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A TRIBUTE TO BHARAT RATNA SIR MOKSHAGUNDAM VISVESVARYA

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We have assembled here to pay tribute to Sir Mokshagundam Visvesvarya, an eminent engineer and statesman who played a key role in building a modern India. Today is his 162nd birth anniversary and we are celebrating 55th Engineers day. He was popularly known as MV.

Sir MV was born at Muddan Halli, village in Kolar district of Karnataka on 15th Sep. 1860. His father Srinivasa Shastri was a Sanskrit scholar and an Ayurvedic practitioner. He lost his father at an early age.

Mokshgundam Visvesvarya took primary education at his village school Chikaballarpur and then went to Bangalore for higher education in 1881. He had a great appetite for studies since very childhood.

M.V. was admitted to central college at Bangalore. Here he used to get scholarship, but the amount was not sufficient to meet all his needs. The financial hardship , however, could not dampen the great scholar who continued his studies and topped the list of successful candidates. He got his engineering education from Pune Engineering college and topped the list of whole University in 1883.

These are a few noted contributions of Sir M. Visvesvarya

He was the Chief architect for the construction of Krishna Raja Sagar Dam in Mysuru. This work of him was instrumental in converting the barren lands into fertile grounds for farming. The adjoining Brindavan garden is the living example of his aesthetic sense. He played an imperative role in building a structure to safeguard Visakhapatnam port from sea erosion. He was the Chief Designer of the flood protection system of Hyderabad city. He is also credited with the development of the Block system which would prevent the wasteful flow of water in dams. He was the one who designed a plan for road construction between Tirumala and Tirupati. He also commissioned several new Railway lines in Mysore state. His work and methodology was appreciated by all and his book “Planned Economy for India” written by him in 1934 still works as guide for planning of India. Recognized all over the globe for his involvement in harnessing water resources, Visvesvarya was accountable for the construction and consolidation of dams across India.

He also served as the 19th Diwan of Mysore from 1912 to 1919. During his tenure, the Mysore state underwent rapid development in the field of education, finance and industry. Many canals were constructed and Mysore University was established.

As an engineer and an administrator, the kind of work which Sir M. V has done will stand as an inspiration to many more generations to come. He was one of the engineers in the country who made the **“unthinkable achievable”.**

He was awarded the highest Indian honour , the **Bharat Ratna** in year 1955. for his work in the fields of engineering and education. His life is a source of inspiration for every Indian. He will always live by being an inspiration to all the youths and engineers of our country.

Sir M. V. was a true patriot, a great scholar and an able administrator. He breathed his last on 14th April 1962.

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Smart Engineering for a Better World

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Abstract

Smart Engineering aims at a new approach for describing, designing and dimensioning Smart Products. Design methodology is far advanced and provides both a systematic approach to develop new products as well as appropriate methods to support development tasks in specific development phases. As the development of new technologies in the 21st century is very rapid, simultaneously demands for smart products are on the rise. A smart product from smart engineering is paving the way for better world. All the revolutions like industry 4.0, Sustainable development goals, light weight structures, ergonomic and aesthetic design materials, smart materials, highly efficient machines are different ways in which we are going towards smart engineering. Customers are also looking for smart products that are lashed with new era of technology like artificial intelligence, Internet of things, etc. For example old black and white TV got replaced with LCD TV then it also got replaced by Smart TV which integrated the facility of internet with TV and got huge customer demand. Similarly Smart watch is also a marvelous example of Smart Engineering. In defence also, modern arms and ammunition is being developed which has accurate and precise target destroying capacity and it is an example of smart engineering. Secured nation with modern defence infrastructure is utmost necessary for better tomorrow which can be realized from present situation of China-Taiwan and Russia-Ukraine. It can be said it is a step ahead Engineering and will be definitely better for world if used in positive manner.

Keywords: Smart Engineering, Smart Products, Cross-Product communication

Main Thrust

Smart Engineering describes methods, processes, and IT tools for the interdisciplinary, system-oriented development of innovative, intelligent and networked products**,** production plants**,** and infrastructures. These aspects are commonly known under the term "Industry 4.0". The comprehensive exchange of information between all components involved in the production process plays a major and decisive role. In addition, it is also about the exchange of information between the individual sub-processes of both product development and manufacturing, to improve performance, quality, customer acceptance, and cost reduction of products**.** An equally important sub-area is an interdisciplinary "Life Cycle Management" to improve the knowledge domains and interactions that have so far largely been insufficiently linked, and thus to counteract a continuous loss of information and experience. Thus, especially in the area of networking of all development and production steps from interdisciplinary concepts to the production process, product use, and final disposal, there are fields of action to be developed in the area of product data and process models.

Smart Engineering comprises a new procedural paradigm for describing, designing and dimensioning Smart Products. The new innovative approach of Smart Products results from the concept of Cyber-Physical Systems which requires products being equipped with embedded systems, sensors and actuators as well as the ability to communicate with other Smart Products. A **cyber-physical system** (**CPS**) or intelligent system is a computer system in which a mechanism is controlled or monitored by computer-based algorithms. These new features challenge engineering as product engineering and development has to be taken into account consistently. The concept of Cyber-Physical Systems is considered as a fundamental approach to enable the development of Smart Products using Smart Engineering. The main features of Cyber-Physical Systems are sensors, actuators and embedded intelligence as known from mechatronic and automotive systems.

Furthermore Cyber-Physical Systems are considered as a breakthrough technology to develop the “Internet of Things”. While Cyber-Physical Systems are considered as a fundamental basis of Smart Products, their features are even more advanced due to their embedded intelligence. Smart Products are aiming at embedded intelligence enabling products reacting autonomously due to their communication with other Smart Products in a predefined environment. Due to the high industrial potential the German Ministry of Education and Research has identified Smart Products and Smart Factories as a key element of their initiative called “Industry 4.0”. To enable the development of Smart Products an advanced approach for engineering is required. This approach is called Smart Engineering and its target is to describe, to design and to engineer Smart Products. For Smart Engineering a profound knowledge of sensor technologies, actuator technologies, control logics and communication protocols is required. Therefore, a basic analysis of sensor and actuator technologies as well as an analysis of communication protocols is done. Smart Engineering is based on the products’ with specification to derive the description of the functional behavior. New approaches are aiming to integrate the challenging innovation of Smart Products into a product development and design. Developed and developing nations are taking high interest in Smart Engineering work to boost their economy and technology.

Status of India: India is continuously working towards smart product development by utilizing smart engineering. Many new factories and industries are established which are fully or partially automated. Many world class institutions have been established to provide smart engineering education and solution. Many parts of the country have Special Economic zone and IT Zone. Education system is going through transformation phases to adapt new education policy which strongly supports technology enabled learning. New courses have been started online-offline both like data analytics, artificial intelligence, Internet of things, Robotics, Mechatronics, etc which will form foundation for Smart Engineering.

Conclusion:

Smart Engineering gives technological innovation that improves efficiency and teaches young Engineers valuable skills. Finally, smart engineering comprises the integration of product development, production planning, and production control for the rapid market-ready implementation of innovative product ideas and thus the creation of value through a digitally influenced development process. Important here is the development of a PLM concept (PLM: Product Lifecycle Management) to capture the entire product life cycle and thus improve productivity, quality, and reliability across all process boundaries. This gives solution to conserve natural resources through sensors and networks. Thus young technocrats with latest technological knowledge will have smart solution to complex problems with Smart Engineering concept, so as to benefit the society and to create a better world for human beings.

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Smart Materials in Civil Engineering for Better World:

C.B RAI , F.I.E (India)

Keywords: Smart construction, Waste materials, Sustainable development, concrete, cost, Recycled aggregate

Introduction:

Smart Engineering- It describes methods, processes and IT tools for the interdisciplinary system oriented development of innovative, intelligent and networked products and production plants, and infrastructures.

It comprises the integration of product development, production planning and production control for the rapid market-ready implementation of innovative product, ideas and thus the creation of value through a digitally influenced development process.

In civil engineering, due to urbanization the demand for construction materials increases, with the increase in demand there is a strong need to utilize alternative materials for sustainable development however the responsible management of waste is an essential aspect of sustainable building. Fly ash is generated in huge quantities every day in major thermal power stations of Maharashtra. About 50 to 100 tons of fly ash is produced daily in a normal thermal power station depending on its capacity, quality of coal, load factor, etc. The huge quantities of fly ash are being accumulated day by day, occupying large area. Disposal of this huge quantity is therefore a problem. It is as fine as and sometimes even finer than cement. It contains silica,alumina, calcium oxide, and iron oxide. The fly ash can be used as an eco-friendly material for the construction of rigid pavement.

Another alternative for rigid pavement is foundry sand. The use of foundry sand in various construction engineering applications can solve the environmental problems. Foundry sand consists primarily of silica sand, coated with a thin film of burnt carbon, residual and dust. Foundry sand can be used in concrete to improve its strength and other durability factors. Foundry Sand can be used as a partial replacement of fine aggregates as supplementary replacement to achieve different properties of concrete. This foundry sand consumes a large area of local landfill space. Some industries burn their sludge in incinerators, contributing to our serious air pollution problems. To reduce disposal and pollution problems emanating from these industrial wastes, it is most essential to develop profitable building materials from them. Keeping this in view, it is used to produce low cost concrete by blending various ratios of fine aggregate with used foundry sand. The waste steel scraps obtained from lathe can be used in concrete pavement. In each lathe industries wastes are available in form of steel scraps are yield by the lathe machines in process of finishing of different machines parts and dumping of these wastes in the barren soil contaminating the soil and ground water that builds an unhealthy environment. Now a day's these steel scraps as a waste products used by innovative construction industry and also in transportation and highway industry. In addition to get sustainable progress and environmental remuneration, lathe scrap as worn-recycle fibers with concrete are likely to be used. When the steel scrap reinforced in concrete then it is called as steel fiber reinforced concrete (SFRC). The use of SFRC enhanced the workability and mechanical strength properties of concrete. Expanded polystyrene (EPS) is a lightweight cellular plastics material consisting of fine spherical shaped particles which are comprised of about 98% air and 2% polystyrene. It has a closed cell structure and cannot absorb water. It has a good sound and thermal insulation characteristics as well as impact resistance. Polystyrene foam is a non-biodegradable material. It is a waste material from packaging industry. It creates disposal problem. Utilizing crushed polystyrene granules in concrete is a valuable waste disposal method and enhances the tensile and compressive strength of light weight concrete. There are many advantages to be gained from the use of lightweight concrete. These include lighter loads during construction, reduced self-weight in structures and increased thermal resistance. Lightweight concrete is generally accepted as concrete having a density of about 1800 kg/m3 or less. The Indian ceramics industry, which is comprised of wall and floor tiles, sanitary ware, bricks and roof tiles, refractory materials and ceramic materials for domestic and others use is producing approximately 15 to 30 MT per annum waste. Out of total waste, 30% goes as waste in India and dumped the powder in open space. Ceramic waste is of generally two types, waste earthenware and also cracked during the manufacturing process. Ceramic waste is considered as non-hazardous solid waste and possesses pozzolanic properties. Therefore, after recycling can be reuse in different building construction application. The researchers used ceramic waste to make green concrete by using minimum 20% replacement natural aggregate. It was found that ceramic waste based concrete shows good workability and achieves characteristics strength. Use of non-hazardous industrial waste is also gaining popularity in India to use in building construction work for developing building material components. Even ceramic waste was also used to replace fine aggregate and found good compressive strength and abrasion resistance, together with less penetration by chlorides which could provide greater protection for the reinforcement used in reinforced concrete. However, such a use of ceramic waste.

powder should not compromise the quality and performance of the highway infrastructure nor create environmental problems. Hence, this paper presents the study on use of recycled waste material in concrete construction to curb the disposal problem via using an innovative way in concrete.

