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What ails structural engineers?

J.D. Buch

Engineering education today is more advanced than ever before. Students are also much brighter due to wider exposure to advanced technology. They are computer literate. Yet, many design offices experience that even after one year of training, fresh structural engineers cannot function independently when they have to handle even simple design problems. Many of them do not grow with experience, and excellence is generally lacking. It is necessary to investigate the reasons for this sorry state before remedial measures can be developed.

Most consulting engineering offices - for 90% of their time - deal with designing medium-sized private and public buildings. Most such assignments involve designing trusses, north-lights and other simple elements. Structural engineers should therefore have a sufficient background in designing and detailing such structures when they join a consulting office as fresh engineers. With an adequate academic background and subsequent experience in the design office, structural engineers progressively acquire the capability and confidence to design major structures that may require more competence. However, the present curriculum in engineering institutions fails to train design engineers to meet the requirements of their profession.

Reasons

The major reasons, in my opinion, for such lack of ability in fresh engineers are:

- Too-heavy a course content and yet not currently oriented
- Ever-changing nature of structural engineering
- Demanding a mind-set for continuous learning
- Lacking exposure to the latest developments
- Lacking in training to properly approach design problems

Remedial measures

Remedial measures can be found by developing a response to each of the above situations.

Remodel the curriculum to suit the needs of professional practice

At B.Tech level, 'Structural Engineering' is just one of the many subjects in the curriculum. Design offices should therefore prefer to have engineers with a minimum qualification of M.Tech with a major in Structural Engineering. Engineers who have only a B.Tech degree should be encouraged to attend a part-time or full-time

M.Tech course. My suggestions, based on a review of the present two-year M.Tech curriculum are as under:

1. The present curriculum, with so many papers on varied aspects of structural analysis and design, gives students wide exposure to the subject. But this results in putting them into the category of 'Jack of all' and 'Master of none'. Therefore, it is advisable to reduce the quantum of course content and concentrate more on the design and detailing of 'every day' structures. Designing advanced structures may be made a selective subject for further specialisation.

2. The planning of a building project is the work of a team – an architect, structural engineer and consultants for various utility services. The coordinated purpose of the planning team is to achieve a safe, functional and economic building.

   In order to develop a coordinated structural scheme, it is essential that structural engineers have a broad general knowledge of requirements of other disciplines of planning. They should know the basic flow diagrams of plumbing, electrical and HVAC systems. They should also know how to assess water and power requirements, estimate heat loads for preliminary estimation of HVAC plant capacity, and estimate the requirements of pumps for various services. This basic knowledge will help them in appreciating the needs of other services and in developing a suitable structural system.

   The introduction of such a course (10% of the total credit requirements) in the M.Tech programme will go a long way towards achieving the objective of matching the course contents to the needs of professional practice.

3. In the present M.Tech. programme, 'Foundation and Soil Engineering' constitutes only a 4-credit course. Selecting types of foundation depends on an understanding of Soil Engineering. In my opinion, the 'Structure major' programme is incomplete without more emphasis on the 'Soil Mechanics' course. This subject may be included as an independent course (20% of the total credits) with practical work in soil testing. It is a common experience in most structural engineering offices that design engineers read only the 'recommendations' from the Geotechnical Report to prepare the basis of a foundation design. Unless engineers know about methods of soil testing, they will not appreciate the reliability level of the recommendations, since each method of testing has its limitations.

4. For the implementation of a project, only the details given on construction drawings are followed. The builder is not concerned with the design method that is followed. The present curriculum – both at B.Tech and M.Tech stages – do not adequately emphasise the drawing work. Structural Engineers should be able to prepare on their own (without aid from draftsmen) details that would clearly translate the design need in construction drawings. The requirements of the 'minor and major projects course' in the present curriculum may be revised to include detailed working drawings.

At B.Tech. level, students should become conversant in detailing (on their own) simple structures such as staircases, canopies, trusses and gantries. Design offices in UK and USA, commonly assign only marginal design work to most fresh engineers. At least for the first six months, they work on the drawing board (now on CAD) and on quantity surveying in order to get trained in the office practice.

These additions to the course credit may be balanced by laying less emphasis on, or even deleting, the outdated courses.

Be ready to learn and grow with the ever-changing methods

Till the mid-sixties, structural engineers worked with log tables and slide rules. Next came calculators and 640 kb computers, further advancing to present-day computers and software. Earlier, engineers worked on ft-lb units, then on metric units and now on SI units. The change is gradual but continuous. Today's fresh engineers will also face changes. When a change is introduced, the tendency is to resist; inertia does not easily allow one to adapt oneself to a change, even if the change is an advancement over the old.

A structural engineer who does not change with time, stagnates.

Constant updating of knowledge and expertise

Generally, expertise in a subject comes with experience. This is true if the subject method one has learnt in school has not become drastically insufficient. Over a period, due to social and industrial advancement, sizes of structures have become large and more complex,

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demanding more knowledge of analysis of such structures.

By working in the practical field, engineers develop more and more understanding of the particular field of engagement. At the same time, these engineers may start forgetting college-level mathematics, with the result that it becomes difficult to read and fully understand literature on advanced theories of design. This makes it obligatory for practising Structural Engineers to keep on revising their mathematics and brush up their fundamentals.

It is my belief that if refresher courses are devised, restricting the scope to whatever is the basic minimum, such courses can be very useful. Too much should not be included in these courses.

Provide for exposure to the latest developments

One can count on one's fingertips the structural engineering magazines published in India. To my knowledge, there is none on 'structural steel'. Journals from other countries are very expensive, so most of the offices do not subscribe to such journals. Seminars and conferences also have become very expensive, so most firms do not sponsor the participation of practising engineers. This leads to lack of exposure to developments and to stagnation. The structural engineering profession seriously needs to address this problem and find resources to remedy this.

Develop a proper approach to a problem

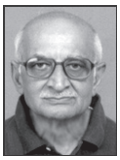
Due to rapid advancement in the social and industrial areas, the demand for taller buildings and complex industrial structures keeps on increasing. A fresh structural engineer therefore may need to design such structures for the first time without having experience on similar work. The design brief, particularly for industrial works, may be inadequate and not fully reliable. The soil investigation report may be vague. There may not be a code available for a particular type of structure. In such a situation, it is necessary that

1. A similar structure should be seen and its structural problems should be studied.
2. The basic process of manufacturing (for industrial work) should be understood.
3. The load data from suppliers and the soil data from the report should not be taken at face value.
4. Failure/distress cases, if any, should be studied.

It is not enough for a structural engineer to design structures only from the given loads and code requirements. It is the moral responsibility of a structural engineer to design a safe, functional and economical structure for efficient operation. Clients entrust work to consultants assuming that they are experts. In case of malfunction, therefore, they cannot take shelter under any excuse.

Conclusion

It is necessary to improve the quality of structural engineering practice in India. Deliberations are required to develop effective methods to implement the remedial measures suggested here.



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