UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

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STEEL STANDARDS AND STANDARDIZATION ON A COUNTRY-WIDE BASIS

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by

B.S. Krishnamachar,
Indian Standards Institution

SUMMARY

In India where steel scarcity has been experienced for many years, increased production of steel together with its optimum utilisation assumed urgency and great importance since the attainment of independence in 1947. In order to meet this demand, the Government of India entrusted the National Standards Body, namely, the Indian Standards Institution (ISI), with the work of formulation of standards for production of steel and codes of practice for utilization of steel laying special emphasis on steel economy.

ISI made a detailed study of the national and company standards current in other countries of the world and took note of the current developments in the rolling technique and shape engineering. Based on this study, Indian Standards for an efficient series of hot-rolled steel sections and codes of practice for use of steel in building construction were formulated keeping "Steel Economy" as the main criteria. By formulating an Indian Standard for Carbon Alloy and Tool Steels based on indigenous raw materials, ISI has been able to drastically cut down a large variety of steels at present being used in India, thus assisting the establishment of an alloy steel industry in the country on an economic and sound footing.

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INTRODUCTION

The production of steel in the developing countries is a very small fraction of what is being produced in the developed countries; and, therefore, it may be thought that there would be hardly anything new in a paper covering the standardization activity in the field of steel in a developing country, for it would largely cover those fields which have already been traversed better by the developed countries. But it may be pointed out that for a developing country, like India, there is not only plenty of scope to follow what has already been done elsewhere, but there are new grounds also to be broken. For instance, even with our maximum possible effort, we are able to meet at this stage the demands of only a small fraction of our very large population; and, therefore, for us it becomes equally important - rather more important - to think how the volume of production can be utilized best. Our standardization activity has, therefore, been geared not only with improved production technology but also with considerations of optimum utilization aspect.

2. This paper, therefore, discusses, with special reference to Steel Economy, the standardization work that has been done in India during the last 10 years. This would illustrate what benefits developing countries can get by undertaking similar standardization work in their own countries.

HISTORICAL BACKGROUND

3. India has been experiencing steel scarcity for many years but it became acute since the Second World War. It may be interesting to note that the Indian steel industry reached its peak production of 1.36 million tons during the war but it came down to about 0.85 million tons in 1948. Production could be stepped up only gradually to about one million ton by 1952 and over 1.5 million tons by 1957. The present production is around 5 million tons.

4. Shortly after the attainment of independence in 1947, ambitious plans for rapid industrialization of the country were formulated by the Government of India. Steel being an essential basic raw material for all industries, serious thought was given to increase its production. It was, however, realized that inspite of plans for the expansion of production of steel in the two existing steel mills, there would still remain considerable gap between the supply and demand of steel in the years to come. The question of import of large quantities of steel was

ruled out in view of the necessity to give first priority to imports of food and capital equipment. It was apparent that production of steel must be enhanced. Simultaneously, the need for conservation of steel through efficient use of available resources assumed urgent importance for a speedy development of national economy. The realization of this fact led the Government of India to appoint in May 1949 a special committee under the Institution of Engineers (India), to examine in detail and suggest ways and means of conserving available steel. This Committee after careful study suggested:

a. the use of alternate materials to the maximum possible extent,

b. making improvements in design procedures by improving the existing codes,

c. the increased use of steel of higher performance and rationalization of steel sections, and

d. the promotion of welding in place of riveting.

5. The recommendations of this Committee were considered by the Planning Commission of the Government of India in December 1950 and the Government was requested to entrust to Indian Standards Institution the responsibility of taking up a steel economy programme involving formulation and implementation of standards relating to steel production and use.

6. The Institution, which was hardly four years old at that time, was conscious of the responsibility placed on its shoulders. Such a comprehensive programme of national standardization had never been tackled by any standards organization of the world. Many complex problems were involved, some requiring close study and careful compilation of available data and experience of industrially advanced countries; some requiring critical examination of India's own needs and potentialities; others demanding breaking of new ground and answers to questions of basic engineering importance.

7. It was evident from the beginning that original thinking and a fresh outlook would be needed to achieve speedy results, and speedy results were vital if full advantage was to be reaped for the benefit of the fast developing economy of the country.