RESEARCH OUTCOMES:

The various researchers Suryawanshi et al. (2012), Vojtech Vaclavik et al. (2012), Prajapati et al. (2013), Electricwala Fatima et al. (2013) Joshi et al. (2014), Thomus Tamut et al. (2014), studied the use of various waste materials in civil engineering projects.

Suryawanshi1 et al. (2012) studied the use of ecofriendly waste material like fly ash in rigid pavement construction and has done its cost benefit analysis. It has been concluded that construction of rigid pavement with flyash save rupees one lakh per km and proves economical over rigid pavements. In concrete roads and runways, a part of cement and sand can be replaced by good quality fly ash to the extent of 10 – 30 % and 5 – 15 % respectively. This would result in lowering the cost of resultant concrete without any loss of strength and with increased durability.

Vojtech Vaclavik[2] et al. (2012) describes the use of polyurethane foam after the end of its life cycle as an aggregate both for thermal insulating mortars for various wall surfaces and for lightweight concrete. He studied the use of polyurethane foam and concluded that polyurethane foam after the end of its life cycle is a full-value alternative to expanded volcanic glass and polystyrene crumb used at present as aggregates in thermal insulating renders and plasters.

Prajapati[3] et al. (2013) describes the study of rigid pavement by using the used foundry sand. The experimental study has been performed by preparing a concrete mix of M20 grade as per IS: 10262-1982. The evaluation of Used Foundry Sand for use as a replacement of fine aggregate material begins with the concrete testing.

It was found that The compressive strength and flexural strength of concrete increases with increase in foundry sand upto 50% and the maximum compressive strength, flexural strength is achieved at 50% replacement of natural fine aggregate with used foundry sand which comes to be 40.89 N/mm2 and 8.45 N/mm2 respectively as shown in Fig.1. The cost of rigid pavement also decreases with the use of foundry sand. Use of foundry sand in concrete can save the ferrous and non-ferrous metal industries disposal, cost and produce a 'greener' concrete for construction. Environmental effects from wastes and disposal problems of waste can be reduced through this research.

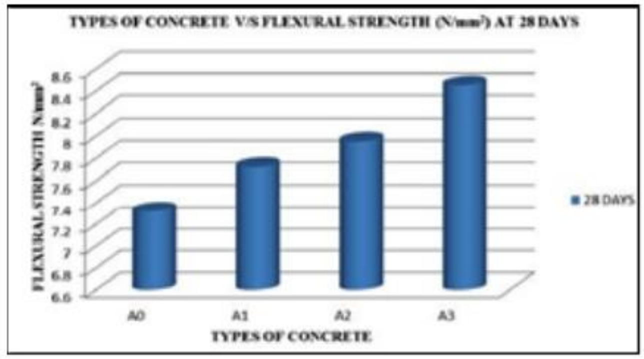

Figure 1: Variation of compressive strength and flexural strength for different types of concrete.

Electricwala Fatima[4] et al. (2013) describes the use of ceramic dust as construction material in rigid pavement. For this research, mainly three materials were used namely ceramic waste, aggregate and cement to prepare required samples. The mix design methodology was developed based upon absolute volume method by conducting several trial mix and proportion of these mixes were used to find an

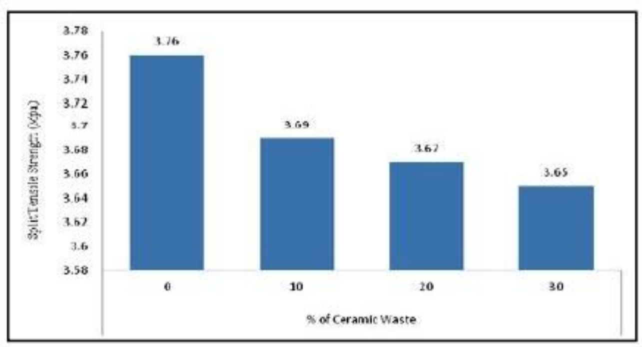

Figure 2: Variation of compressive strength

optimum mix proportion. The experimental investigation was done to determine Compressive strength, Flexural

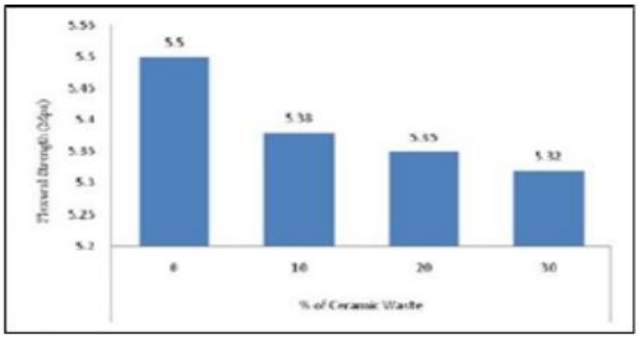

Figure 3: Variation of flexural strength.

Strength, Split Tensile strength and Modulus of Elasticity of concrete mixed with different ratios of 10%, 20% and 30% ceramic dust for dry lean concrete (DLC) and pavement quality concrete (PQC). Hence, it was concluded that 20% replacement of ceramic waste may be for PQC and DLC may be used with proper quality control and assurance.

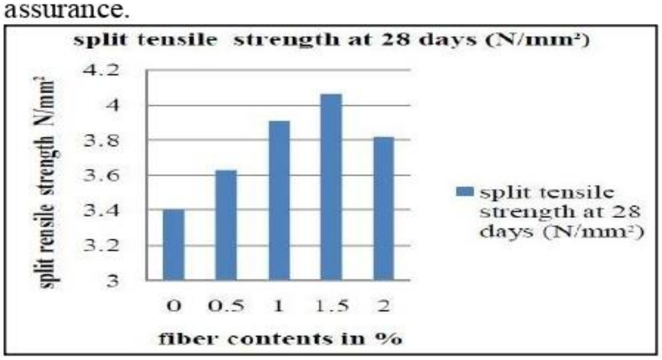

Figure 4: Variation of Split Tensile strength.

Joshi5 et al. (2014) studied the reuse of lathe waste steel scrap in concrete pavements. The compressive strength, flexural strength and spilt tensile strength was studied for varying percentage of fiber contents (0.5 – 2.0) and found that compressive strength of steel fiber reinforced concrete (SFRC) slightly increases 3% as compared to plain concrete as shown in Fig. 5. Tensile strength of scraps steel fiber concrete increases up to 20% considerable increases as shown in Fig. 6. Flexural strength of SFRC effectively increases nearly 40 % as shown in Fig. 7. However, results were found that mechanical properties of SSFRC increases up to addition of 1.5% fiber contents and on further increasing fiber contents it will decrease the strength. Due to increase in flexural strength of SFRC, fatigue behavior of SFRC also need to analyzed, stress ratio for SFRC obtained i.e. 0.65 to 0.90.

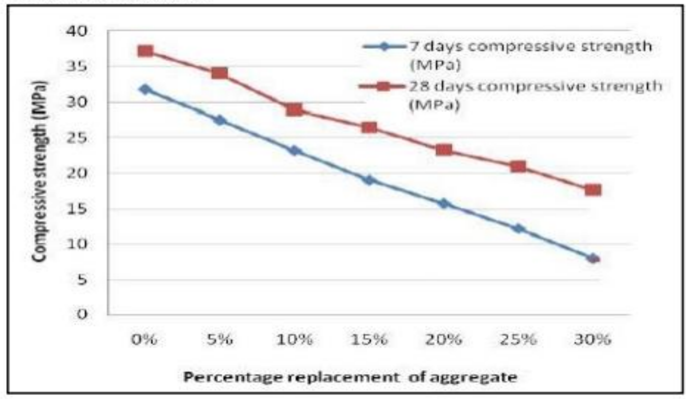

Figure 5: Variation of Compressive strength.

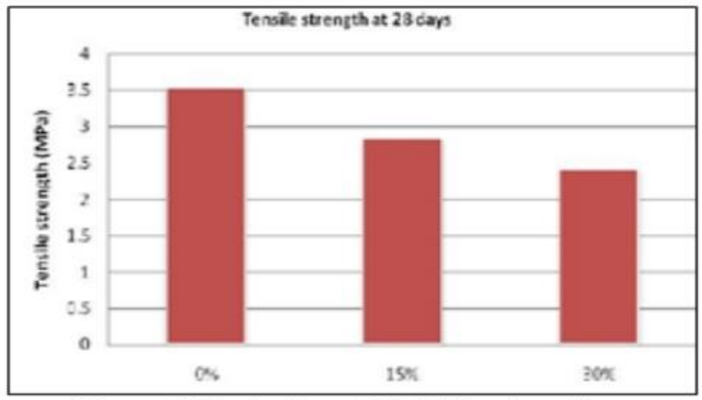

Figure6:Variation of Splitting tensile strength.

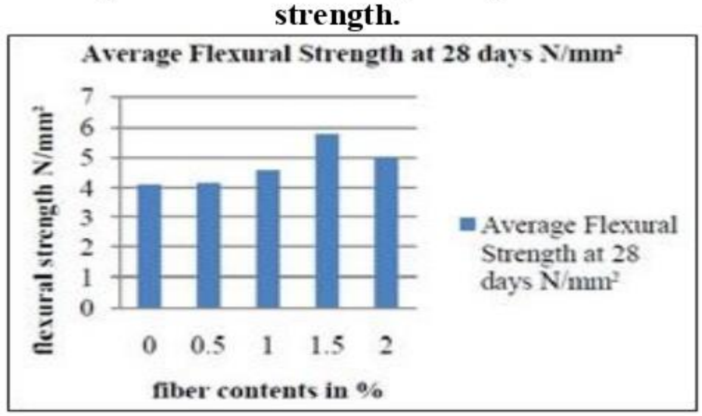

Figure 7: Variation of Average flexural strength.

Thomus Tamut[6] et al. (2014) studied the partial replacement of coarse aggregates by expanded polystyrene beads in concrete. The objective of investigation was to study the properties, such as compressive strength and tensile strengths of lightweight concrete containing Expanded

Polystyrene (EPS) beads. The properties are compared with those of the normal concrete i.e., without EPS beads

The variation of compressive strength and split tensile strength was as shown in Fig. 8 and 9 respectively. From results it was concluded that, increase in the EPS beads content in concrete mixes reduces the compressive and tensile strength of concrete. All the EPS concrete without any special bonding agent show good workability and could easily be compacted and finished. Workability increases with increase in EPS beads content.

