

CAREER PROFILE OF WOMEN IN CIVIL ENGINEERING PROFESSION IN INDIA

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ABSTRACT

Participation of women in the engineering profession is important from the viewpoint of national development. It is also an important factor in improving the quality of life of women themselves. The career paths of women and men who are engineers are not comparable either. Cultural contradiction between being a woman and being an engineer is mirrored in everyday language, where women are depicted as soft and while technology is described as hard. The civil engineering industry remains one of the most male dominated sectors and women are under-represented. Much of the current literature describes the difficulties experienced by women who work in this sector including cultural and structural barriers, such as harassment and discrimination, limited networking opportunities and long and inflexible working hours which often result in poor career prospects and high levels of stress for women. This paper is a platform for the presentation and discussion of the role of women in engineering and particularly in civil engineering, with particular reference to issues, challenges and opportunities. This will provide an insight of women into the education in civil engineering and employment prospects in construction sector.

Keywords: Women, Civil Engineering, Employment, Construction, Education, Gender equality

INTRODUCTION

All modern societies recognize that education and a career are not only the right of a woman, but key factor that contributes to the economic and social development of a nation. Participation of women in the engineering profession is important from the viewpoint of national development. It is also an important factor in improving the quality of life of women themselves. In spite of this recognition, the participation and contribution of women in many professions is insignificant. Though it is said, the percentage of women enrolled to under graduate in various disciplines in India is limited and the figure 1 shows the condition of the decade back. The presence of women in Engineering is much lower than in the Sciences, Arts and Medicine at the Bachelor's level and now there has been a steady improvement in numbers over the years in the engineering stream. There were about 2 women to 100 men in Engineering in early 70's to 30 women to every 100 men in 2000. Despite the fact that the

first woman obtained her engineering degree as early as in 1892, their presence in this important profession has traditionally remained low and this has been a matter of concern all over the world even today.

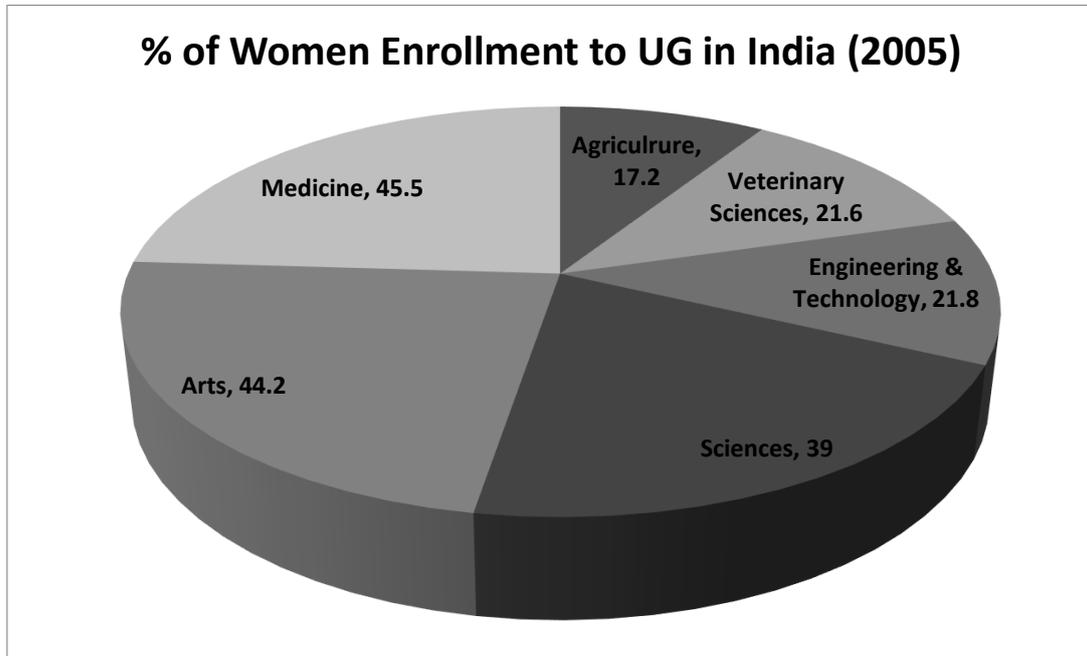


Figure 1, Percentage of Women enrolled to under graduate in various disciplines in India, 2005, Source: Current Science, 2005.

