading to less use of petroleum products, so the most economical. Also, less pollution of the environment will be there.

Keywords: co-efficient of friction, eco-friendly, economical, infra-structure, people-friendly, pro-national, pro-people.

I. INTRODUCTION

There is need to facilitate the development of the capacity in human-beings to develop pro-people and pro-national technologies, production-systems, and management models. Being people-friendly means that technology, production-systems, and management-models should promote the interests of the overwhelming majority of the people. Being eco-friendly means that these must utilise the Nature positively and enrich it. In our country, there should be more stress on promotion of labour-intensive enterprises so as to solve the wide-spread and serious problem of unemployment. The nature and direction of our industrial production should be to fulfill real national and peoples' needs. The technologies should be such that these utilise and develop local resources and expertise. This will facilitate our movement on the path of having and establishing the self-reliance in our country. [7], [8], [9], [10], [13], [14], [18]. In this context, there is need to review the existing technologies, production-systems, and management-models; to learn correct lessons; and to

advance further. There is a humble attempt to do so in the area of modes of transportation, in this paper.

The human-beings are to live and continue their race. For this, there is objective need to satisfy three basic necessities of food, clothing, and shelter. Apart from these three basic necessities, there are so many other necessities of human-beings like gain of knowledge, experimentation, electricity, fuels, instruments of all types, and so on. Also all these necessities go on increasing as the society moves forward. To satisfy all these necessities, production-processes are necessary. As all necessities go on increasing, so there is continuous need to improve and advance all the production-processes. For this, development of productive-forces (means of production plus human-resources) is a must. To develop productive-forces, the development of productive-relations is also necessary. Development of productive-forces and productive-relations is what constitutes the development of economic-base of the country. [6].

Infra-structure is necessary for economic development of the nation. Transportation is an important aspect of infra-structure. So transportation is necessary for the economic development of the nation. Every form of production like food, clothing, medicines, building materials, raw-materials, agricultural-production, capital-goods, and so on, are to be transported from production-site to the distribution-site at all stages. During production-stage, there is constant need to bring all the required raw-materials like steel, coal, chemical fertilizers, manure, seeds, building-materials, and so on, to the production-sites of all kinds. During distribution-stage, there is constant need to carry all the final (finished)-products from production-sites to the distribution-sites. [6].

II. ROLE OF TRANSPORTATION

It should be noted that production-stages and distribution-stages are inter-mingled. For instance, take the case of an enterprise manufacturing machines. It is the production-site and it requires steel, electricity, coal, other metals etc. as raw-materials and fuels for producing machines, which are to be distributed to other enterprises requiring these machines. These raw-materials and fuels are distributed at this production-site by other production-sites such as steel-plants, electricity-power-plants, coal-mines, metallurgical-plants etc. So every production-site is at the same time a distribution-site, and every distribution-site is at the same time a production-site. These two aspects of production and distribution of every enterprise go hand in hand. In the operation and development of these two aspects, the transportation plays a prominent role.

Therefore if the transportation as an inseparable part of infra-structure is under-developed in the country, then it would put hurdles in the path of economic development. Efficient transportation definitely lowers the cost of production also.

The development of transportation is vital not only for economic development of the country and the people, but also for the development of the country and the people in social and cultural spheres. The development in social and cultural spheres requires development and advancement of natural and life sciences, engineering and technological sciences, medical sciences, social sciences, art and literature; and for all this, establishment of institutions is a major task to be accomplished. Clearly to develop and advance all this, the efficient transportation is needed.

III. BASIC PATHS FOR TRANSPORTATION

There may be three basic paths for transportation viz. land, water, and air. Path by land gets reflected through two modes viz. by road and by rail. So in the final analysis, there are four basic modes of transport viz. roadways, railways, waterways, and airways. Roadways include city-streets, feeder-roads, village-roads, state-highways, and national-highways. Railways are basically developed for long distance transportation. Waterways mean transportation through oceans, rivers, canals, and lakes. [4].

Different modes of transport are developed historically according to needs of the socio-economic systems of the times and availability of the paths for transportation. Also in present times, these are being mainly developed with respect to needs of the present socio-economic system.