8. In order to handle this work, a separate section which popularly came to be known as "Steel Economy Section", was set up at the ISI with competent technical staff. Also, the services of a firm of consultants Messrs Ramseyer and Miller Inc. of New York, were secured through the Technical Co-operation Mission of US Government. Active co-operation of the major steel producers of India, of leading metallurgists and structural engineers, and of the Government Departments concerned was enlisted in the course of time.

9. All this took the best part of three years, for the search for experts had to be made not only in India but also in the leading countries of the world before arrangements indicated were finalized. An expert committee consisting of representatives drawn from industry, scientific institutions, and Government departments was set up under the chairmanship of one of the most eminent administrators with wide knowledge of steel production, namely, Shri J.J. Ghandy, Director-in-Charge of Tata Iron and Steel Co. The programme was finally launched on 13 February 1954 which incidentally was not a Friday.

10. While work on this project proceeded and before two years had elapsed, advantages and the need for an all-out attack on standardization of metals and metal products, and for co-ordinating the metallurgical aspects of these products with the use aspect became so apparent that ISI had to decide to create a new Department known as the Structural and Metals Department whose responsibility included not only the 'Steel Economy Project' but also all other metals and structural engineering. This Department came into being on 26 October 1956.

STEEL ECONOMY PROGRAMME OF ISI

11. The comprehensive character of the Steel Economy Project may be gauged by the brief statement of its scope:

a. Formulation of standards for hot-rolled sections, such as I-beams, angles, channels, etc;

b. Formulation of standards for cold-formed light-gauge sections, made from sheet steel or the so-called steel strip;

c. Formulation of codes of practice for the design of steel structures, including the question of liberalizing factors of safety;

d. Preparation of standard specifications, codes of practice and other aids for popularizing welding as a medium of fabrication of steel structures;

e. Sponsoring experimental and other investigations necessary for the formulation of higher efficiency standards, relating to production and use of structural steel; and

f. Preparation of typical designs, drawings and other aids to the implementation of the higher efficiency standards.

HOT-ROLLED SECTIONS

12. During the past 45 years, engineers have come to realize that the capacity of any structural member to take and transfer loads and forces depends upon the arrangement of the metal in the member and that this capacity could be raised by judicious distribution of the material in the cross-section of the member, thus increasing the efficiency of the metal used. This realization has led to the development of the so-called science of shape engineering now commonly accepted and widely applied in most branches of engineering. Mathematical analysis of theories coupled with experimental verification, which constitute this science, has resulted in many improvements, such as triangular roof trusses replacing horizontal beams, columns built up of thin members replacing the solid sections, open web girders replacing solid web members for heavy loads, and so forth.

13. Inspite of this development of shape engineering, production standards in India for structural sections had not kept pace with the progressive improvement in rolling mill design and technique and better understanding of the principles and application of shape engineering. The only attempt made for improvement was the example of Tata Iron and Steel Co., who had placed on the market just before the Second World War, certain light weight beams which were up to 25 per cent lighter than conventional sections.

14. A study of the work being done in other countries of the world with regard to standardization of hot-rolled sections indicated that improvements in standards were carried out mainly through rationalization in the number and grading of sections and through redesign of certain sections. Rationalization in numbers and improvement to gradation of sections have been attempted in practically all steel producing countries. But, improvements effected through scientific analysis of

efficiency properties were particularly noticeable in countries where there was severe competition among the rolling mills in the home market and in the export market, or where the steel industry had to face severe competition from re-inforced and pre-stressed concrete. Whatever the motives, these developments in overseas countries furnished an excellent starting point for the ISI project whose objective was to achieve national economy.

15. Four years of intensive study at the ISI Secretariat and by the expert committee resulted in the formulation of Indian Standards on improved and rationalized series of beams, channels, angles, tee bars, and bulb angles. For obvious reasons, all these standards have been based on metric system of measurements. In formulating the high efficiency standards, note has been taken of many factors, such as the production standards current at that time in India, limitations and capabilities of the existing mills and of the new mills being installed; the national standards and the competitive company standards introduced in other countries; the unsuccessful attempts made in other countries towards improvement of standards for steel sections; the important aspect of efficiency in the utilization of sections in structures; the analysis of the factors which affect the efficiency and the extent to which it is possible to achieve efficiency in practice under Indian working conditions.