At present, the percentage enrolment of women in engineering colleges and institutions has increased substantially. Taking into account the fact that the numbers of engineering colleges have also increased radically, the annual out-turn of women engineering graduates has increased many times. Compared to the earlier years therefore, the population of women engineers is growing at a much faster pace. The proportion of women is high in some programmes and very low in others. The career paths of women and men who are engineers are not comparable either. Moreover, a cultural contradiction between being a woman and being an engineer is mirrored in every-day language, where women are depicted as 'soft' while technology is described as 'hard'. There has been a great deal of speculation both in the public discourse about women engineers and in feminist critique of the construction of science and technology, around who the woman engineer is, and about what women in technology will bring.

This paper deals with collection and analysis of the data on enrolment and numbers graduating per year, career profiles and career problems of women engineers. Women are still concentrated in certain disciplines, and most professions continue to be sex-segregated.

Equitable representation would offer women equal access to well-paid, high-status engineering careers and add new perspectives to scientific and technical innovation.

WOMEN IN ENGINEERING IN DEVELOPED NATIONS

There is much data and information out there on gender, diversity engineering in particular. Only 9% of the engineering workforce is female and only 6% of registered engineers and technicians are women. England has the lowest percentage of female engineering professionals in Europe, at less than 10%, while Latvia, Bulgaria and Cyprus lead with nearly 30%. 15.8% of engineering and technology undergraduates in the UK are female, when comparing with India, where over 30% of engineering students are women on engineering courses account for over 30% of the students. The proportion of young women studying engineering and physics has remained virtually static since 2012. The UK needs to significantly increase the number of people with engineering skills. As of 2015, the annual shortfall of the right engineering skills is 55000 and need to double; at least, the number of UK based university engineering students. Women and men engineering and technology students express similar levels of intent to work in engineering & technology, but 66.2% of the men and 47.4% of the women graduates in 2011 went on to work in engineering and technology. In a survey of 300 female engineers, 84% were either happy or extremely happy with their career choice and Engineering students are second only to medics in securing full-time jobs and earning good salaries, enabling women to meet their full potential in work could add as much as \$28 trillion to annual GDP in 2025.

According to the Bureau of Labor Statistics (BLS), women comprise roughly 13% percent of the engineering workforce and 13% of the civil engineering workforce. When looking at anticipated growth, civil engineering outpaces almost all other engineering disciplines and is expected to grow 24.3% by 2018, with the most growth anticipated in the Engineering Services arena. The following figure.2, gives the percent of women professionals in various Engineering disciplines in United States.