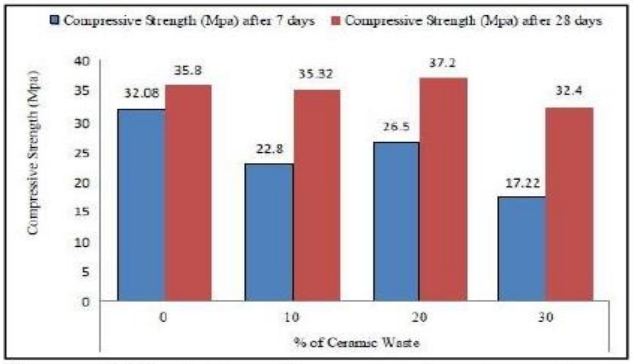

Figure 8: Variation of compressive strength

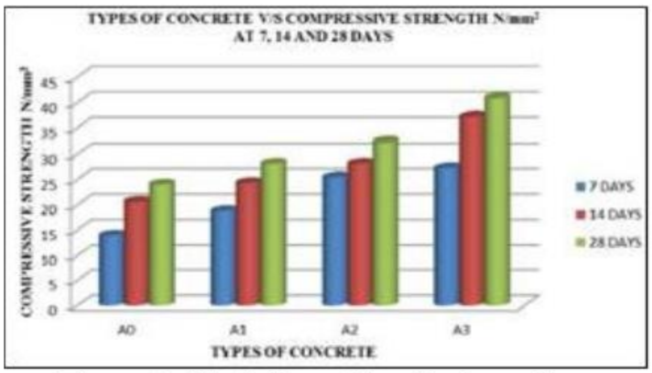

Figure 9: Variation of tensile strength.

CONCLUSIONS:

The above literature review describes the use of different waste materials in the civil engineering construction for better tomorrow. The following conclusions will be drawn on the basis of above literature; The waste materials can be efficiently used in the construction for sustainable development. Cement and sand can be replaced by good quality fly ash to the extent of 10 – 30 % and 5 – 15 % respectively without any loss of strength. Polyurethane foam can be used as an aggregate both for thermal insulating mortars for various wall surfaces and for lightweight concrete. The compressive strength and flexural strength of concrete increases with increase in foundry sand upto 50% and the maximum compressive strength, flexural strength is achieved at 50% replacement of natural fine aggregate with used foundry sand. The cost of rigid pavement also decreases with the use of foundry sand and produced greener concrete for construction. The compressive strength for different proportions of concrete increases as ceramic waste quantity increases up to 20 % and can be used for DLC with proper quality control and assurance. Compressive strength, tensile strength and flexural strength of steel fiber reinforced concrete (SFRC) increases upto 3%, 20% and 40 % respectively as compared to plain concrete. Expanded Polystyrene (EPS) beads can be used as partial replacement of coarse aggregates. An innovative (Smart) mix can be obtained by using above mentioned waste materials in concrete at respective optimum percentage, which would resolve the problems associated with concrete construction.

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Smart Engineering: Technological Innovations Improve Efficiencies And Teach Young Engineers Valuable Skills

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Smart technology—which incorporates sensors into machinery and parts to collect data then analyze, share and use that data in real time—is fast becoming an essential tool in many industries, including manufacturing, transportation, energy, construction, health care, agriculture and more.

This means up-and-coming engineers need to understand how to incorporate sensors and data analytics into their designs. At Mines, faculty and students are working on a wide array of projects that not only give them hands-on experience with smart technology but help industries advance their knowledge and solve real-world problems.

Conserving resources with sensors and networks

Smart technology can help end users manage resources more efficiently and save money.

Most landscape irrigation systems—the kind used for parks, golf courses and lawns—are operated manually or use a timer, which isn't the most efficient. Studies show sensors that monitor existing soil moisture can reduce the amount of water used in sprinkler systems by 61 percent. But existing sensor systems are often cumbersome to install, only manage soil saturation by preventing irrigation from occurring or collect information that requires landscape managers to read and compile the data then decide on an action to take. By the time they reach a decision, conditions may have changed.

The project requires multiple sensors connected into a wireless adhoc network, which Han is developing. The system is designed to irrigate only when necessary and will determine the correct proportion of reclaimed water to use. It's a delicate balance, because reclaimed water is saltier than tap water, and too much salt kills plants. "There are a lot of moving parts that need to communicate smoothly with one another. It's more complicated than it sounds

One complicated step is translating landscape data into actionable information.

To make a proper irrigation decision that balances the need for water conservation while also managing soil salinity, sensors must be able to report moisture and salinity simultaneously. Wireless communications will transmit data to a central location. There, a decision is made about when and how much water is applied to the landscape, sending a command to an irrigation valve to turn water on or off. The goal is to make sure the soil is not too wet, salty or dry, while conserving water and protecting plant health. When salinity gets too high, more water is needed to flush salt out of the soil. However, that requires using additional water, so the "rules of the game" must be determined to solve the optimization problem.

Below the surface, tunnel boring machines used for roads, subways and water systems are big, heavy and slow, usually advancing just a few inches a minute.

We're using AI techniques to learn from data how to operate the machine better. The idea is to make it move faster, be more productive, avoid stoppages and prevent damage to nearby buildings," Mooney said.

Data from sensors measuring pressures, forces, movements and vibrations as the machines work provide valuable information and suggest optimal settings in real time. In Seattle, Mooney and his crew installed a monitoring system that warned operators of impending boulders, allowing them to make adjustments and avoid damaging expensive equipment. Require necessary initiative that aims to dramatically improve the speed for building small-diameter tunnels. Normally, it takes about 24 hours to construct a small-diameter tunnel 500 meters long, but working with key industry collaborators, the Mines Rapid Tunneling Technology Team thinks they can get that down to 83 minutes or less.

Some of the improvement will come from using smart sensor data to make adjustments on the fly. "Our research has shown we can improve drilling and tunneling speed by 30 percent to 100 percent by using AI,"

Mooney believes intelligent drilling will inevitably become an industry standard. "To be cost effective, industry will push the envelope as far as technology will let them. If one contractor does it, the rest will have to adapt to be competitive," he said.

Taking smart tech to the Moon

Smart drilling techniques could also be used in **outer space**, and Mines researchers are already working on extraterrestrial applications.

Scientists now know the Moon contains water, which could be used both for drinking and to create fuel for further space exploration. But first, you have to find the water and figure out how to get to it,

ASA's current plans involve taking samples of the lunar surface and sending them to Earth to determine whether a site contains enough water to make drilling worthwhile.

Jet Propulsion Laboratory to develop an inter-spacecraft wireless communication network. The network would let rovers, landers and other vehicles exchange and organize their information, then feed it to a single carrier with high storage capacity and computing power. The carrier would transmit data to Earth.

"It's about communication and control and making sure spacecraft are covering all the locations they're supposed to cover. The robots could communicate with each other and adjust their decisions in real time."

Using sensors and data wisely

From urban underground to outer space, Mines faculty and students are finding innovative ways to incorporate smart technology into engineering decisions. Working their way through these technical problems is proving advantageous for young engineers, providing students with skills in data management and coding that are integral to tomorrow's technologies and valuable to employers.

Mines' emphasis on problem-solving ability, working under pressure and creativity enables students to pick up smart technology skills quickly. Even more important, the foundation Mines provides helps shape their decisions about when and how to use such technology.

“Smart technology can be quite dumb if it isn’t used right,” Mooney said. “We need students with strong fundamentals who know how to use technology and judge whether it’s doing what it’s supposed to do.”

Technical knowledge, sound judgment, quick problem-solving ability and creativity all came together last fall for Sumner Evans MS ’19, who was part of a Mines team that beat 20 competitors from across the globe to win a Facebook hackathon.

The team developed an Android app that creates an interactive indoor map from a photo of a floorplan using augmented reality technology. They created the app in just 24 hours on a software platform only one of them had any experience with.

With just an hour left in the competition, the team tested their app only to find it didn’t work. They managed to fix the software bug just as the event organizer was counting down the last seconds.

Their Mines education gave the team the foundation it needed to win, Evans said. “What Mines provides isn’t so much experience with a particular smart technology,” he explained. “Technology comes and goes. What Mines does is prepare students to move into any new technology and contribute.”

Smart Engineering for Better World

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Associate Professor, RPSIT Patna

Abstract. The convergence and synergies of the latest ICT developments in the areas of embedded micro-devices, mobile communication, hardware infrastructures, as well as Internet and software technologies penetrate any artifact and product in our real lives. Traditional products are becoming more and more multidisciplinary, intelligent, networked, agile, and include product-related services. However, not only consumer goods (i.e. smartphones) but also industrial goods are becoming 'smart'. Smart Product Service Systems (smartPSS) will dominate most industrial sectors in the near future and lead to the 4th Industrial Revolution. Thus, the engineering of these smartPSS will be of crucial importance for the competitiveness of industrial companies. This contribution summarizes the related ICT developments and describes their successive penetration of industrial products. It points out the need for new Smart Engineering approaches, which also use the latest ICT innovation and similarly smart features like smartPSS. Smart Engineering defines the highest level of requirements for engineering processes, methods, and tools.

Keywords: smart products, product service systems, engineering methods, lifecycle management.

1 Introduction

Current innovations in all fields of Information and Communication Technologies (ICT) lead to huge progress. Among the most important ICT innovations are new driver-technologies like the "Internet of Things, "Internet of Services" [1], the new IPv6 standard, or social media. Recent contributions for these new internet developments are provided by combinations of new software (e.g. semantic technologies, big data), hardware components (e.g. smart devices, cloud computing) and communication infrastructure (e.g. LTE and WiFi hotspots). Embedded micro-devices increasingly enable physical products to interact with their environments by using RFID tags, micro-sensors and micro-actuators (cf. Fig. 1).

From the integration of these ICT innovations and the increasing availability of digital contents, disruptive potentials are emerging for all artifacts and products in our real lives. Latest forecasts show that the monthly mobile data traffic will surpass

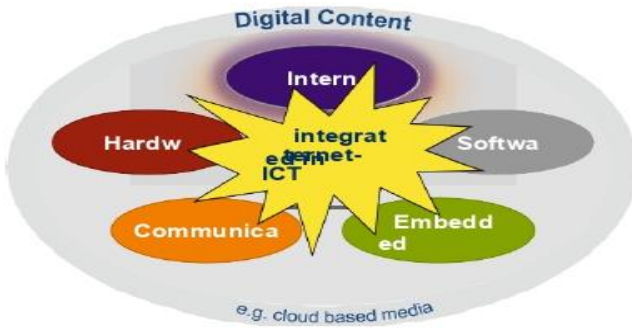

Fig. 1. Integration of Internet-driven ICT Innovations

15,000,000 terabytes [2]. This also includes the ICT penetration of products, services, processes, methods, organization structures, business models and eco-systems of traditional industries, which is currently leading into the 4th Industrial Revolution, whose impact will be in in line with the [3].

— 1st Industrial Revolution: mechanical production facilities powered by water and stream,
— 2nd Industrial Revolution: mass production based on the division of labor powered by electrical energy, and the
— 3rd Industrial Revolution: automation through introduction of electronics and IT.

2 Products and Services of the 4th Industrial Revolution

Traditional products and services are becoming ever smarter [4]. The term 'smart' in general implies the attributes clever, intelligent, agile, modern, and intuitive. Initially, this vertical process of becoming 'smart' addresses mechatronic systems and traditional service systems in a separate manner (cf. Fig. 2).

In an effort to combine mechatronic systems and traditional product systems within holistic concepts, Product Service Systems (PSS) describe the first level of horizontal integration. PSS can be defined as an integrated product and service offerings that deliver value in use [5].

