An Engineer in Agony

by

Prof. Dr. Madhusudan Bhattacharyya

Professor of Machine Design

Jadavpur University

ABSTRACT

Steels, even today are used as principal materials of engineering construction. Its use can be further economized if some nondestructive method of determining residual stresses on weldment can be found.

1. INTROUCTION

t is no wonder that still today steels are the . ncipal materials of engineering construc-.ion. And designs are considerably being improved with a bid to economise the use of steels and consequently reducing the cost. In the age of tight neck-to-neck competition sometimes the economy is achieved at the cost of safety even: of course such costly designs are given trial in underdeveloped (so lovingly called developing) countries, thus Head I win, tail you lose principle is practised.

2. WHY WEIGHT REDUCTION ?

(a) The weight of a machine or a component determines its cost. In machine tool building it amounts to 20-30% of the total production expenses for not-too-precision machine tools.

b) The weight of transport machines, like rolling stocks, aircrafts, spaceships etc., increases the running cost of fuel. Thus costlier the fuel, more the endevours to cut down the tare weight.

c) More the weight of the superstructure of bridges, more the load on the foundation necessitating sinking more money for foundation.

An index of a rational design from the point of view of metal consumption is its specific weight i. e., the ratio between the consumed metal for an application to the

useful load it is to carry. Given below the the specific weights for a few applications :

Weight of Aircraft Engines	8 to 14 N/kW
Weight of Car Engines	33 N/kW
Weight of Lorry Engines	80 to 200 N/kW
Weight of Tractor Engines	130 to 525 N/kW

In case of Railway passenger cars the weight of the car per passenger :

i) For suburban two axle cars	3 kN to 4 kN
ii) For four axle cars	4.4 kN to 4.9 kN
iii) For sleeping cars	30 kN to 33 kN

An index analogous in structure may serve for assessing the rationality of designed units. It is also to be noted that with speed increasing the specific weights also reduce. For ordinary lathes specific weight has been reduced from 6.7 kN/kW in 1875 to 2 kN/kw in 1980.

3. WHY STEELS ?

1) Steels are superior in strength, rigidity or stiffness to those of any other commercially available materials. Moreover by suitable addition of alloying material / metal higher strength alloy steels are available.

For the same deflection, steels have to be loaded

2.5 times than C.I.

2 times than Bronze

2.913 times than Aluminium and

4.26 times than Magnesium

when all are of same cross-section and are loaded the same way.

It can be proved that, weight for weight steels are still the lightest, most economical metal for equivalent rigidity.

2) Steels are widely available the world over.

3) Steels lend themselves to almost all the manufacturing operation e.g., metal cutting,casting, forging, rolling, welding etc. and people are, due to their long acquaintance with steels, more confident while working with steels.

4. ARE STEELS LOOSING TO FRP ?

FRP now-a-days due to its light weight and moderate strengths is used in various applications. But it has not been able to replace metals as yet. With technological break-throughs things unthought of today may also happen.

5. A BIRD IN HAND IS BETTER THAN A DOZEN IN THE BUSH

As it stands today, steels are used in massive scale in engineering fabrication. Therefore, it would be wiser to pay attention to the economic use of steels. After the second world war, when steels became scarce, engineers were under compulsion and it was at that time that welding came in the fabrication world in a very big way because it offers :

(a) Lesser weight to strength ratio and

(b) More design flexibility

Since then welding is ever going ahead.

It was not long when engineers understood that welding was not all full of roses, but thorns were very much there as

(i) distortion and
(ii) residual stresses

These two big deterrents are to be given a tough fight in practice by appropriate selection of welding process, welding sequence and pre-and post-weld treatments. While distortion can be checked up physically with ease, residual stresses are not. Even if some methods are there to measure the residual stresses, they are to be carried out either on small samples the results of which are ill-extrapolated to predict the residual stresses for actual jobs or to be carried by the relaxation technique which calls for physical damage to the jobs.

Therefore, the problem of residual stresses in welded jobs is present even these days and so many welded structures fail on this count.

6. SOLUTION TO THIS IMPASSE

Solution lies in devising some non-destructive method for the determination of residual stresses. Intensive attempt was made by the use of directional hardness method, which although proved very good for annealed specimen of brass, aluminium and steels for both uniaxial (and biaxial compressive only) loading, did show up erratic results in case of welded jobs. This aspect was brought to the notice of all concerned – the educational institutions, the research organisations and the fabricational industries and it was also stated explicitly that more research and investigations needed to be taken up.

7. CRY IN THE WILDERNESS

The appeal so made fell on the deaf ears of all. The reasons for this indifferent attitudes are not far to seek.

(1) Experimental job is much time consuming and laborious. It requires support from the workshop staff which is rarely to be expected in the research and educational institutions.

(2) This type of jobs are termed low-tech work and hence no possibility of appreciation.

(3) Publication of papers from this type of work often requires a long time. In its place, people prefer to fiddle with the computer keys ; no-dust, no-noise, no-risk games allure people for mass production of papers which in turn may bring them honour in cash and/or kind from so many institutions from India and abroad.

8. CRAZE FOR HI-TECH

High-tech is talked of and automation, modernization and computerisation are advocated. There is nothing wrong in it. In the competitive world, those are required for survival. But they have to be implemented in the right earnest. Unifortunately the massive

investment made in India for modernization has proved entirely futile while the picture in the other countries is totally different.

9. CAUSES OF FUTILITY

The terms modernization, automation, computerisation have only been used as catchy words ; they convey the least to those who plan save and except that only a very few are sincere and they get lost in the jungles of self-seekers. The effect therefore, for India has been catastrophic - soaring prices, increase of poverty, debt trap and probably if the state of affairs continues to be same, death-trap for the nation will not be far ahead.

10. REMEDY

Productivity has to be increased. One would do well to remember whatever productivity figures are shown by the public and the organised private sectors they stand on the edifice of hard labour put by the workers in unorganised sectors.

Indiscriminate foreign loans should not be taken, for the economy of India is already shattered under foreign debts.

11. WHAT CAN BE MANUFACTURED MUST NOT BE IMPORTED

It would benefit all to remember that foreign loans come as goods from foreign countries; even if it is accepted for arguments' sake that updated technological products find their way to India, does it not mean that the exporting countries' labours are paid while foreign debt increases day by day ? What is more, whatever they have to export, India must be needing the same.

Building castles in air used to be possible in fairies' tale but the same proverb is true for India. The organisations which are incapable to maintain even so-called low-tech goods like machines and instruments are given hundreds of crores of rupees grant for modernizing with high-tech products, eventually to turn to costly junks in no remote a future, if not from the date of arrival.

12. KEY WORD

Low-tech and high-tech are not two separate compartments. They two are supplementary. High-tech is based on Low-tech. Any organisation failing to prove its worth for low-tech cannot step for high-tech. So called motivated march towards Hi-Tech costs the nation a lot which the nation can ill-afford any more.

o—o—o