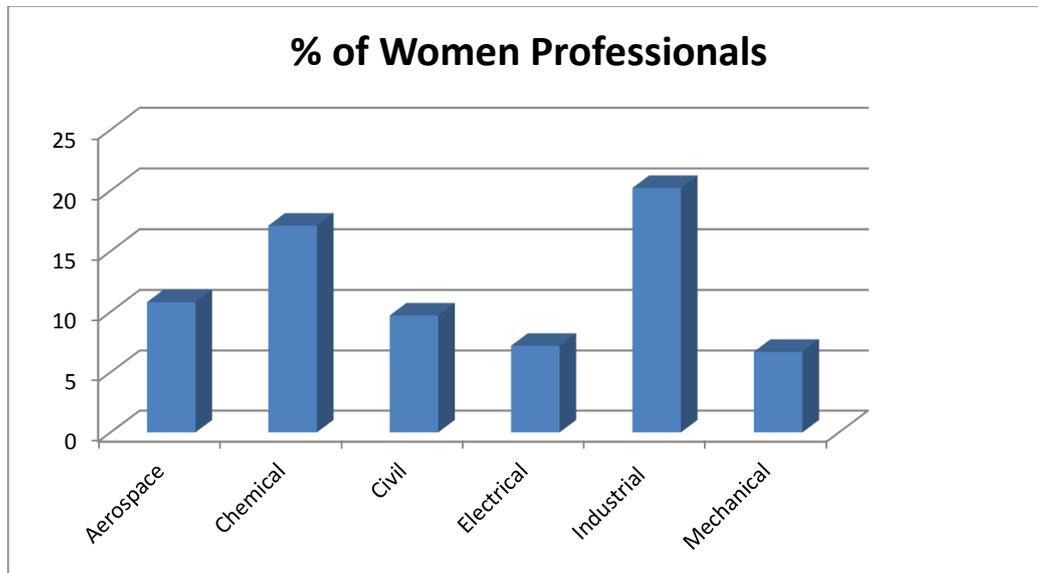


Figure 2, Percentage of Women professionals in Engineering Disciplines in United States, Source: United States Bureau of Labour Studies (2012)

According to the Engineering Workforce Commission (EWC), in 2010, 19.7% of all civil engineering degrees were awarded to women, in comparison to 18.2% of all engineering degrees awarded to women. The EWC also reported that over the past five years, civil engineering consistently awarded more Master's and Doctoral degrees to women than any other engineering discipline, at 26% for each degree category, respectively. Civil engineering outpaces all other engineering disciplines by 3% in the awarding of Master's degrees and 4% in the awarding of Doctoral degrees.

WOMEN TO ENGINEERING

Sukhatme and Parikh (2006) reported that the percentage of women getting B.Tech. degrees from IIT Bombay increased from 1.8% in 1972 to 7.9% in 2005. This trend seems to indicate that more women are enrolling in Engineering, perhaps, based on the assumption at the outset that jobs are aplenty. Women got 1.5% of the total engineering degrees in 1980 and 23.9% of the total engineering degrees in 1998 showing a steady and impressive increase in their enrolment in engineering in India (Patel and Parmentier 2005). Despite the impressive increase in women's enrolment, reality after graduation remains harsh, where employers are overtly or covertly rejecting women engineers. Improvement in enrolment and graduation rates has not resulted in improvement in employment figures. Workforce participation of women in 1980 was 34% and went down to 32% in 1998 (Patel and Parmentier 2005). Kerala, the state with the highest female literacy rate, had high enrolment figures of 30% with even higher unemployment rates of 35.9% in 1990 and 41.5% in 1998 for women engineers (Sukumaran et al 2006; Patel and Parmentier 2005). Women with engineering degrees have an unemployment rate that was five times higher than that for men.

WOMEN IN CIVIL ENGINEERING

Civil engineering, one of the oldest and broadest branches of engineering, is mainly concerned with the design, creation and maintenance of infrastructure in the built and natural environments surrounding us. It's about creating a sustainable society that has clean water, power and treatment of waste, with an infrastructure to provide road, rail, docks, harbours and airports. It also includes protecting the environment and it is the caring profession of the built environment. The discipline takes in railway lines, highways, tunnel and bridges, as well as water courses and sewage systems, coastal development and geotechnical engineering. Civil engineers design and supervise the creation of structures. They use computer technologies and advanced materials to design structures that meet the needs of a growing population while protecting the environment, reducing the dangers from natural phenomenon like storms, and considering future needs of the community. A career in civil engineering can be diverse and exciting, touching on everything from geology to surveying to risk management. It is a career in which a women can play a role in improving people's quality of life. It also offers the satisfaction of seeing a project through from initial concept to design and creation. On a day-to-day basis, as a civil engineer your responsibilities could include managing budgets, approving project drawings and reports, overseeing orders and delivery of equipment, taking care of any changes a client wants to make, resolving problems and ensuring that work is completed on time and within budget.

