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Comparative Study between Hot Rolled Parallel Flange Section and Tapered Flange Section

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Abstract—*As a structural engineer our main aim is to design the structure with minimum cost and maximum efficiency. The structure must be capable enough to take care of strength and stiffness requirements. Hot rolled parallel flange section has many advantage over conventional tapered flange section, in terms of strength, axial and bending load carrying capacity, workability, economy, cross sectional area requirement, lateral stiffness and easy to weld and bolt. These Parallel Flange section are of three type as per IS: 12778-2004. They are Narrow parallel flange section (NPB), Wide parallel flange section (WPB) and bearing pile sections. Narrow parallel flange sections are generally used as beam member and wide parallel flange sections are used in both beam and column member. Using these Parallel Flange section complex fabrication with ease and in large quantity can be obtained. As per IS: 800-2007, IS: 808-1989 hot rolled tapered section are categorized as: - (ISLB) light beam, (ISMB) medium beam, (ISWB) wide flange and (ISHB) heavy beams. The parallel flange section has greater superiority over tapered flange section in terms of large choice of different profile member, reduction in weight of steel required and saving in time can be done. Due to advancement in technology and design procedure the Narrow flange sections are getting popular among the masses and these are widely used now a days in numerous building construction. Parallel flange section having yield stress 300 MPa, 350 MPa and 410 MPa are being fabricated in India. In the field of civil engineering the scope of these Hot rolled Parallel flange section is very wide. It has greater demand in Steel Moment Resisting frame (SMRF) design. So keeping in mind the usefulness and properties of parallel flange section they can be utilized in all areas of construction technology.*

1. INTRODUCTION

Steel sections have been used for construction purposes in India since long time. Greater advancement has been done in the area of Technology, Analysis and Designing of these complex steel sections. In the recent time Moment Resisting Frames (MRF) structures are being largely used in the field of construction, as they offer greater resistance to seismic forces and are very superior then the conventional method of construction. Indian Hot Rolled

Tapered flange and parallel flange sections are used in the design and manufacturing of steel structures. Tapered flange sections are conventional sections which are being used in construction industry since longer times, but now a days much more modifications has been done and as a result of which Parallel flange sections are very much popular among the people. These Parallel Flange section offers greater lateral stiffness and is very economical as lesser material is required for the same depth of the section and at the same time its Moment of Inertia(I) and Plastic Moment capacity(M) is also higher than those of Tapered flange section. Indian hot rolled tapered flange section has the maximum depth of 600 mm for all (ISLB, ISMB, ISWB and ISHB) steel section, and as per SP 6(1) 1964 the moment of inertia(I) and nominal plastic moment capacity(M) of ISWB 600 is highest which is then followed by ISMB 600. In comparing with Tapered flange section, the maximum depth of parallel flange section can be upto 900 mm and its flange width is also more.

Safety and stability of the structure depends on various factors and elements of which this structure is made up of, some of the prominent parameter include strength, Ductility, Stiffness and Cross sectional property. Connection in steel structure offers greater durability and resistance against various external forces and also against internal stresses generating due to these forces. These connections should be properly designed and thoroughly analyzed as they work, as the backbone of any construction related to steel structure. Any carelessness at any stage of design, manufacturing and construction may leads to the failure of the structure.

Many researchers have given their views regarding performance and practical application of these Parallel and Tapered flange section, It is evident from various research work that parallel flanged section has greater superiority and much more possibility of being used in various high rise structure in seismic prone area and it also has larger probability of technological and sectional modifications in the coming future, with slight change in its manufacturing and designing method much more advancement can be done in this area and its performance can be enhanced. It is due to this reasons parallel flange sections of beam and column elements are in great demand and lot of research are still being going on these steel sections in India as they not only reduces the dead weight of structure but also provide greater strength and saving of money at the same time.

FIG 1.0:- TYPICAL HOT ROLLED PARALLEL FLANGE SECTION

FIG 2.0:- TYPICAL HOT ROLLED TAPAERED FLANGE SECTION

2. METHODOLOGY

The analysis and designing of typical hot rolled (tapered and parallel) sections are being done on a very small scale since very limited research work has been carried in this area. In this paper a detailed comparison has been done between the various parameters and properties of both parallel flange and tapered flange section. Some of the prominent area of comparison include- section modulus, load bearing capacity in axial compression and bending, lateral stiffness, cross sectional area requirement, lesser weight, more workability and economical.