Every mode of transport has relative advantages and disadvantages. For instance, airways is the fastest mode of transportation, journey is continuous without any disturbances as on land and water, has ability to approach any area which is otherwise inaccessible by other modes of transport, more comfortable, the most time-saving, yet the weight-carrying-capacity is the lowest as compared to other modes of transportation, adverse weather-conditions affect its operation to a very great extent, and operating expenses are generally very high; waterways is although the slowest mode, but it needs the less energy per unit load and per unit distance; railways are advantageous for long distance transportation, good mode for transportation of bulk goods, and act as arteries for land-transportation; and roadways act as feeder-system for transportation to interior parts and to the intermediate localities, door-to-door service being possible only by roadways, it is nearest to the people, and it requires less investment as compared to the huge investment in railways.

IV. CASE OF WATERWAYS AND AIRWAYS

In case of waterways and airways, the vehicle and load has to move through fluids. In case of fluids, there is viscous dragging force due to viscosity of the fluid which is

infact internal-fraction between layers of the moving fluid. It is the property of the fluid due to which an internal force of friction is developed among layers of the fluid having relative motion. Clearly, motion of the fluid is opposed. It is quantified by concept of co-efficient of viscosity, which is equal to the tangential force needed to maintain velocity-gradient of unity between two parallel layers of fluid each having area unity.

Whenever a small spherical body moves through a viscous fluid, then layers of the fluid which touch the body, are dragged along with the body, while the layers of the fluid away from the body remain at rest. Hence a relative motion between different layers of the fluid is developed. As a result, a backward dragging force comes into play. This viscous-drag opposes the motion of the body through the fluid. This is called Stokes' Law and its mathematical formulation is: $F = 6\pi\,\eta\,r\,v$, where 6π is a constant of proportionality, η is the co-efficient of viscosity of the fluid, r is the radius of the spherical body, and v is the velocity of the body. Clearly, if the fluid is more viscous, has more velocity, large radius (i.e. large size), then the viscous-dragging force will be large and hence more power will be required to move the body through the fluid. This viscous-dragging force is in addition to the viscous-drag which is inherent in the fluid motion. We note that in general there is always disturbance in the fluid, although it seems to be in static-state, so naturally some viscous-drag is always there. Moreover, when a body moves through the fluid, then there is also the presence of external-friction between the surface of the body and the "surface" of the fluid taking fluid as a bulk quantity.

TABLE I COMPARATIVE VALUES OF U AND μ OF SOME FLUIDS [1]

Sr. No.	Fluid	Co-efficient of Viscosity (μ)	Kinematic Viscosity (υ)
Liquids			
1.	Water	0.0114	0.0114
2.	Mercury	0.016	0.0012
3.	Parafin oil	0.2	0.25
4.	Glycerine	13	10
5.	Castor oil	15	15
6.	Pitch	10^{10}	10^{10}
Gases			
7.	Air	0.00018	0.15
8.	Nitrogen	0.00017	0.15
9.	Oxygen	0.0002	0.15
10.	Hydrogen	0.00009	1.5
11.	Helium	0.0002	0.12
12.	Carbon dioxide	0.00014	0.077

Normally we call it "air-friction" Therefore, when a body moves through a fluid, then the body has to struggle against three opposing forces: viscous-dragging force inherent in the fluid, viscous-dragging force due to the motion of the body through the fluid, viscous-dragging force due to external friction (air-friction), and all these three opposing forces reinforce one-another to become a formidable opposing force. This situation is experienced by the bodies when they move through air and water as is the case of airways and waterways.

Role of viscosity concerning motion of fluids is more determined by a relatively new concept of "Kinematic Viscosity" rather than the concept "Co-efficient of Viscosity", which is denoted by υ, and is given by: $\upsilon = \frac{\mu}{\rho}$, where ρ is the density of the fluid. [1], [2], [3]. Comparative values of υ and μ of some fluids are given in Table I.

We see that kinematic viscosity for air is greater than that of water, so more power will be required for the vehicle and the load to move through air than through water.

V. CASE OF RAILWAYS AND ROADWAYS

Now railways and roadways are both modes of land-transportation. Although initial investment in Railways is enormous, yet railways are safe and comfortable, provide cheap means of transportation for the people, and heavy goods can be transported for long distances by railways, Railways provide maximum revenue, and provide employment on a large-scale. In addition to all this, Railways need less power to move. It is a common estimation that the energy requirement to carry unit load per unit distance in case of railways is one-fourth to one-sixth of the energy requirement for roadways. [5], [11], [12], [15], [16].