Challenges in the Construction industry

There is little doubt that a number of developing countries have seen a dramatic increase in both output and employment in the construction industry in the past 30 years. Construction is a major component of investment; hence expansion in construction activity is closely related to economic growth. Numerous studies have shown that construction output grows particularly fast, often exceeding the rate of growth of the economy as a whole, as countries put their basic infrastructure in place during the early stages of development.

Decline in number of Civil Engineering students

In many countries, the number of students that choose a civil engineering career is in decline. Success patterns in society have changed and many prospective students believe that an engineering career is a more difficult route to success than others. This perception may be due to obsolete study plans, perceived high work commitment, perceived low salaries, a lack of research careers, or a view that civil engineers are technicians that do not get to the top compared to, say, business or management graduates. But it is also because civil engineering has not recently been explained well to society, compared to science or other branches of engineering and technology. Other reasons for such perceptions are, study of civil engineering is hard with a high mathematical component compared to other study programs such as the social sciences, and the entrance salary is low compared to other professions; and the new Bachelor degrees in civil engineering may make this even worse. Civil engineering companies and other professions within the built environment do not encourage continuous professional development; they employ engineers when there is work and drop them when

the contract terminates. In the hierarchy of building companies, civil engineers are often regarded as expendable, less important than other professionals when in fact they are the resources upon which such companies are based. Time and working pressure is extremely high during the important phases of construction and supervision at building sites, which are usually away from the company office and demands additional time for travelling or working away from home.

Opportunities in India

Civil engineering, which is considered a challenging field to work in, is no more a male driven profession. In fact, it is offering various lucrative opportunities to women as well. It is a misconception that civil engineering is a male-dominant field and women would have a difficult time working on outdoor projects. This is an era of specialization and same holds true for civil engineering. Working on computers in air-conditioned offices or getting opportunity to work abroad is now also possible in civil engineering field. Nowadays, over 20:80 girls to boy's ratio are studying civil engineering at various institutes. Due to rapid urbanization this profession offers huge growth opportunities. There is no compulsion that one has to work on site. Due to the introduction of new software's estimation work has become easier. Girls have a huge opportunity waiting in the civil engineering field and all they need is determination to work in the challenging field.

About the openings and benefits of working in the public sector, there is scope in the areas like infrastructure development, maintenance and repairs, design and planning and non-conventional technology application. According to the Indian central government's infrastructure policies, there will be a huge demand for civil engineers in the near future. Apart from good pay packages, the sector offers engineers to work on mega projects along with job security. In India, on entry-level, fresher's can easily earn around INR 15,000 to INR 35,000 per month and with experience of 3 years, the package can go above INR 50,000.

The jobs all involve many different types of people from many different job disciplines. In project design you work with most all engineering disciplines, lawyers, developers, citizens, planners, architects, contractors, surveyors, just to name a few. It is a very rewarding job. Watching something you designed be constructed and function well is a great thrill. It is also fulfilling to solve the design problems and it is somewhat like a puzzle or game to try and come up with the best design for the least cost while still making it look good. And women are good at this; they typically plan well and can think outside the box to come up with innovative solutions. They also pay close attention to details which is extremely important in this field. There are many female civil engineers in the workforce today.

Discipline wise Enrollment in India

Engineering and Technology is one of the major streams with 42.5 lakh students enrolled. The share of male students enrolled in Engineering is 72%. Female participation in this sector is relatively low. This stream has 17 sub streams like Electronics Engineering, Computer

Engineering, Mechanical Engineering, Electrical Engineering etc. The top 5 sub stream are Mechanical Engineering with 10.9 lakh students, Computer Engineering with 7.6 Lakh students, Electronics Engineering with 7.4 Lakh students, Civil Engineering with 6.3 lakh students and Electrical Engineering with 4.7 Lakh students enrolled. In Information technology/ Computer Application stream, there are 6.8 lakh students enrolled. Engineering and Technology stream is divided into 19 sub-streams with total number of 30587 students enrolled for Ph.D. and 2.61 lakh students at PG level. Mechanical Engineering has highest number of 3919 students enrolled for Ph.D. with 91.6% male students. Electronics engineering is the second highest having 3560 students with 74.5% male students. At PG level also, Computer Engineering has highest number of 55098 students with 43% male students. The table mentioned below gives discipline wise enrollment of Men and Women graduates in 2015-16 in India.