16. In the work of ISI on standardization of steel sections, detailed analysis and efforts at improving the sections on consideration of economy and efficiency in use have been directed mainly to beam and channel sections. The improvements effected could be summarized as follows:

a. reduction in web thickness,
b. increase in the width of flanges,
c. reduction in the slope of flanges,
d. rationalization in the number of sections produced and arrangement of sections in more systematic series, and
e. general reduction of weight.

17. In the case of angles, tee bars, etc, the work has been mostly one of conversion and rationalization of the present production standards to the metric system and additions and deletions of certain sections found necessary from consideration of consumers requirements.

18. When considerable progress had been made by ISI in evolving new standards for hot-rolled steel sections, it came to notice that the countries of the European Coal and Steel Community (CECA), had undertaken similar work more or less on the same method of approach. The recent examples of similar effort are reflected in the work done in Hungary and USSR.

19. Attention is now being paid to roll all the Indian Standard Sections in the mills in this country and when these standards are fully implemented, it is expected that they will lead to a definite saving of steel between 5 to 15 per cent. An average saving of 10 per cent is considered quite significant from the national point of view. A special study has been undertaken to make an objective assessment of this saving in steel due to implementation of Indian Standards.

COLD-FORMED LIGHT-GAUGE SECTIONS

20. Another application of shape engineering is in cold-formed light-gauge steel sections, which are manufactured by cold-forming light-gauge steel sheet or steel strip of suitable widths and thickness from 1.2 mm to 4.5 mm, in a press brake or a rolling mill. Commonly used shapes are angles, channels, zees(Z) and certain irregular shapes desired to meet requirements of a particular design. Combinations of sections are made by connecting elements of two or more simpler sections by seam welds, bolts, screws, or some other suitable fastening device.

21. Cold-formed light-gauge sections are increasingly used in building construction, aircraft, automobile and various other mobile or stationary constructions where light weight and strength are specially desired. They have become popular in USA, UK and certain other European countries. In India also, they have been used but to a very limited extent in some of the industries, like coach-building, wagon-building and in building construction. Apart from lightness and strength, cold-formed light-gauge sections have an additional advantage from fabrication and transportation points of view. It is anticipated that the use of these sections will result in economy of steel to the extent of about 40 per cent when compared to the normal hot-rolled sections.

22. Although it is appreciated that the inherent advantage of using light-gauge sections is best exploited by designing individual members to suit the requirements of a given job, yet it was felt that further advantages could be gained, if a set of standardized sections were made available which could meet effectively the normal day-to-day requirements of designer and erector. With this end in view, an Indian Standard Specification for Cold-formed Light-gauge Structural Steel Sections (IS: 811-1961) has been published. So far as known, no other country except UK has attempted standardization of these sections. The thinking in this country was that in the absence of competition among fabricators of such sections and in view of India's peculiar needs, it would be useful for ISI to prepare a standard for cold-formed light-gauge sections.

TUBULAR SECTIONS

23. Study of shape engineering brings out the superior structural characteristics of tubes or pipes. Weight for weight tubular sections can carry much more load than ordinary rolled sections and they are easier to maintain. Their load-bearing advantages become particularly significant where axial compressive and torsional stresses are involved. With the development of new fabrication techniques suited to tubular construction, their use in overseas countries has made rapid strides during the past decade or two. They are becoming increasingly popular for common types of structures in India. It was estimated that use of tubes in certain types of structures could lead to a saving in steel to the extent of 15 per cent. An Indian Standard Specification for Tubes for Structural Purposes has, therefore, been formulated.

STANDARD DESIGN CODES

24. In the beginning of the present century it was the practice to allow large factors of safety, as designers had no adequate and reliable data relating to external loads to which structures might be subjected. There was very little experimental research data on prototype structures. The analysis of structures was rather elementary, and in a number of cases was based on empirical and semi-empirical formulae with very little theoretical support. Great strides have since been made in analysing the stresses developed under loads in structures, and in more precise determination of loads to be allowed in the design of structures. Actual behaviour of structures under complex loads is also better known today than in the past.

25. The ISI Committee made an intensive study of national and departmental codes for the use of steel, currently prevalent in India and various countries of the world. Considerable data were also collected in this country from different regions with regard to wind pressures, temperature variations, working loads, earthquake effects, etc. As a result of this intensive study, the basic code for the design of steel structures was formulated. Some of the design formulae incorporated in the Indian Standard Code represent a definite improvement over those hitherto used in the country and also current in a number of other countries. Further, the permissible stresses have been liberalized. A correct application of this Code in the design of structure is expected to result in considerable savings in steel.