Driven by the current ICT penetration of products and services, new opportunities arise for the horizontal integration into comprehensive smart product service systems (smartPSS). smartPSS are integrated socio-technical Product Service Systems based on networked smart product and smart service systems aiming to fulfill customer needs. One of the most popular examples is the conversion from mobile phones to smartphones. Smartphones incorporate many functions of traditional physical products like digital cameras and audio players. In addition, they integrate a multitude of IT-driven services like weather forecasts or navigation services. Other examples include smart cars, smart factories, smart homes, or smart energy grids. These smartPSS are defined by the following main characteristics:

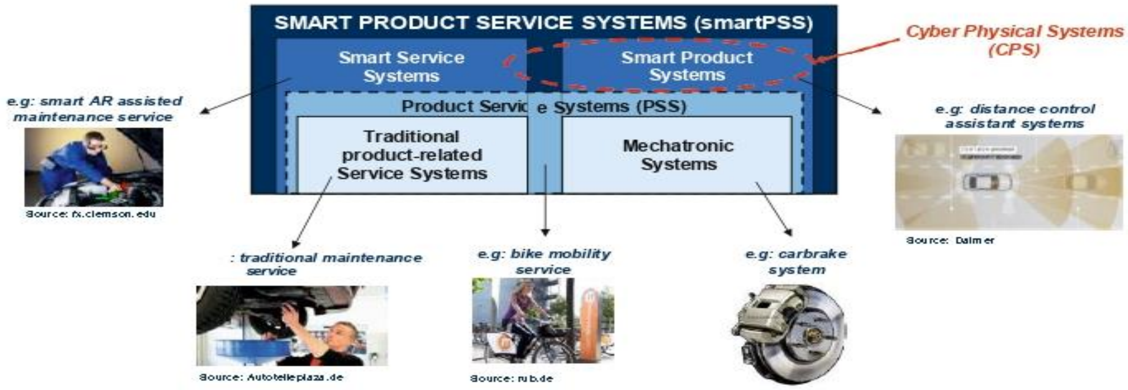

Fig. 2. Classification of products and services

Table 1. Main characteristics of smartPSS

High degree of autonomy	
	autonomous behavior of components
	context awareness, self-learning components
	real-time reactivity, self-control and organization
Strong human centration	
	high degree of personalization
	intense, multi-modal, easy-to-use human-machine interfaces
Openness and variability of smartPSS solutions along the lifecycle	
	dynamic reconfiguration
	interchangeability of product and service modules during operation
Innovative business models	
	New stakeholders
	New cost and risk models
Very high degree of complexity	
	a huge number of heterogeneous, interconnected components
	interdisciplinary technical and non-technical components
	multi-sectorial system of systems
	strong interaction between provider and customer

3 Need for Smart Engineering within the 4th Industrial Revolution

Engineering lifecycles cover the "development", "manufacturing planning", "planning of product use and service provision", and "planning of reconfiguration or the end of life" for products and services. Engineering processes cover all technical activities including the definition, design, documentation, simulation, and management of products and services, as well as those of related processes along the entire lifecycle. These engineering processes are supported by specific engineering methodologies like

[6], [7], [8], [9], [10] and customized IT tools. Analyzing the availability of engineering methodologies for various products and services leads to the conclusion that, for the engineering of smartPSS, no appropriate methodologies exist (cf. Fig. 3).

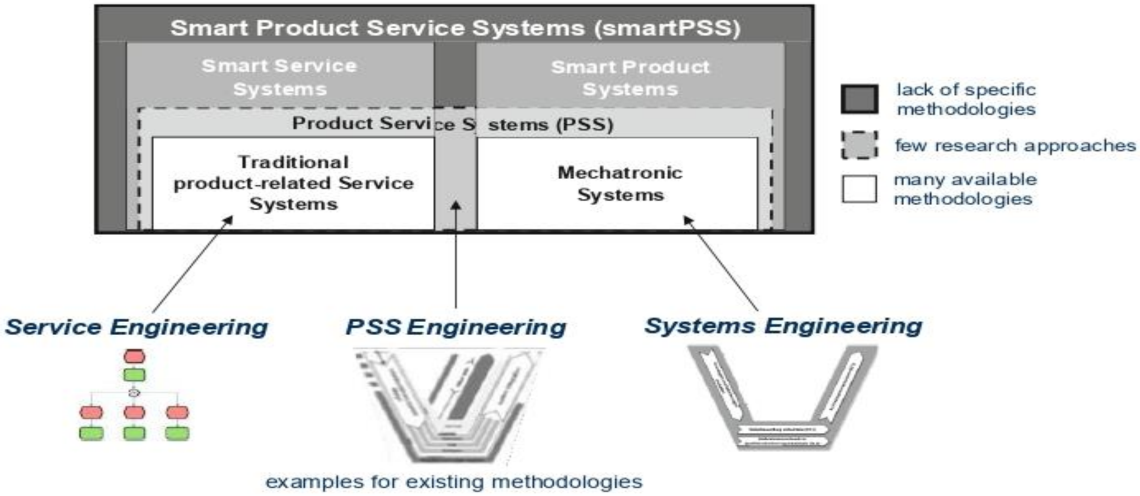

Fig. 3. Availability of engineering methodologies

Thus, the suitability of existing methodologies has to be evaluated according to smartPSS-specific engineering requirements. Based on the main characteristics of smartPSS, the following specific requirements have been derived:

Generic Process Models and Methodologies
Existing systems engineering and PSS engineering approaches have to be extended and adapted by generic processes and methodologies with a focus on early engineering phases (requirement engineering, functional / architectural design, partitioning, rough assessment). In addition, engineering processes have to be flexible and definable in real-time during operation. The required methodologies have to be pragmatic and semi-formal.

Consideration of Several Design Disciplines
The Engineering of smartPSS requires the interdisciplinary collaboration of various technical, social, and business-oriented experts. Hence, there is a strong need for a holistic integration of the discipline-specific models (e.g. product models, software models, service models, business models) and all involved stakeholders along the entire lifecycle (e.g. customers, partners, service providers).

Stronger User Focus
Real-time decision support for users of the methodology requires assistant systems for analysis, assessment, and simulations. Furthermore, intuitive visualization and social media techniques as well as template libraries have be implemented to ensure that the methodology is easy to use.

Use of Product Use Data and Knowledge
smartPSS facilitate provider access to use and operational data via embedded sensors. Appropriate methods and cloud-based services for the exploitation of that data are required. The generated knowledge can be used to improve smartPSS development processes.

In line with these requirements, methodologies in the areas of "System Engineering", "Service Engineering" and "PSS Engineering" have been analyzed (cf. Fig. 4).

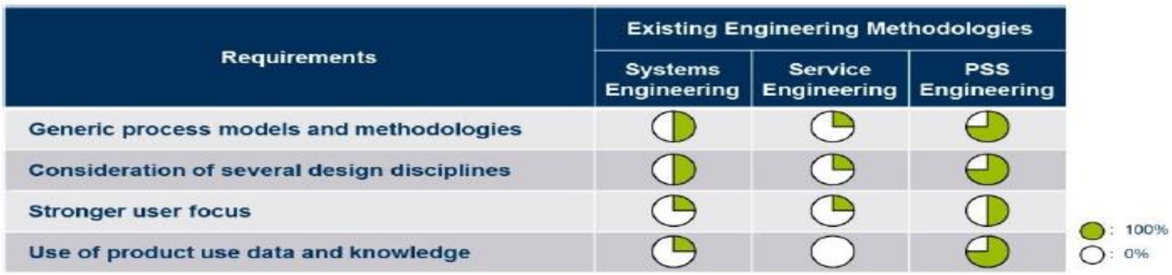

Fig. 4. Suitability of existing engineering methodologies for smartPSS

None of the existing engineering methodologies are able to meet the identified requirements sufficiently. Moreover, the analysis has shown that the most specific approaches within the considered areas of methodologies only have a focus on product and service development. Further lifecycle phases (e.g. product use) are only rarely covered by the existing methodologies. As a consequence, there is a strong need for new smartPSS-specific engineering methodologies.

The 4th industrial revolution driven by ICT innovations will provide game changing capabilities for new engineering approaches and methodologies. These capabilities serve as enablers for the development of agile processes, intuitive methods and intelligent IT tools that contribute to smarter engineering.

Based on the previously introduced results and reflections, a holistic vision for a new Smart Engineering has been defined (cf. Fig. 5).

The revolutionary environment of the Smart Engineering vision is the Internet of Data, Things, Services, and Humans. Components of information and material processes, as well as virtual smartPSS models and real smart PSS will be part of a smart cloud-based infrastructure. This will provide on-demand access to globally distributed engineering models, data, and services and serve as an important base for Smart Engineering processes. That way, a new level of integration between virtual and physical processes can be achieved. In addition, the cloud-based infrastructure allows to lead back product operation data into engineering processes. Smart services can use that data to generate knowledge and improve virtual smartPSS models. Modern visualization techniques can process the data for intuitive use. Smart Engineering also comprises a deep integration of engineering and business processes along the entire smartPSS lifecycle. Smart Lifecycle Management constitutes a comprehensive approach for the management of any key elements, such as engineering models, processes and tools. This requires a paradigm shift in traditional lifecycle management approaches and solutions.

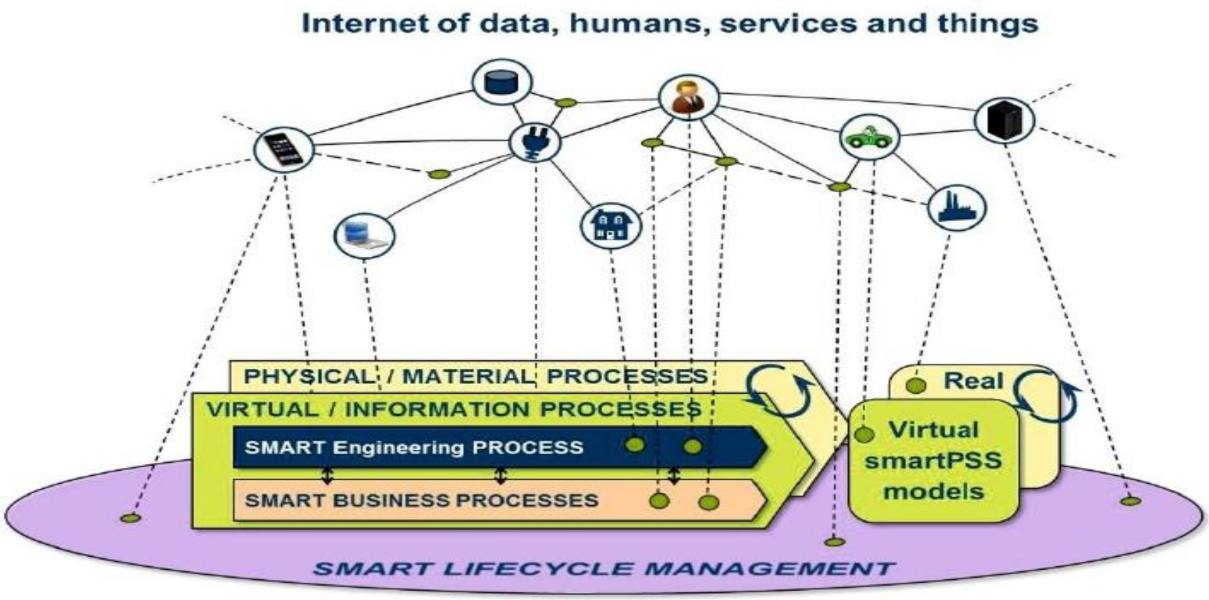

Fig. 5. Smart Engineering vision

4 Current Smart Engineering Initiatives

A large variety of current global research activities already reveal the introduced change in engineering approaches [4]. Concrete examples for research projects in the area of Smart Engineering include:

— Lifecycle Management of Product Service Systems (TR29) [11],
— Product Use Feedback Assistant for Product Development (WiRPro) [12],
— Product Authentication Service (MobilAuthent) [13],
— Tracking & Tracing of Smart Products (LAENDmarKS) [14],
— Augmented Reality based maintenance by using smart devices (smartARM) [15],
— Model based engineering of cybertronic systems (mecPro^2) [16],
— Semantic Product Memory (SemProM) [17],
— System architecture for closed-loop PLM (PROMISE) [18],
— Further initiatives in the field of Industrial Internet [19].