Table 1, Enrollment of Graduates in Engineering in India (2015-16)

S.No	Discipline	Male	Female	Total
01	Mechanical Engineering	965434	43258	1008692
02	Computer Engineering	418315	346484	764799
03	Electronics Engineering	412756	330248	743004
04	Civil Engineering	512474	120900	633374
05	Electrical Engineering	348437	118904	467341
06	Information Technology	99204	87015	186219
07	Chemical Engineering	35569	11797	47366
08	Agriculture Engineering	11060	5401	16461
09	Aeronautical Engineering	10919	3140	14059
10	Metallurgical Engineering	7762	2338	10100
11	Mining Engineering	8120	207	8327
12	Food Technology	4749	3334	8083
13	Marine Engineering	3035	108	3143
14	Dairy Technology	1333	607	1940

In India, the participation of women in engineering was negligible till the early 1980s. It is only in the past 15 years that their enrolment has shown an increasing trend. This movement began first in the southern states and has gradually spread to other parts of the country. However, with the increase in numbers, women engineers are facing many problems in their careers. These problems need to be understood and analyzed. The Indian National Science Academy constituted a committee to investigate the issue of Science Career for Women and suggest measures to increase women's participation in study and practice of science.

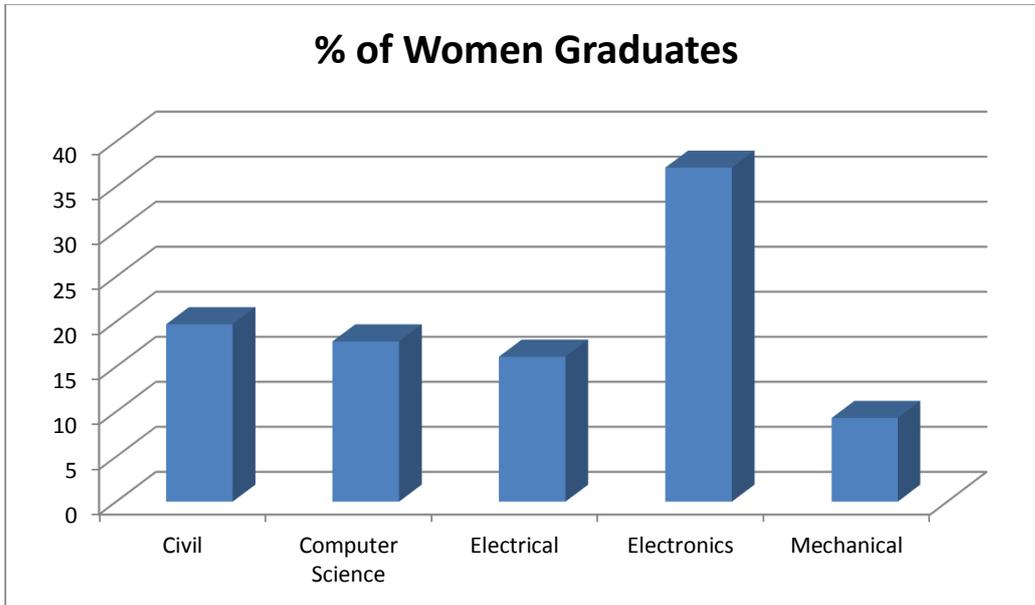


Figure 3, Percentage of Women Graduates in Engineering Disciplines in India, Source: University Grant Commission (2002)