26. Other basic codes for design of structures include one for the use of tubular sections in structures, and another for the use of cold-formed light-gauge sections in general building construction. Work is also in progress on other codes of practice, such as design of cranes, transmission towers, etc.

WELDING

27. The technique of welding came into vogue in America and Europe during the First World War. India took to it slowly sometime during 1935. Although there is a growing appreciation of the advantages of welding, the progress so far made cannot be regarded as satisfactory or adequate. After a detailed study of the present position, the ISI Committee was of the view that development of welding on correct lines in this country could take place only if suitable welding materials and equipment were made readily available, satisfactory design procedure were followed and an acceptable basis was established for the training and periodical testing of welders and for inspection of welds at site. With this point in view, a number of Indian Standards of basic importance pertaining to welding have been published, which include a code of practice for use of metal arc welding for general construction in mild steel, code of practice for training and testing of metal arc welders, qualifying tests for metal arc welders, general recommendations for the radiographic examination of fusion welded joints, code of practice for safety and health requirements in welding, and specifications for electrodes, filler rods and equipment for eye and face-protection during welding.

28. It is estimated that the use of welding in place of riveting would result in saving steel from 10 to 30 per cent, depending upon the type of structure.

HANDBOOKS

29. It was realized that merely the formulation and publication of standard specifications and codes of practice would not be sufficient to ensure that these would be correctly interpreted and applied in practice to the maximum advantage. Although the basic training imparted in our engineering colleges is more or less on the same lines as in other countries, our engineering graduates do not have the same opportunity to gain experience in well established design offices under the guidance of experienced engineers. Large majority of Indian engineers who enter the field of design are left to their own resources in gaining experience. Therefore, the designs prepared by them cannot always be the most economical. Thus, in order to assist these designers and also fabricators, work was undertaken to prepare a number of handbooks giving worked out design examples of several typical structures, designed to the best advantage as regards economy in material and labour. These handbooks, in addition to providing explanations to the Indian Standard Codes and Specifications, would also give charts, tables and graphs, thus making the task of the designer easy and less time consuming. Assistance to prepare the first drafts of these handbooks was obtained from experts in the field from USA. These drafts have to be considerably modified to suit Indian conditions. So far, three handbooks have been published and work is in progress on a number of other handbooks.

STANDARDIZATION AND RATIONALIZATION OF CARBON, ALLOY AND TOOL STEELS

30. Another important programme initiated by ISI relates to standardization and rationalisation of carbon, alloy and tool steels. The indigenous production of alloy and special steels has been insignificant compared to the demand, with the result that practically all alloy and special steels required by the country are being imported. As a result of large scale industrialization undertaken in this country, technical assistance has been obtained from a number of foreign countries. In almost all cases, the equipment, manufacturing schedules and specifications for raw materials have been based on the practice followed in the countries from where the assistance was obtained. As may be expected, there is a natural reluctance [illegible] designers or production engineers to use any material other than [illegible] they are familiar and this state of affairs has led to a multiplicity

of specifications for engineering materials which are being used in the country. This situation was further aggravated by the absence of a comprehensive Indian Standard for different types of carbon, alloy and tool steels.

31. Furthermore, India has not had an established alloy and special steels industry although during the Second World War, manufacture of steels covering practically the entire range from carbon tool steels to quality aircraft steels and ordnance steels was undertaken in this country. With the cessation of hostility, it became apparent that it was difficult to produce alloy and special steels in large integrated plants mass producing structural steels.

32. The Technical Committee took note of this fact and felt that in order to encourage the establishment of an alloy and special steels industry in the country on a sound footing, it was necessary, as a first step, to reduce the number of such steels used by the various industries to ensure their manufacture in economical quantities. Secondly, since India does not possess resources for some of the most important alloying elements for steels, such as nickel and molybdenum, due regard had to be given for their conservation and, as far as possible, to the development of steels using indigenously available alloying elements.