Since these research activities address many isolated, partial aspects of Smart Engineering they have to be considered as foundations for the 4th Industrial Revolution. The increasing strategic importance of Smart Engineering in the context of the 4th Industrial Revolution is visible on massive national research programs like "Industrie 4.0" [20], "Smart Service Welt" [21], "Excellence Cluster it's OWL" [22].

5 Conclusion

The 4th Industrial Revolution is foreshadowing opportunities and challenges in nearly any industrial area. smartPSS require new Smart Engineering methodologies, which should benefit from new enormous innovations concerning ICT infrastructures and ICT components within smartPSS. These methodologies will be an important factor for the future competiveness of industrial companies. It is therefore inevitably essential to make strong efforts in the development of suitable engineering approaches in line with the presented Smart Engineering vision. Many projects aiming at the development of such approaches are already underway. Nevertheless, a lot more concerted interdisciplinary national and international research collaboration is required to successfully address this enormous challenge.

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Smart Engineering for a Better World

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Engineer is said to be the one who has given today's era the form of modernity. Therefore, in today's time, engineering is also important for the development of every country in the world.

Engineering has created many things in this world due to which we are seeing this modern world today, which include many things such as different type of machine and equipment's, manufacturing of vehicles, build roads, making giant building and much more. In today's modern era everything is possible only because of engineering. The main purpose of this engineering is to make the life of human being easier; it means any work can be completed in less time. Due to which we save a lot of time. As in the olden times, bullock carts were mostly used to travel from one place to another which took a lot of time to reach their destination, but engineering saved us a lot of time by manufacturing many types of vehicles.

Such as motorcycle car, train, plane etc. There are many such examples due to which our life has become easier.

Engineering encompasses a whole range of industries that could include on-site, practical construction work as well as evaluating safety systems from an office. They use the knowledge they have within a specific industry in order to make things work and solve problems, where this be with transport, medicine, entertainment, space or the environment. In fact, engineering is behind everything. Mobile phone? They are down to engineers. Make –up? Also, down to engineers. Cars, computers, shoes and even cutlery? It's all down to engineers. The environment that engineers work in ranges from offices to studios and laboratories to the outdoors and even underground. Engineering is very closely link to technology, and the rise of it, which is why it has played a huge part in technological advances including computers, hospital machines, the internet and more.

Healthcare has also improved dramatically thanks to advancements in medical technology thanks to engineers. The improvement of medical technology has meant that the discovery of illnesses and treatment has helped to save and improve the lives of many people.

Credible engineers that has changed society include Alan Turing, who invented the Engima machine that helped to bring an end to world war II, the engineers behind high speed flight that helped to send man to space and the engineers behind advancements in communication who had of we could see and talk to someone on a screen from anywhere in the world. New developments are taking place every single day. Have you heard of the metro in India? It will increase the transport capacity without pollution and save time and money. Engineers play an important role in development and globalization which change the society life style but the nature had to pay the brunt of this development. The environment has suffered due to the effects of increased urbanization and industrialization. The industrial revolution of the 19th century also cause environment damage in Europe but the current environmental degradation, though, is on global scale. The main question is how engineers helping the environment? The development the renewable energy sector has made over the past decade, in spite of all the regulatory setbacks, has been incredible. With this increased focus on renewable and sustainable energy, and resulting improvements to the national grid, it won't be long before more and more people feel confident in making the switch to electric cars, further reducing our reliance on fossil fuels. As the demand from consumers continues to grow, so does the speed with which developments are made, with many now looking to nuclear fusion as the long-term solution to our energy need. Speaking of cars- self driving cars will not only make the world a much safer place, but it will probably be much more fun too! Robots could speed up operations in the warehousing and logistic sector making shipping times even shorter; they could help with search and rescue operations.

Engineering is an important and learned profession. Engineers are expected to exhibit the highest standards of honesty and integrity. Engineering has a direct and vital impact on the quality of life for all people. Accordingly, the service provided by engineers requires honesty, impartiality, fairness, and equity, and must be dedicated to protection of the public health, safety, and welfare. Improved technologies with ethics make smart engineering for better world.

Conclusion:-

Engineers and practice of engineering has one primary goal: to benefit mankind as well as lifting up the standard of living. It has always helped us in sustainable development and provides steps to protect our earth and surroundings nature.

Smart Engineering for a Better World

Er. Rahul Kumar, AMIE

Engineer's Day on September 15 as a mark of remembrance and tribute to MokshagundamVisvesvaraya, who is considered as one of the greatest engineers in the country. Vishveshvarya is also known as the father of Indian Engineering because of his enormous contributions and innovations in the field of engineering and development of society. India has been celebrating Visvesvaraya's birth anniversary as Engineer's Day since 1968. Engineer’s Day is celebrated to pay honor to the engineers for their contribution to the growth and development of the nation.

The year 2022 will mark the 54th anniversary of the Engineers Day in India and 161st birth anniversary of Sir MokshagundamVisvesvarayya. It will be celebrated on 15 September, Thursday. & the Theme: Smart Engineering for a Better World.

In different cities, an engineer’s day is celebrated in different ways. Different departments of Engineering have different styles to celebrate. Celebration methods may also very from one company to another. While government corporations follow the annual theme of engineering day, private companies can follow the theme or determine their own theme.

India is proud of the contribution of our engineers towards nation building." In 2019, PM Modi said engineers are synonymous with diligence and determination. "Human progress would be incomplete without their innovative zeal. Greetings on Engineers Day and best wishes to all hardworking engineers.

Now we know that, Engineer is a person with a proper education in the field of engineering. The word engineer is derived from the Latin root ingenious, meaning "cleverness". Engineers design materials, structures, machines and systems while considering the limitations imposed by practicality, safety and cost.

Engineers play a major role in the growth of a company. The way they celebrate this birthday does not matter. It is therefore important that they wait for the annual event to stay motivated and continue their excellent work for the general public.

Every profession has an equal demand as well as importance in the nation. We could not imagine the beautiful architectures, buildings, bridges, roads, dams, etc in absence of engineers. The engineers work for making these structures in reality. These facilities enhance the development of the nation.

Engineers are persons who discover the world by their pen and brain.

Skilful organizing of vitality, capital and helpful useful resource for the upper good of the group is what everyone knows as engineering. Each of the expert engineers is a warrior with the weapon of data and fantastic administration.

Engineering for a Better Future' also encompasses issue of environmental sustainability. There is no well established roadmap towards building a smart infrastructure and trying to replicate a generic might not work. Such developments are extremely contextual and should reflect challenges, priorities and aspirations at the regional level. The solutions would require synergy between industry, academia and government and should foster an ecosystem where different players can participate and share best practices and develop action plans for switching to a smart infrastructure for a sustainable and prosperous future. The engineers need to understand that there is tremendous pressure on the existing service infrastructures which are inadequate and not designed to sustain challenges like air pollution, waste management, traffic congestions, effective health care and housing for all etc.

As engineers it is important that we adopt smart engineering to leapfrog into new realms in this era of smart engineering for a better tomorrow.

At last "Science is about knowing; engineering is about doing".

"Science is discovering the essential struths about what exist in the Universe, engineering is about creating things that never existed."

Application of smart engineering practices in hill slopes under seismic excitation

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Introduction

An appropriate utilization of available resources in our surroundings are essential for better future. The functionality of world is completely based on the natural resources. For sustainable environment, growing population and human desire has enhanced the available technologies using the available resources. Especially the over consumption of resources due to "unawareness" makes us more vulnerable towards disaster. This impact the requirements of human as well as other species on earth. It results in migration of population from one place to other. Due to unavailability of plain land, the few population has shifted to hilly region. The Natural and manmade resources are being consumed in very speedy manner across the hilly regions due to mass construction for railways, tunnels, highways and multistoried buildings etc. project in these regions.

As far as engineering practices is concern for the construction on hillside poses more challenges to the civil engineers. Regarding to the population growth and narrowness of available lands, people build their houses on hillside slopes (see Fig. 1). However, as per codal provision the whole hilly region is highly vulnerable due to seismic excitation and manmade activities. The slopes available in that regions are not very stable. The projects which are causing more vibration in the hills are making more strain accumulation in the slopes. Recently series of landslides have occurred in the Sikkim-Siliguri highway due to the heavy rainfall (see Fig. 2). The main reason was the several strain localized points within the slope mass were found. One of the reason may be tunnel construction activities in the regions. The ballast was created many localized points in the slope of hills too. This strain localization triggered the progressive failure in the slope mass.

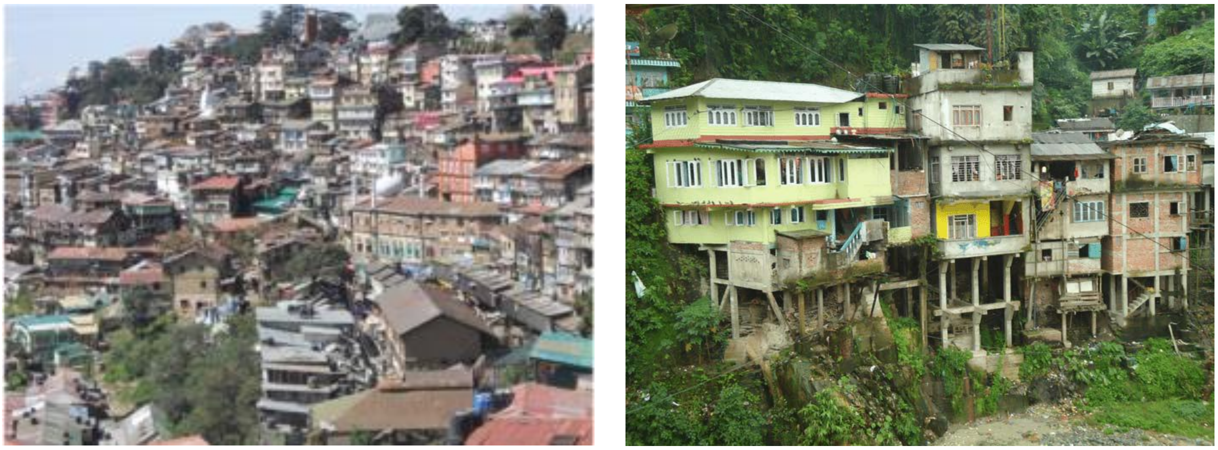

Figure 1. Migration of population on hills (images by Kumar, 2018)

Figure 2. Slopes failures at Sikkim Highway, in Indian Himalayan (images by TOI)

Smart engineering practices

For the stated issue researchers and engineers have taken many way to find the stability of slope. Numerous methods have been developed for assessing the stability of soil slopes, most of which are based on the concept of ideally plastic response when failure is imminent. Among them, the limit equilibrium methods enjoy wide acceptance due to their reasonable agreement with reality and their simplicity. Limit equilibrium solutions, however, are not rigorous. Limit equilibrium methods often violate the stress boundary conditions; they do not enforce an appropriate plastic flow rule for the soil, while the developing stresses may not everywhere obey the requirement for non-incidence of soil strength. Moreover, the introduction of assumptions necessary to remove static indeterminacy leads to kinematically inadmissible collapse mechanisms.