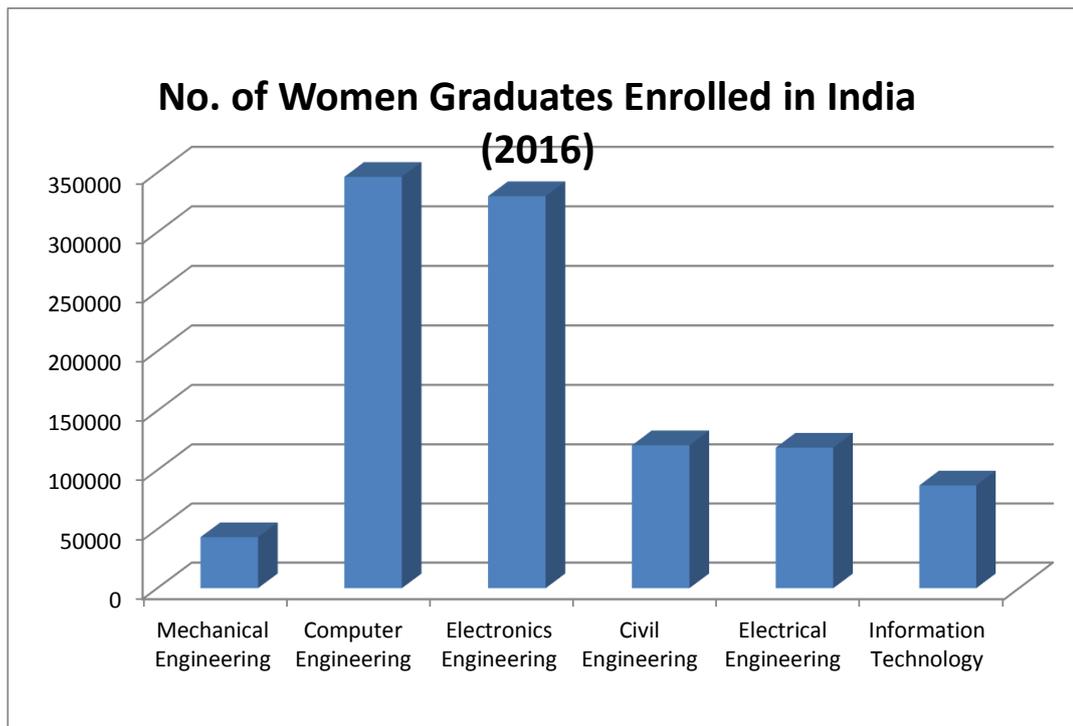


Figure 4, No. of Women Graduates Enrolled in Engineering Disciplines in India, Source: MHRD, Govt. of India (2016)

Job status in India

It can be seen that only 54.9% of the women engineers are employed. Further analysis of the data reveals that out of 54.9%, only 44.7% have been continuously employed after graduation, the remaining 9.3% intermittently employed. Thus the employed fraction has reduced by 13.8%. The unemployed fraction has increased from 26.1% to 30.6%. Simultaneous increase of the stock and the unemployed fractions implies that a larger number of women engineers remain without a job. This is not a happy scenario. Finding the first job after graduation continues to be a major hurdle in the career path of women engineers. This is duly reflected by a higher percentage of unemployment amongst the younger members and the fact that the unemployed were without a job for over a year at the time of data collection. An important facet that emerged from the previous studies was that the unemployment of women engineers was highest in Kerala, that too amongst those having a degree in Civil Engineering. The overall unemployment amongst women engineers from Kerala was found to be 36% whereas unemployment amongst the women Civil Engineers from Kerala was over 50%. The highest percentage of unemployment is now in Andhra Pradesh where 45.7% of the women engineers are unemployed. Unemployment in Karnataka and Tamil Nadu is 33.5% and 31.9% respectively.

WHY CHOOSE CIVIL ENGINEERING?

The world needs more engineers to provide enough homes, workplaces, roads, clean water and energy supplies for the future and provide sustainable engineered solutions to safeguard the future environment. Engineering jobs are well paid, have good long-term prospects and scope to move around if you want to, even abroad. Many girls who are curious, imaginative or practical take qualifications in science and maths and go into jobs in Civil Engineering, where they enjoy finding solutions to problems in construction.