Force of friction is a force which is developed at the surfaces of contact two bodies and drags the relative motion of the bodies. The force of external (contact) friction, which is developed between the surfaces of two bodies when the actual motion has not yet taken place, is called static friction. The maximum value of force of external (contact) friction, which is developed between the surfaces of two bodies when the actual motion has not yet taken place, is called limiting friction. In this situation, clearly one body will just about to move over the surface of the other bodies. Force of limiting friction between any two bodies in contact is directly proportional to normal reaction R. The force of external (contact) friction, which is developed between the surfaces of two bodies when the actual motion has taken place, is called kinetic (dynamic) friction. Kinetic (dynamic) friction is always less than limiting friction. Kinetic (dynamic) friction is of two kinds. Kinetic (dynamic) friction, which is developed between the surfaces of two bodies, when one body is actually sliding over the surface of the other body, is known as sliding friction. On the other

hand, kinetic (dynamic) friction, which is developed between the surfaces of two bodies, when one body is actually rolling over the surface of the other body, is known as rolling friction. Force of friction F is directly proportional to normal reaction R i.e. $F \propto R$, this implies $F = (\mu).R$, where μ is a constant of proportionality, called co-efficient of limiting friction. Therefore $\mu = F/R$. Since $F_k < F$, so co-efficient of kinetic (dynamical) friction is less than co-efficient of limiting friction. Almost 20% of the petrol used in an automobile is utilised to overcome friction in engine and in driving. The co-efficient of friction between steel-and-steel surfaces in case of railways (0.23) is far less than co-efficient of friction between rubber-and-dry concrete surfaces (0.6-0.85) and between rubber-and-wet concrete (0.45-0.75) in case of roadways.

The role of the phenomenon of elasticity is also important. A deforming force is that force which when applied on a body changes the configuration of the body. The property of a body to regain its original configuration i.e. length, volume, shape etc., when the deforming forces are removed, is called elasticity. The configuration of a body is changed when a deforming force is applied on the body, because the normal positions of the atoms and molecules of the body are changed. The result is that an internal restoring force develops which tends to bring the body back to its initial configuration. This internal restring force acting per unit area of a deformed body is called stress. Strain is the ratio of change in configuration and the original configuration. The upper limit of deforming force upto which if the deforming force is removed, the body regains its original form completely, and beyond which if the deforming force is increased, the body loses its property of elasticity and gets permanently deformed, is called elastic limit. Hooke's Law states that within elastic limit, the extension produced in a wire is directly proportional to the load applied. That is within elastic limit, extension $\propto$ load applied. Modified Hooke's Law states that within elastic limit, the stress developed is directly proportional to the strain produced in a body. That is within elastic limit, stress $\propto$ strain. This implies stress = (E).(strain), where E is a constant of proportionality called co-efficient of elasticity or modulus of elasticity of the material of the body. Thus E = Stress/Strain.

Young's Modulus of elasticity (Y) of the material of the body is the ratio of the normal stress and the corresponding longitudinal strain produced, within elastic limit. So, Y = normal stress/ longitudinal strain. Bulk modulus of elasticity (B) of the material of the body is the ratio of the normal stress and the corresponding volumetric strain produced, within elastic limit. So, B = normal stress/ volumetric strain. Shear modulus of elasticity or modulus of rigidity (G) of the material of the body is the ratio of the tangential stress and the corresponding shearing strain produced, within elastic limit. So, B = tangential stress/ shearing strain.

TABLE II YOUNG'S MODULI (Y) AND YIELD STRENGTH OF SOME MATERIALS [17]