This article has suggested the smart engineering approach to rectify the instable slopes especially due to seismic excitation. The finite element method (FEM) is an effective approach to resolve the slope stability issues. Generally two different methodologies has been adopted while doing calculation with FEM. These methodologies are (1) the critical slip surface using stress fields obtained from the stress and deformation finite element (FE) analysis; and (2) computation of factor of safety through an iterative FE analysis. The engineering skills generally try to employ the second approach. However this approach is little time consuming and not much able to estimate the safety factor in precise manner.

As we know that, smart engineering is the way where we performed analysis with innovative methods. The smart way of doing the analysis is the estimation of deformation in slopes. This is able to predict almost the same critical plane surface in slope (Kumar and Kumari, 2022; Farghaly, 2016). The advantages of the FE approach over the conventional slope stability methods can be summarized as follows:

(1) No assumption needs to be made a priori about the shape and location of the slip surface. Failure occurs naturally within the soil when the applied shear stresses exceed the shear strength of the soil mass.
(2) The solution is kinematically admissible, and there are no arbitrary assumptions about the slice side forces.
(3) It can capture progressive failure phenomena, and provides information about the displacement field until the ultimate state.
(4) It can readily handle irregular slope geometries in two and three dimensions, complex soil stratigraphy, and calculation of low quantities (due to steady seepage, or to transient flow).

The finite element analysis of a slope has been carried out with an innovative way of estimation of deformations in slope. For this buildings with various configuration were constructed on slope with isolated and raft foundations. The boundary condition was applied at the lateral boundaries of the model to absorb the seismic waves at the boundaries and to mitigate the reflection of waves at boundary itself (see Fig. 3).

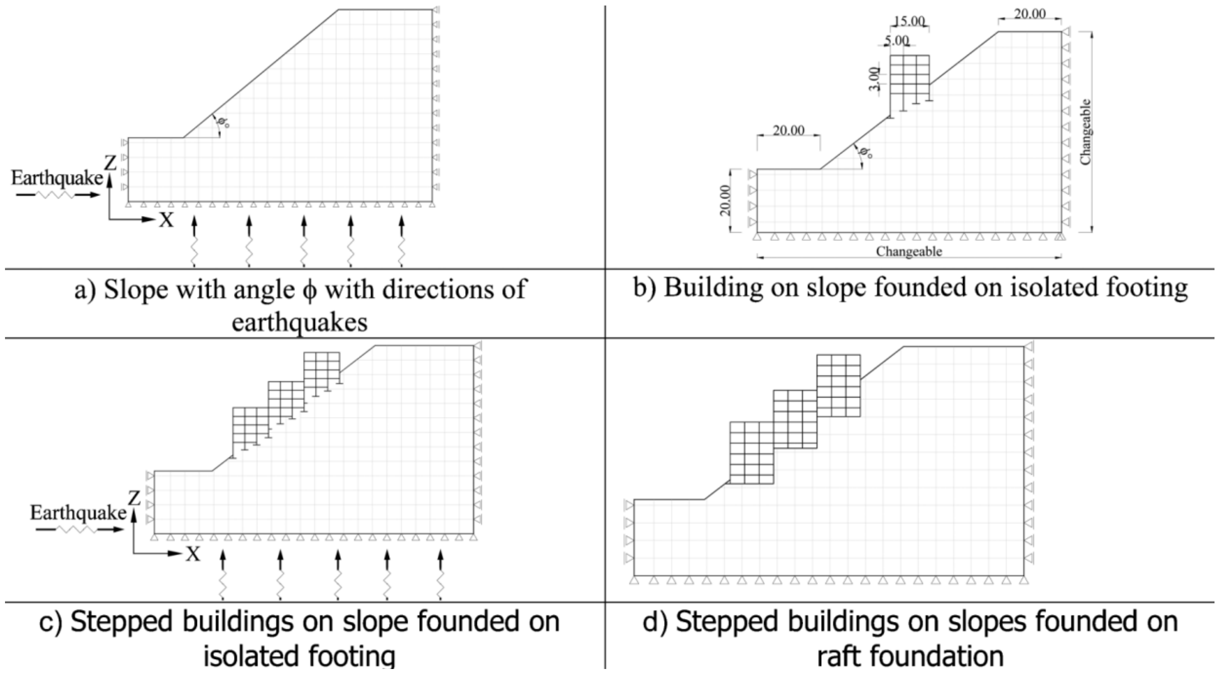

Figure. 3 Finite element model for buildings on slope with various configurations

The El-Centro (1940) seismic excitation was applied at the base of slope to observe deformation of building and behavior of slope. The result was observed and show in Fig. 4. The deformation of building under seismic excitation can be observed clearly. The deformation in soil slope mass also can be seen with intense mark at various places. The maximum deformation in soil slope was observed at the foundation of the building and upper toe of slope. It can also be observed that the deformation in slope started from the toe of slope. It suggest the progressive failure in slope. This is the application of smart engineering results for slopes that it may fail due to deformation and strain accumulation slope mass and start deforming from the toe of slope.

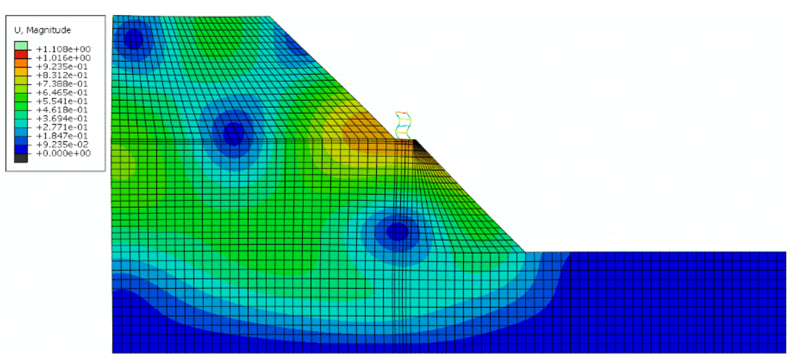

Figure. 4 Deformation behavior of building on slope during seismic excitation

Scope of the study

The Bihar State Disaster Management Authority, Patna (BSDMA) has studied that 63.7 % of total area of Bihar state i.e. 22 districts are predominantly under seismic zone IV and 15.2 % of the total area of Bihar lies in the seismic zone V covering 10 districts of North Bihar. Apart from seismic disaster the state is also prone to flood disaster. Approximately 76 % North Bihar live under the recurring threat of flood disaster. Bihar is also experiencing rapid urbanization. Due to this the cities of Bihar becoming more vulnerable due to consumption of both natural and manmade resources.

Hence, the methodology adopted can be extended for finding an impact of seismic excitation for various complex civil engineering structures. The underground structure especially need more attention. This study also helpful in context of multi-hazard places like Bihar state.

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Smart Engineering for a Better World

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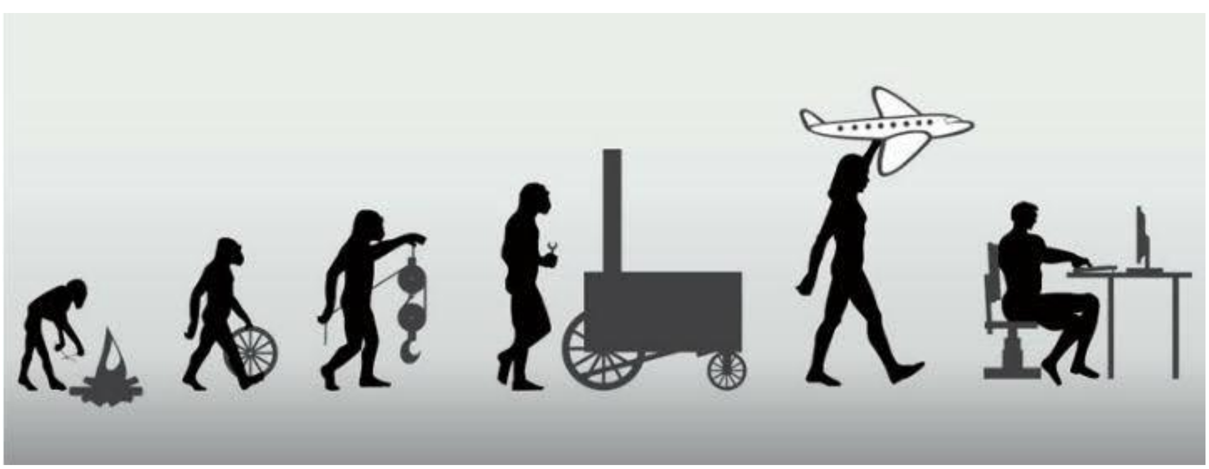
Engineering is the science and business that presents practical solutions to the problems faced in meeting the diverse needs of human beings. For this it uses the knowledge of mathematical, physical and natural science. Engineering produces physical goods and services; develop and control industrial processes. For this, it provides methods, designs and specifications using technical standards.

We have been using the word engineering since few centuries, but we have been using it for our society for many ages. A great example of engineering in our culture is found in Treta yuga. During the war of Ramayana, when Shri Ramchandra ji proceeded to climb lanka, it was difficult to move through the waves of the sea, and then two soldiers of monkey army respectively Nal and Neel, built a stone bridge on the sea, the concept of building the bridge over the sea is prevailing from Treta yuga and is an excellent example of engineering.

The history of technology is actually the history of the discovery of tools and techniques used to manufacture useful things, it similar in many ways to the history of humankind. There is a close relationship between history of technology and history of science. Technology has paved the way for scientific research (especially in modern era) while scientific knowledge has paved the way for the development of new technology. The wheel was invented in 4000 BC, it has proved to be the world's most useful technology. On one hand technological artifacts are the product of the economy and on the other hand they are also the factors of economic progress. Technological innovation is influenced by and influences the culture tradition of the society, from Stone Age to today's time. Technology and innovation plays vital role to change the face and thinking of the society.



The development journey of engineering in India starts from prehistoric times. India past was full of knowledge and Indians used to lead the world. The oldest scientific and technical activities have been found in Mehrgarh which now in Pakistan. Through the Indus valley civilization, this journey comes to the states and empires, this journey continue in medieval India also; Even during the British Raj, there was considerable progress in science and technology in India and after the attainment of independence, India is progressing rapidly in all fields of science and technology. In 2009, India has registered its strong presence in this area by sending vehicle to the moon and making a new discovery of getting water there.

There is a fine line between needs and desires. As long as we used engineering to satisfy needs, till then there was a harmony between human and nature, but since we started using it to full fill our desire, then this engineering become a curse for us and nature. Like , the invention of the wheel, as long as it was our need, it neither harmed nature nor human life. But when this need turn into desire we started manufacturing many types of vehicles, which increased environmental pollution and it started having a bad effect on human health. When we look at the architecture of the cities of the Harappan civilization, we are proud of our engineering, which made our life so much easier. The same achievement is visible when we look at today's cities, but it has also become a reason for climate change. There is call to adopt the practice of sustainability and sustainable development. Engineers play a vital role in sustainable development because of their role in society. Engineers built, they produce and restore. Engineers are important in sustainable development because they have the ability to reduce the energy shortage through the use of renewable energy and this case limit pollution which affect the environment and lead to climate change. Engineers must need to understand the ethical roles for their profession which are:

Creating new technology:

First role of engineer in our changing world is create new technologies to solve world problems. Technological and scientific discoveries have significant impact on people. Problems that engineers have helped or are helping solve are lack of clean water, lack of adequate sanitation and no access to electricity. Currently only 8% of rural Malwai towns have electric power. Currently one man and his business is making a push to bring electricity to more rural Malawi towns. Magnetic power company, wants to spread the access of electricity in his community in Malawi by building hydroelectric generator. Hasting is converting motor castings and other scrap materials to Nano-hydro-generators. There are other people in the world just like Hastings trying to help create a better world. Not only do engineers create new technologies but they also have social responsibilities.