33. As a first step, the Technical Committee collected all available data in the country with regard to present and future requirements of various types of steels in terms of tonnage, specifications and, where possible, forms, shapes and sizes. After a detailed investigation of the information thus collected, discussions were held with various user industries to bring down the variety of steels for use in the country, and an Indian Standard on the subject has now been published (IS:1570-1961 Schedules for Wrought Steels for General Engineering Purposes). It has been possible to reduce over 1,000 varieties of steels to about 140 varieties.

USE OF ALTERNATIVE MATERIALS

34. In order to encourage use of alternative materials, a number of Indian Standards relating to stones, bricks, timber and cement concrete have been formulated.

STRUCTURAL RESEARCH

35. The ISI Technical Committee found during its work on the Steel Economy Project that on many subjects, the available Indian data were inadequate, and that the data available from outside sources were not directly usable due to the widely different

conditions under which they were collected. On certain other problems, practical experience and experimental data were either not altogether available or, when available, were incomplete. After a close scrutiny of these problems and with the collaboration of the Council of Scientific and Industrial Research, various institutions in India were enlisted to undertake a co-ordinated programme of experimental investigations. The progress made so far has not been very substantial due to many difficulties, such as in the supply of raw materials and equipment, and shortage of technical personnel. But, wherever the results of investigations were available, these have been incorporated in the published Indian Standards; those to follow will help improve the existing standards. Work is now in progress with regard to investigations relating to corrosion protection of steel structures with particular reference to light-gauge steel. This programme covers classification of areas in India on the basis of corrosion potential of the prevailing atmosphere, development of suitable protective coatings, accelerated methods of tests to assess the corrosiveness of various environments, and evolution of corrosion protection schemes.

INSPECTION AND CERTIFICATION

36. A peculiar system existing in this country for a long time is the one relating to the sale of so-called "untested steel". Under the existing procedure, the inspectorates of the Government of India are responsible for inspection of structural steel required by the Government departments. Their representatives also inspect and certify the steel for open market, put up by the manufacturers. The material which conforms to the requirements of the national standard or other standards required by the consumers are certified for sale under the category of "tested steel". But, an appreciable tonnage of steel meant for structural purposes is, at present, sold as "untested steel". Since the strength properties of this steel are not guaranteed or certified or even known, it is not possible to use it efficiently by allowing stresses and loads to the maximum safe limits. In order to make best use of this category of steel, a separate Indian Standard Specification has been formulated to cover this material. Further, most of the steel produced in this country is expected to be covered under the ISI Certification Marks Scheme. The ISI Certification Mark is a third party guarantee to the purchaser that the goods have been inspected, tested and certified by or under the supervision of a competent agency and that they may be purchased with reasonable assurance about quality.

CONCLUSION

37. The work done in India on steel standardization has clearly brought out that the nation as a whole has large benefits to derive. On a conservative estimate, about 20 per cent of steel is expected to be saved if all the Indian Standards relating to the production and use of steel are fully implemented. A special study has been undertaken to make an objective assessment of this saving in steel due to implementation of Indian Standards. In the context of the target of 18 million tons of annual production of steel by the end of the Fourth Five Year Plan, an appreciable quantity of which would be used for structural purposes, a reduction of even one million ton per year would amount to a recurring saving of well over 100 million dollars besides all the investment, costs and the effort involved in the production of such extra quantity.

38. The work done in India has also attracted attention of the United Nations Economic Commission for Latin America which has instituted a similar programme of work. A Seminar on steel products, standardization and simplification was organized last year at Santiago, and in response to the desire expressed by the Latin American authorities concerned, the author had the pleasure to assist them by working as a Consultant to the Seminar at Santiago, organizing a programme of training standards engineers and formulating recommendations relating to the semi-finished steel products and steel bars for structural purposes.

39. At the international level, the Subcommittee on Iron and Steel of the UN Commission for Asia and the Far East has suggested that a similar Steel Economy Programme should be established in each country of the ECAFE Region. Also, a Working Group under the Technical Committee ISO/TC 17 - Steel, with India as Secretariat, has started work with regard to redesign of hot rolled steel sections with the ultimate object that international standards may be evolved for the benefit of all countries.

40. It can, therefore, be seen from the example given in the case of India that much benefit can be derived by establishing steel standardisation programmes on country-wide basis taking into consideration the requirements and limitations of each country with regard to raw materials, production techniques and equipment available. A start on these lines would ultimately lead to the establishment of regional standards and the industry that is best suited to the region.

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