Sr. No.	Substance	Young's Modulus of Elasticity (Y)	Ultimate Strength	Yield Strength
1.	Aluminium	$70\times 10^9\ \mathrm{Nm^{-2}}$	$110\times 10^6\ \mathrm{Nm^{-2}}$	95
2.	Copper	$110\times 10^9\ \mathrm{Nm^{-2}}$	$400\times 10^6\ \mathrm{Nm^{-2}}$	200
3.	Iron	$190\times 10^9\ \mathrm{Nm^{-2}}$	$330\times 10^6\ \mathrm{Nm^{-2}}$	170
4.	Steel	$200\times 10^9\ \mathrm{Nm^{-2}}$	$400\times 10^6\ \mathrm{Nm^{-2}}$	250
5.	Glass	$65\times 10^9\ \mathrm{Nm^{-2}}$	$50\times 10^6\ \mathrm{Nm^{-2}}$	---
6.	Concrete	$30\times 10^9\ \mathrm{Nm^{-2}}$	$40\times 10^6\ \mathrm{Nm^{-2}}$	---
7.	Wood	$13\times 10^9\ \mathrm{Nm^{-2}}$	$50\times 10^6\ \mathrm{Nm^{-2}}$	---
8.	Bone	$9\times 10^9\ \mathrm{Nm^{-2}}$	$170\times 10^6\ \mathrm{Nm^{-2}}$	---
9.	Polystyrene	$3\times 10^9\ \mathrm{Nm^{-2}}$	$48\times 10^6\ \mathrm{Nm^{-2}}$	---

TABLE III BULK MODULI (B) OF SOME MATERIALS [17]

Sr. No.	Substance	Bulk Modulus of Elasticity (B)
Solids		
1.	Aluminium	$72\times 10^9\ \mathrm{Nm^{-2}}$
2.	Brass	$61\times 10^9\ \mathrm{Nm^{-2}}$
3.	Copper	$140\times 10^9\ \mathrm{Nm^{-2}}$
4.	Glass	$37\times 10^9\ \mathrm{Nm^{-2}}$
5.	Iron	$100\times 10^9\ \mathrm{Nm^{-2}}$
6.	Nickel	$260\times 10^9\ \mathrm{Nm^{-2}}$
7.	Steel	$160\times 10^9\ \mathrm{Nm^{-2}}$
Liquids		
8.	Water	$2.2\times 10^9\ \mathrm{Nm^{-2}}$
9.	Ethanol	$0.9\times 10^9\ \mathrm{Nm^{-2}}$
10.	Carbon Disuphide	$1.56\times 10^9\ \mathrm{Nm^{-2}}$
11.	Glycerine	$4.76\times 10^9\ \mathrm{Nm^{-2}}$
12.	Mercury	$25\times 10^9\ \mathrm{Nm^{-2}}$
Gases		
13.	Air (at STP)	$1.0\times 10^{-4}\ \mathrm{Nm^{-2}}$

TABLE IV SHEAR MODULUS OF ELASTICITY OR MODULUS OF RIGIDITY (G) OF SOME MATERIALS [17]

Sr. No.	Substance	Bulk Modulus of Elasticity (B)
1.	Aluminium	$25\times 10^9\ \mathrm{Nm}^{-2}$
2.	Brass	$36\times 10^9\ \mathrm{Nm}^{-2}$
3.	Copper	$42\times 10^9\ \mathrm{Nm}^{-2}$
4.	Glass	$23\times 10^9\ \mathrm{Nm}^{-2}$
5.	Iron	$70\times 10^9\ \mathrm{Nm}^{-2}$
6.	Lead	$5.6\times 10^9\ \mathrm{Nm}^{-2}$
7.	Nickel	$77\times 10^9\ \mathrm{Nm}^{-2}$
8.	Steel	$84\times 10^9\ \mathrm{Nm}^{-2}$
9.	Tungsten	$150\times 10^9\ \mathrm{Nm}^{-2}$
10.	Wood	$10\times 10^9\ \mathrm{Nm}^{-2}$

We see that all the three kinds of modulus of elasticity of steel is quite large, also it has other good properties like being flexible and being comparatively cheap, as a result of which steel is used in rails. Also co-efficient of friction for steel-steel surfaces is small. These factors combined lead to the selection of steel in railways.

Of the modes of transportation of roadways and railways, supreme stress should be on the development of railways, because basic point here is that co-efficient of friction between steel-and-steel surfaces (in case of railways) is far less than co-efficient of friction between rubber-and-concrete surfaces (in case of roadways). So, in case of railways, less force is required to move trains, leading to less use of petroleum products, so the most economical. Also, less pollution of the environment will be there. [18].

VI. CONCLUSION

Infra-structure is necessary for economic development of the nation. Transportation is an important aspect of infra-structure. Efficient transportation definitely lowers the cost of production. Every mode of transport has relative advantages and disadvantages.