Social Responsibilities:

The second role of engineer is they have many different social responsibilities in our changing world. Engineering has to follow many different codes of ethics/engineer's conduct depending on the type of engineer he or she is. Most engineers view professional codes as static statements developed by others with little or no input from the individual engineer. Some people fear that professional responsibilities may also have underemphasized some ethics such as safety and welfare of the public, legal liabilities of engineers, environmental responsibilities, quality and communication. Engineers have to care about social justice because they are trying to engineer different new products and solutions to help create a sustainable future for everyone.

Develop new solution:

The third role of engineer in the ever changing world in develops new solution but before you can develop a new solution you must research the problem and then you can develop new prototypes. There are many benefits of creating a prototype before crating a final product. Prototyping allows the developer to explore other possible solutions and how they look and function.

The role of engineers has always been and will be in making the world better yesterday, today and tomorrow.

Smart Engineering for a Better World

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The way we see the world today has been possible only because of ***Smart Engineering***. But what does it mean by the term "Smart"? It's vague, isn't it! Well, when people say "Smart", they mean a complete package that is convenient and ingenious.

But how is engineering and technology leading the way in making lives better? Actually, a person leads which type of life depends on two factors. First, how much the person has ownership of productive resources, such as her own knowledge and labour-power, as well as capital such as a productive plot of land or livestock. Second, there is how much production possibilities exist in the economy. In other words, a person may acquire the ability to buy goods and services by getting a wage income or by organizing productive factors held by her or others, but this will depend on the employment and entrepreneurial opportunities, which rely on the production possibilities of the local economy.

This is where technologies come in picture: available technologies determine the production possibilities. These technologies can be either capital-embodied technologies, such as machines and infrastructure, or labour-embodied technologies, such as procedures followed by workers to produce goods and services, or business models and management practices. Therefore, the complete set of technologies in the country determines the country's productive capacity.

Fundamentally, engineering is an enabler and driver of economic and social development. This is because engineering plays a crucial role in the production of goods and services, through creating new knowledge and ensuring there is the capacity in place to produce and move goods and services – infrastructure, transportation networks and logistical arrangements.

Engineering threads every aspect of the development of a locality and a nation, such as: infrastructures, transportation, machineries and technology we use every day and also the generation and distribution of power and the provision of health and education services.

Through research, innovation and application, engineering is a key driver of economic growth, most recently exemplified perhaps in the rapid growth of countries across East and South Asia. In these cases, rapid growth in increasingly value-adding industries such as consumer electronics, shipbuilding, manufacturing and software has directly and indirectly helped lift millions out of poverty through job creation and facilitated the formation of a generation of well-trained, skilled young people.

The Academy advocates for global dialogue among engineers and policymakers to help ensure equitable and sustainable progress. The need for coordination and collaboration is ever more necessary with the increasing globalization of economies, supply chains, research endeavours and communities, as well as environmental impacts, global futures are inextricably connected. Addressing these global challenges is undoubtedly difficult but engineers working closely with other professions and disciplines, are well placed to play an important role in developing clean, accessible and scalable solutions to local challenges through research and innovation.

Research and innovations are the soul of smart engineering. From the invention of wheels in ancient times to the innovation of smartphones a few years ago, scientists and engineers have found cutting-edge ways to build a modern society. Innovations in engineering have transformed how we communicate, think about our health, travel, and work.

Human development in recent decades has been accompanied by rapid changes in technology and an increasing proliferation of digitized devices and services and the pace of change seems likely to accelerate as a result of "frontier technologies" such as artificial intelligence (AI), machine-learning, internet of things (IoT), big data, blockchain, 5G, 3D printing, robotics, drones, gene editing, solar photovoltaic (Solar PV), biotechnology and nanotechnology. These technologies can be used to boost productivity and improve livelihoods. These modern technologies have evolved such devices that are intelligent, autonomous and interconnected. These modern devices can communicate, transmit and accumulate data, then use it to improve their performance. Smartphones, the internet, cloud computing and hundreds of other inventions are changing every facet of our lives. AI, for example, combined with robotics can transform production and business processes. 3D printing allows faster and cheaper low-volume production and rapid, iterative prototyping of new products. These devices are bringing new and exciting possibilities into our lives. For example, now home appliances can communicate among themselves and with their maker over the cloud, enabling real-time insight. You can see this occurring in personal devices as well as industrial machines on the factory floor. During the COVID-19 pandemic, AI and big data have been used for screening patients, monitoring the outbreaks, tracking and tracing cases of the disease, predicting its evolution and assessing infection risks. Other examples have ranged from the use of IoT to monitor the quality of groundwater in India, to the use of drones for delivering medical supplies to remote communities in Rwanda and Ghana.

Information technology advancements have led to meaningful strides in health-oriented services, particularly in remote monitoring of emergency diseases. Now it is possible to control vital signs of patients in emergencies by wearable smart sensors.

Finance companies have used these technologies, for example, for making credit decisions, and for risk management, fraud prevention, trading, personalized banking and process automation. The manufacturing sector has used them for predictive maintenance, quality control and human-robot combined work.

The rapid technology evolution for integrated circuits enables faster processing/computing and more memory in smaller devices at lower cost. Similarly, the rapid development of color touch-screens, small digital cameras, etc. makes it possible to envisage services to a device that were seen as utopian 10 years ago. Now, the mobile device has become a multi-purpose device, not only a mobile phone for voice communications.

During recent decades of digitization, the world has seen growing prosperity. As a group, these 11 frontier technologies already represent a $350-billion market and one that by 2025 could grow to over $3.2 trillion. People on average are living longer and healthier lives, getting more education and better access to clean water, sanitation and electricity. Incomes too have been rising. Rapid economic growth in emerging economies has fuelled the rise of a global middle class. Moreover, frontier technologies could offer a window of opportunity for developing countries to accelerate economic growth.

Innovation is the Way Forward…

As we evolve more, our hunger for curiosity will also increase, leading to more innovations that will improve our lives. The future surely seems bright with engineering innovations popping up each day, leading to a better world for lives.

The life cycle of Indian leather

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Abstract

A properly sourced and rightly manufactured leather is a truly sustainable material. Unique advantages with leather are that:

- *It's made from a by-product, which amounts to recycling*
- *It's a long-lasting bio-degradable material.*

These two are very important elements of sustainability. Leather is a sustainable, circular and biodegradable material when made with the rightly sourced products. With the appropriate technology, the leather industry can take huge steps in minimizing the carbon footprint and making steps towards a circular economy.

A Life Cycle Analysis (LCA) determines the impact of innovations and the value of bio-based technology and products, as well as the biodegradability of products, leather, their relations, and how to influence those for a more circular leather value chain.

Introduction

There are globally approximately 5.5 million tons of rawhides on a wet salted basis that were processed to yield about 460,000 tons of heavy leathers and about 940 million square meters of light leathers, including split leathers in 2021. The Indian leather industry is one of the oldest industries that still occupies a place of prominence in view of its substantial export earnings, employment generation and growth. The export of leather and leather products increased manifold over the past decades, 80% being value added leather products. The export of footwear, leather and leather products from India was to the tune of US $ 3.68 billion during 2020-21. The industry is bestowed with an affluence of raw materials as India is endowed with 20% of world cattle & buffalo and 11% of world goat & sheep population.

Global brands sourcing from India include Florsheim, Nunn Bush, Reebok, Stacy Adams, Gabor, Nike, Clarks, Salamander, Adidas, Ecco, Deichmann, Cole Hann, Elefanten, St Michaels, Wal Mart etc. There has been increasing emphasis on its planned development, aimed at optimum utilization of available raw materials for maximizing the returns, particularly from exports.

In the recent years there has been a large shift of leather industries from industrialized to developing countries like India, prompted by stringent environmental regulations in the former. India has about 3000 tanneries with a total processing capacity of 700,000 tons of hides and skins per year. More than 90% of the tanneries are small or medium sized, with processing capacities of less than 2–3 tons of hides/skins per day. The highest concentration of tanneries in India is on the banks of the Ganga river system in North India and the Palar river system in South India. The manufacturing processes of leather tanning require considerable quantities of water and chemicals. They discharge nearly 30–35 L of water for every kilogram of leather processed.

LCA framework

The leather industry becomes a highly regulated industry with responsible value chain partners manufacturing leather under tightly controlled auditing programs that are supportive to raise the standard of modern leather manufacturing. Fashion brands increasingly source leather from leather manufacturers audited according to these standards and increasingly demand them to use chemicals that are certified according to the ZDHC levels. ZDHC (Zero Discharge of Hazardous Chemicals) aims to ensure the environmental sustainability of chemicals used in the leather, textile and footwear industry. ZDHC is a group of apparel and footwear brands and retailers working to steer many industries towards zero discharge of hazardous chemicals. The growing importance of these standards is crucial for the leather industry to ensure that brands, designers and consumers value leather as a sustainable and unique material.

Life cycle analysis (LCA) techniques present an effective tool to measure the impact of a products or processes on the environment in an effort to squarely face the environmental challenges.

The life cycle assessment framework consists of four phases as under:

1	Goal definition and scoping	The researchers have to define the intended use of the results and users of the result. The definition of the scope of the LCA

		sets the borders of the assessment – what is included in the system and what detailed assessment methods are to be used.
2	Inventory analysis	The second step includes inventory of the inputs such as raw materials and energy and the outputs such as wastes and emissions that occur during the life cycle.
3	Impact assessment	The third step is integration of inventory elements into an assessment of environmental performance which requires the emissions and material use to be transformed into estimates of environmental impacts. The results of this stage of LCA are '*Eco profile*'.
4	Improvement analysis	The final and the most important step is interpretation of the results of impact assessment and suggestions for improvements.

Life cycle case study

The inventory of the inputs and outputs for 100 m^2 of bovine shoe upper finished leather in Black colour with thickness 1.2 – 1.4 mm during its various life cycle stages such as slaughtering, hide preservation, tanning and finishing, waste management, transportation and electricity production was done. The inventory was done to quantify the material and energy use and the waste produced by the system investigated. The inventory of hide preservation, waste management, transportation and electricity production systems were based on practical data obtained in August 2022.

The results indicated that significant environmental impacts were caused during the tanning and finishing of leather as well as the electricity production and transportation required in the life cycle. The use of fossil fuels in the production of energy had greater impact with increased emissions leading to about 15080 kg CO_2 equivalent of global warming and about 71 kg SO_2 equivalent of acidification. Further resource use of 176 kg of coal, 6.4 kg of fuel oil, 17.7 m^3 of water and 362 kg of chemicals, of which about 202 kg were hazardous, were consumed, and wastewater of about 17.2 m^3, BOD of 56 kg, COD of about 149 kg, TDS of 739 kg and solid waste of about 1448 kg were generated during the life cycle for the production of 100 m^2 of leather. Out of the total solid waste generated, about 80% were biodegradable, 14% non-biodegradable contributed by tanning, finishing and electricity production stages and 6% were hazardous mainly from tanning and finishing stages of leather.