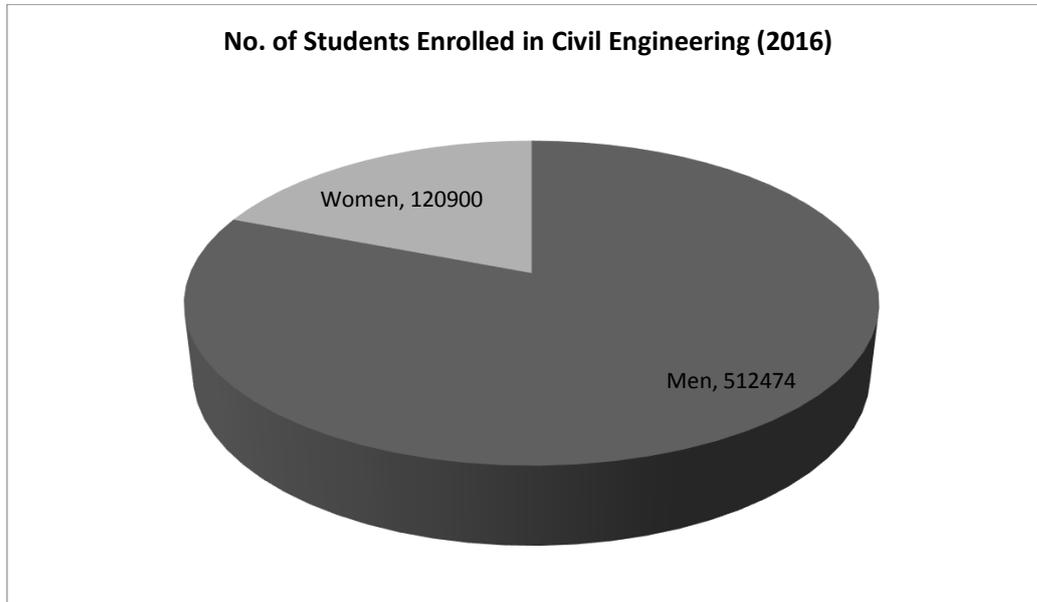


Figure 5, No. of students Enrolled in Civil Engineering in India, Source: MHRD, Govt. of India (2016)

CHALLENGES FACED

- A. Occupational choices remain gender biased:** Despite the progress that has been achieved in girls' and women's education, occupational segregation remains a predominant feature of training and labour markets, limiting women's choices and confining them to lower-paid and lower-status jobs than men. Not only are women overrepresented in some occupations (and under-represented in others); segregation often also occurs within occupations, with men holding the more responsible jobs (UNDAW, 2009). This vertical segregation is usually not associated with higher levels of skills or experience.
- B. Women still face more barriers to education and training, especially in rural, informal and traditional economies:** While there is evidence at global level of progress in women's access to education and training, this overall view obscures the wide discrepancies that exist across and within countries. Women in rural areas face the challenge of combining education and training with farming, household, community and care responsibilities. Educational and training provision that is available is often difficult to reach and insufficiently flexible. These difficulties are particularly acute in traditional societies, where families are often less willing to invest in a girl's education because of established practices of early marriage, low remuneration for women's work, familial reservations regarding women working outside their homes, and expectations that girls and women will do most of the household chores. As a consequence, educational disadvantage accumulates throughout women's lives as basic education is often a prerequisite for further skills development.

- C. For women, higher skills levels do not mean better jobs:** Higher levels of education generally lead to a lower proportion of people “neither employed nor in education or training” (NEET). Yet even where girls and women are able to acquire skills for work, they often face social, cultural, economic and practical constraints that pose barriers to their making full use of those skills in gaining appropriate work. Thus in low-income countries, there are likely to be more women than men among the NEET (OECD, 2012).