Parallel flange sections are hot rolled steel sections. The proper designing of parallel flange section allows better utilisation and efficient distribution of materials in cross section, and this will lead to higher value of section modulus which on further provide greater Strength, Ductility and Stiffness. Parallel Flange sections are more durable and also its fabrication is easy than the conventional tapered flange sections. Connections can be provided very easily and in simple way. In many developed countries steel section with increased plastic moment capacity and section modulus are in use now a days. In India there are limitations of depth of section, width of flange and also its place of use. Some are efficient as column member and some at the same time are equally good as beam and column member. In many foreign countries these sections are used for roads, railways, bridges, dams, multi storey buildings, and at some important installations but in our country it has been limited to small area like building construction.

On comparing the properties of Parallel and Tapered Flange section we can say that:-

- NPB(Narrow parallel beam) section is more superior than corresponding MB(medium) section, as mass of section gets reduced and increase in section modulus, and
- NPB section is more efficient than corresponding MB section in bending and compression it is because the value of radius of gyration(K) is more about the minor axis.

Tapered flange sections are conventional steel section which are obsolete and are not used regularly. The design and analysis of tapered flange section are limited to elastic design methods. Which are based on the linear approach. However if the section is behaving differently and non linearly then some other method are also used for the designing and analysis of steel section. These method is based upon the software based approach of analysis of structure like- Finite element method. Due to lesser availability of information regarding the performance of these hot rolled sections and also about their utilisation in any particular case, we can rightly say that there is huge scope in steel structure designing and many more advancement can be done to make these steel section economical and durable for use in near future.

Some prominent work done by the Researchers, Academicians and Scientists are summarised as follows:

1. Sritawat Kitipornchai and Nicolas S Trahair studied theelastic stabilityof double symmetric I-beams with tapered flanges/ tapered webs and proposed a generalised form to calculate lateral torsional buckling load under given loading condition.
2. Y.B. Yang and J.D Yau, M.A. Bradford and P.E. Cuk and S.L. chan developed. Using finite element method they analysed.
3. W.J. Krefeld, D.J. Butler and G.B. Anderson conducted the experimental studies on tapered flanges and tapered web and also gave their views on their load carrying capacity.
4. James M. Gere and Winfred O. Carter presented the graphical view of tapered columns under buckling load condition.

5. Charles G. Culver and Stephen M.Preg investigated tapered beam-columns under various loading condition and they proposed the differential equation for determining the critical load and moments. They used mathematical approach to prove their analysis.

6. B.J. Vickery, experimentally observed the failure behaviour of steel with tapered beams/columns and the conclusion was drawn regarding material saving by using the tapered members asagainst the uniform members.

3. CONCLUSION

Designers, fabricators and people around the world are using these parallel flange section over tapered flange section due to their extensive cost benefit and wide applicability in the field of construction. By giving preference to parallel flanged section over conventional tapered sections, higher strength, efficiency, workability, more axial and bending load carrying capacity and lateral stiffness can be attained together by saving much more time and money. By comparing Indian hot rolled (Parallel and Tapered sections) with those of AISC sections, the AISC sections have greater moment of inertia(I) and their plastic moment capacity(M) is even more higher than those of Indian hot rolled sections but with continuous development and enhancement in designing and manufacturing process we will also be producing steel sections with large flange width and increased material and cross sectional properties. Numerous research work is going on, in the areas of steel sections that can be used in erection of taller structures with enhanced strength and stiffnesscritertia. On the whole it can be said that steel sections would bring a new era of development and advancement in the area of construction and civil engineering.

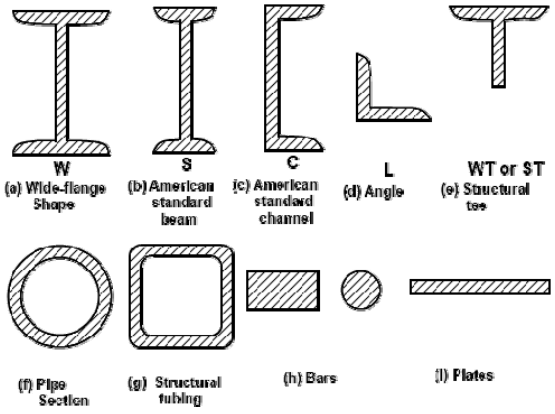

FIG 3.0 TYPICAL AISC SECTIONS

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