The normalised inputs and outputs for different life cycle stages of leather were thus compiled. In the preservation stage large quantity (300 kg) of salt were used which results in higher total dissolved solids (TDS) in wastewater. The results spoke loud about the significant BOD load, solid waste, the average water consumption and wastewater for every 100 m^2 of leather produced.

Pollution load in units of Kg/ ton of wet salted hide could be observed as under: -

PARAMETER	**LOAD**
Biochemical oxygen demand, BOD	**94**
Chemical oxygen demand, COD	**189**
Suspended solids, SS	**88**
Chromium, Cr+++	**6**
Sulphides, S--	**6.5**
Total Kjeldahl Nitrogen (TKN)	**12.5**
Chlorides, Cl-	**230**
Sulphates, SO4 --	**67**
Oil and grease	**7**
Total dissolved solids	**465**

Mass balance of chemicals observed in the usual leather processing followed came as under in units of Kg/ ton of wet salted hide: -

CHEMICAL PRODUCTS	**ADDED IN PROCESS**	**ABSORBED IN LEATHR**	**UN- ABSORBED IN LEATHR**
Chromic oxide, Cr_2O_3	30	19	11

Organic tannins	22	17	5
Fatliquors	14	10	4
Acid dyes	3	2.3	0.7
Acids, bases, salts	185	-	185
Tensides	2	-	2
Enzymes	1.5	-	1.5
Finishing products	88	16	72
Total	**345.5**	**64.3**	**281.2**

The typical action plan emerged to target: -

Lower water consumption with low float technology and continuous process
Improved uptake of chemicals by accelerating reaction mechanism and proper fixing
Avoidance of hazardous and/or banned substances (Substances of Very High Concern, SVHCs)
More recovery from effluent and better quality/re-usability of solid waste
Reduced content of specific pollutants such as heavy metals and electrolytes contained therein.

Conclusion

The increasing focus on environmental practices has led academia and industry to address eco-sustainability in all probable ways. Recent improvements to supply chain management have included environmental sustainability as a key factor, in addition to common drivers such as risk, supply quality, and cost. India's ability to produce and export environmentally friendly leather products depends mainly on the environmentally friendly technologies and production methods, availability of resources to adopt these technologies and, competency of the institutions responsible for monitoring and enforcing environmental standards.

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Smart Engineering for a Better World

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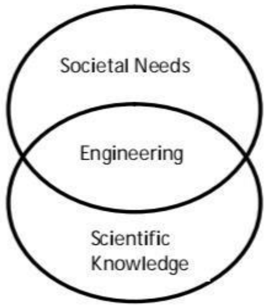
"Scientists study the world as it is, engineers create the world that never has been" (Theodore Von Karma)

An engineer is a person trained and skilled in the design, construction and use engines and machines. An engineer has many different roles in our ever changing society. Technology continues to grow exponentially in our world. It seems like every day you can find a new gadget or device that makes our life easier. Like printing press, transistors, cellular phone, personal computers, the internet etc.

In today's time we are facing the global challenges like depletion of resources, environmental pollution, rapid pollution growth and damage of ecosystem, engineers are playing a major role to overcome this problems. The development in the field of engineering in the 20th century we have always ignored the impact of its on social, economic and environmental natural system. Because of which our planet is facing many problems since the beginning of 21st century, engineers must revisit their mindset and adopt a new mission statement to contribute to the building of a more sustainable, stable and equitable world. As we enter the 21st century we must adopt a more holistic approach to engineering. This will required

i. A major paradigm shift from control of nature to participation with nature
ii. An awareness of ecosystems, ecosystems services, and the preservation and restoration of natural capital.
iii. A new mind set of the mutual enhancement of nature and human that embraces the principle of sustainable development.

If we want to understand the role of engineers, then first of all we have to understand the relationship between engineer and society. The essential services we need to lead a comfortable life today such as electricity, flight, television, medical imaging, sewage network, the telephone, water networks and railway lines are the result of engineering. Engineers plan, design and create the physical structure through which society lives, work and play.



For the last 150 years, engineering practice has been based on a paradigm of controlling nature rather than cooperating with nature. In the control of nature paradigm, human and the natural world are divided and humans adopt an oppositional, manipulative stance towards nature. Despite its drawbacks this approach has led to remarkable engineering achievements during the nineteenth and especially twentieth century. For instance civil and environmental engineers have played a role in improving the condition of humankind on Earth by improving sanitation, developing transportation systems.

The 20th century have witnessed a great achievement in engineering technology in the field of design, information technology (IT), construction, manufacturing, robotic, advanced materials or even the engineering management techniques for problem solving. Some of the newly and enhanced technologies include:

Nuclear technologies- a new source of electric power and new capabilities in medical research and imaging as well as for unwarranted military use

Laser and fiber optics- pulses of light from lasers and used in industrial tools, surgical devices, satellites, and other products. In communications of instance, a single fiber-optic cable can transmit tens of millions of phone calls, data files and video images.

Petroleum and gas technologies- fuel for cars, home, and industries. Petrochemicals are used in products ranging from aspirin to zippers. Engineering in oil exploration and processing, petroleum products have an enormous impact on world economies, people, environment and politics.

Health technologies- Medical professionals have an arsenal of diagnostic and treatment equipment at their disposal. Artificial organs, replacement joints, and bio-materials are but a few of the engineered products that improve the quality of life for millions.

Imaging technologies- Imaging technologies have expanded the reach of our vision. Probing the human body, mapping ocean floors, tracking weather patterns are all the result of engineering advances in imaging technologies.

Space explorations- development of spacecraft has expanded our knowledge base, and improved our capabilities. Thousands of useful products and services have resulted from the space program including medical devices, wireless communication etc.

Agriculture mechanization- machinery of farms: tractors, cultivators, combines, and hundreds of others dramatically increased farm efficiency and productivity.

Electronics- provided the basis for countless innovations; CD players, TVs, and computers, from vacuum tubes to transistors, to integrated circuits, engineers has made electronics smaller, more powerful, and more efficient.

Automobiles- may be the world's major transporter of people and goods, and a strong source of economic growth and stability. The automobile is a showcase of 20th century engineering ingenuity, with innovations made in design production and safety.

Electrification- power has literary lighted the world and impacted countless areas of daily life, including food production and processing, air conditioning and heating, refrigeration, entertainment, transportation, communication, health care and computers.

The six principles will guide an engineer to achieve sustainable development. They will help engineers meet their professional obligations to seek to achieve sustainability, and ensure that this goal is integrated into all their engineering activity.

i. Hold paramount the safety, health, and welfare of the public.
ii. Perform services only in area of their competence. iii. Issue public statements only in an objective and truthful manner. iv. Act for each employer or client as faithful agents or trustees.
v. Avoid deceptive acts.
vi. Conduct themselves honorably, responsibly, ethically, and lawfully so as to enhance the honor, reputation, and usefulness of the profession.

Conclusion:-

The development of modern world has been dominated by science, engineering and technology and the role of the engineer is linked closely to the need of society. Unfortunately engineers are either public relations shy or poor communicators of their success. As famous scientists tend to develop medicines, they appear to be society in a more philanthropic light. The term engineers used in this paper includes any professional scientist, technologist or engineer who uses her skill sets and training to develop practical real world applications.

The 21st century will be defined by some of the huge challenges now facing humanity. Among these are energy and food security, competition and scarcity of natural resources, and climate change. The demand for engineering skills is likely to be higher than ever before in order to deliver sustainable engineering system, low carbon energy technologies, and robust physical infrastructure to protect against geophysical hazards such as sea-level rise and extreme meteorological events.

SMART ENGINEERING FOR BETTER WORLD

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Smart Engineering describes methods, processes, and IT tools for the interdisciplinary, systemoriented development of innovative, intelligent and networked products**,** production plants, and infrastructures. These aspects are commonly known under the term "Industry 4.0". The comprehensive exchange of information between all components involved in the production process plays a major and decisive role. In addition, it is also about the exchange of information between the individual sub-processes of both product development and manufacturing, to improve performance, quality, customer acceptance, and cost reduction of products. An equally important sub-area is an interdisciplinary "Life Cycle Management" to improve the knowledge domains and interactions that have so far largely been insufficiently linked, and thus to counteract a continuous loss of information and experience. Thus, especially in the area of networking of all development and production steps from interdisciplinary concepts to the production process, product use, and final disposal, there are fields of action to be developed in the area of product data and process models.

The applications in the faculty's research profile on Smart Engineering already start in the planning processes of product development. The reason for this is that structuring and the associated information models are already being started, taking into account possible boundary conditions. This digital development process finally leads to the qualification and networking of production and modeling processes, as well as automation technology. The basis for this is to ensure clear communication between sub-processes and production plants. The main challenge in this context is probably secure communication to mobile production components. The Internet of Things is changing the rules for how companies can leverage design and engineering practices to get a leg up on competitors. Smart engineering practices can help you engineer reliable, smart, connected products and systems that enable innovation in the face of complexity.

These devices are bringing new and exciting possibilities into our lives, everything from changing how we commute to illuminating the way the world around us operates. At first, our only concern was about the simple things these devices did: digital displays showed us status, and then digital input enabled us to configure them. Now, devices can talk among themselves and with their maker over the cloud, enabling real-time insight. You can see this occurring in personal devices as well as industrial machines on the factory floor.

Modern devices are instrumented, intelligent and interconnected. They can transmit and accumulate data, then use it to improve their performance. The tremendous functional possibilities for such products offer both opportunities and challenges to manufacturers. The ability to generate new revenue through software upgrades and maintenance services is one such opportunity. However, because these products use software, transmit data and are parts of systems of systems and different ecosystems, traditional engineering processes often need to be modified to address their design and development.

Engineering complexity has grown exponentially at every step along the way. However, this complexity has not been accompanied by an increase in physical components, but in more powerful and varied software capabilities. Engineering lifecycles now include software and its requirements and relationships in an ever-growing fashion. Organizations with the ability to create, design, develop and maintain these new systems can realize better safety, easier compliance and improved security. These enterprises will benefit from well-planned engineering processes that reduce design phase work, allowing similar works to be created from a single blueprint and enabling software that specifies new features and models. Enterprises that lag behind face manufacturing delays, difficulty in meeting compliance and safety goals, and the likelihood of a feature or function attack from their competitors. A thoughtful approach to engineering requires a continuous evolution of requirements definition and product improvement that lets you manage the intelligent software on modern devices, as well as operate globally using cloud-based capabilities. Implementing a continuous engineering solution that incorporates quality, project planning, requirements management and thoughtful design helps ensure predictability; engineering connected devices helps guarantee that devices will be durable and adaptable. While the process must be carefully considered, it must also be quick and agile. Continuous engineering also accelerates the delivery of increasingly sophisticated and cloud-connected products. Engineers can better manage dependencies and respond to change flexibly and rapidly throughout the development lifecycle while controlling costs, quality and potential risks.

The most current capabilities take these efforts one step further by keeping complex requirements, design and test relationships consistent. This allows the maker to manage many versions and configurations across multiple domains so that the right software, services and applications match the right hardware. These capabilities can also help you easily control and reuse engineering artifacts to speed development, reduce risk and improve productivity. Learn how continuous engineering can help you rethink, redesign, reintegrate and re-innovate to build better devices, products and systems.

Finally, smart engineering comprises the integration of product development, production planning, and production control for the rapid market-ready implementation of innovative product ideas and thus the creation of value through a digitally influenced development process. Important here is the development of a PLM concept (PLM: Product Lifecycle Management) to capture the entire product life cycle and thus improve productivity, quality, and reliability across all process boundaries.