PRACTICAL SOLUTIONS

What needs to be done to inspire more women to take up engineering and be involved in employment prospects? Let’s have a look at some of the points below:

- A. Creating gender-sensitive training environments:** Teachers and trainers should receive gender awareness training to raise and address gender issues and avoid, or where necessary challenge, stereotypes. They can help to sensitize employers to these issues and encourage them to offer on-the-job training, including apprenticeships, or internships, to both women and men.
- B. Proper Training materials targeted at women:** Training materials should display images of both women and men performing jobs. Safe school facilities, separate sanitation facilities, and childcare services have all been proved effective in supporting female participation in training and acceptance of facilities by trainees’ parents. Rules against sexual harassment also help foster an environment based on mutual respect and gender equality. Also, interactive learning methods and role plays foster communication, teamwork and respect, and can offer opportunities for both women and men to play different roles, as “leaders” as well as “followers”.
- C. Using counselling, mentoring to create opportunities for women in technology-intensive areas:** Teachers’, parents’ and counsellors’ support are crucial in encouraging young people to examine these perceptions and to raise girls’ interest in non-traditional occupations, in particular those in engineering areas. Other means of opening up girls’ choices include facilitating contacts and discussions with practitioners, especially female practitioners, through girls’ days or career events, and involving families and wider communities in awareness raising and information sharing about potential careers, for example through open days at training centers. Scholarships, temporary quotas for selected training programs, and awards for successful professionals in non-traditional occupations have also proved useful in reducing occupational segregation. Faculties of engineering should provide quality counselling to ensure that program and course choices are a good fit with the student’s interests and abilities.
- D. More positive role models:** Successful practitioners, especially women, can act as role models, showing that it is possible to break through gender barriers, and as mentors, providing invaluable insights into how prejudices can be overcome. Professional networks of female engineers or architects, for example, can help by offering mentoring

to younger colleagues and raising awareness among employers and other professionals, exchanging experience and offering targeted training.

- E. Encourage Participation:** Efforts to encourage women to participate in education, training and productive employment, including in hitherto male-dominated occupations, need to be targeted to the specific context and group selected for intervention. Designed to overcome the range of existing barriers (training fees, timing, facilities etc.) and to respond flexibly to different needs. Designed to address questions of status associated with different jobs and to open up these social perceptions to challenge.
- F. Identify Indicators and set specific Targets:** Ways to give practical effect to gender-specific policies include identifying indicators and setting specific targets with regard to, for example, equal participation of women and men in training programs; equal participation of women and men in the management of skills development systems and institutions; lowering gender segregation both within and between occupations; and enhancing the uptake of STEM subjects by women
- G. Promote Recognition & Showcase achievements:** Progress in scientific and professional associations can be assessed by monitoring the proportion of women elected to positions on the governing body, on important committees, receiving awards and prizes, invited as keynote speakers, panelists on specialty topics and plenary sessions. Qualified women can be found, and recognizing their achievements and expertise will accelerate progress towards a fairer representation and add new perspectives in solving technological problems.

GOOD PRACTICES

The engineering faculty can help to 'normalize' the female engineer amongst staff and students. In addition, they must be aware of an early confidence loss experienced by some female students. In terms of curricula, the provision of quality training in hands-on engineering benefits not only female students but also growing numbers of men, who do not have a 'tinkering' background. Students 'engage' more readily with engineering where the syllabus integrates practical and theoretical elements (e.g. through project work).

CONCLUSION

Women are generally underrepresented in engineering and in particular in civil engineering. However, many women who study engineering go on to have very successful, diverse and interesting careers. There is a wide range of opportunities open to women in all branches of the profession and civil engineering in particular provides a real chance to 'make a difference' and improve life in local communities. Unlike past, the new areas are open/opening in Civil /

Structural Engineering - where the 'Patience' and the naturally 'Creative' attitude of women can be readily utilized. Sincerity, honesty and the attitude takes the person to the peak or makes them to achieve the goals, irrespective of the gender. Attracting, retaining and developing capable women to deliver the expanding program of work are part of the solution. Employers, training providers, schools and the wider community all have parts to play in creating a supportive and motivating environment conducive to the recruitment of women into higher positions in technology-based fields and in administration and management.

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