When a body moves through a fluid, then the body has to struggle against three opposing forces: viscous-dragging force inherent in the fluid, viscous-dragging force due to the motion of the body through the fluid, viscous-dragging force due to external friction (air-friction), and all these three opposing forces reinforce one-another to become a formidable opposing force. Role of viscosity concerning motion of fluids is more determined by a relatively new concept of “Kinematic Viscosity” rather than the concept “Co-efficient of Viscosity”. Kinematic viscosity for air is greater than that of water, more power will be required for the vehicle and the load to move through air than through water. So waterways are more economical as compared to airways.

Co-efficient of friction between steel-and-steel surfaces in case of Railways is far less than co-efficient of friction between rubber-and-concrete surfaces in case of roadways. In case of railways and roadways, the role of the phenomenon of elasticity is also important. Three kinds of modulus of elasticity of steel are large, also it has other good properties like being flexible and being comparatively cheap, as a result of which steel is used in rails. Also co-efficient of friction for steel-steel surfaces is small. So, in case of railways, less force is required to move trains, leading to less use of petroleum products, so the most economical. Also, less pollution of the environment will be there. So, in land-transportation, supreme prominence must be given to the development of railways.

REFERENCES

[1] J. L. Bansal, *Viscous Fluid Dynamics*, New Delhi, Bombay, Calcutta: Oxford & IBH Publishing Co., 1977, Ch. 1.

[2] F. Chorlton, *Textbook of Fluid Dynamics*, 1st Indian ed. Delhi: CBS Publishers & Distributors, 1985, Ch. 2, 3.

[3] Shanti Swarup, *Fluid Dynamics*, Meerut: Krishna Prakashan Mandir, 1987, Ch. 1, 2.

[4] Gurcharan Singh and Jagdish Singh, *Highway Engineering*, Delhi: Standard Publishers Distributors, 2004, Ch. 1.

[5] S C Saxena and S P Arora, *A Textbook of Railway Engineering*, Delhi: Dhanpat Rai Publications, 2006, Ch. 1.

[6] Ruddar Dutt and KPM Sundharam, *Indian Economy*, New Delhi: S. Chand & Company, 2007, Ch. 1, 2, 8.

[7] R R Gaur, R Sangal, and G P Bagaria, *A Foundation Course in Human Values and Professional Ethics (Teacher’s Manual)*, New Delhi: Excel Books, 2009.

[8] R R Gaur, R Sangal, and G P Bagaria, *A Foundation Course in Human Values and Professional Ethics*, New Delhi: Excel Books, 2010, Ch. 15.

[9] Punjab Technical University, Jalandhar, “Souvenir” concerning *National Convention on Integrating Human Values In Technical Education*, 11-12th Dec., 2010, organised by PTU, Jalandhar, in collaboration with IIT Delhi, IIT Kanpur, IIIT Hyderabad, SSUN New Delhi.

[10] Ritu Soryan, *Human Values & Professional Ethics*, New Delhi: Dhanpat Rai & Sons , 2010.

[11] R Srinivasa Kumar, *Highway Engineering*, Hyderabad: Universities Press (India) Private Limited, 2011, Ch. 1.

[12] S K Khanna and CEG Justo, *Highway Engineering*”, 9th ed., Roorkee, India: Nem Chand & Bros, 2011, Ch. 1.

[13] Sanjeev Kumar Bhalla and Rupa Bhalla, *Human Values & Professional Ethics*, New Delhi: Satya Prakashan, 2011-12.

[14] Varinder Kumar, *Human Values & Professional Ethics*, Ludhiana, India: Kalyani Publishers, translated into Punjabi by JBS Nanda, 2012.

[15] Satish Chandra and M M Aggarwal, *Railway Engineering*, India: Oxford University Press, 2013, Ch. 1.

[16] V K Kumawat, *Transportation Engineering-II*, Pune, India: Tech-Max Publications, 2014, Ch. 1.

[17] K L Gomber and K L Gogia, *Fundamental Physics*, vol. 2, Jalandhar, India, Pradeep Publications, 2014, Unit 7.

[18] B. S. Brar, "Pro-People, Pro-National Technology, Production-Systems and Management-Models", a paper presented in *1st National Conference, on Human Values & Professional Ethics*, organised by Deptt. of Mentoring & Value Inculcation, Chandigarh University (Campus Gharuan), on 11th & 12th December, 2015, and published in Conference Proceedings.