

STRATEGIC APPROACHES TO CONSTRUCTION SAFETY: CHALLENGES & OPPORTUNITIES

(Technical Session - Construction Safety)

Pravin Panchal, Sr. Vice President, Corporate Head (EHS, IMS, ESG)
Cemindia Projects Limited (formerly ITD Cementation India Ltd.), Mumbai.
E-mail: pravin.panchal@cemindia.co.in



ABSTRACT

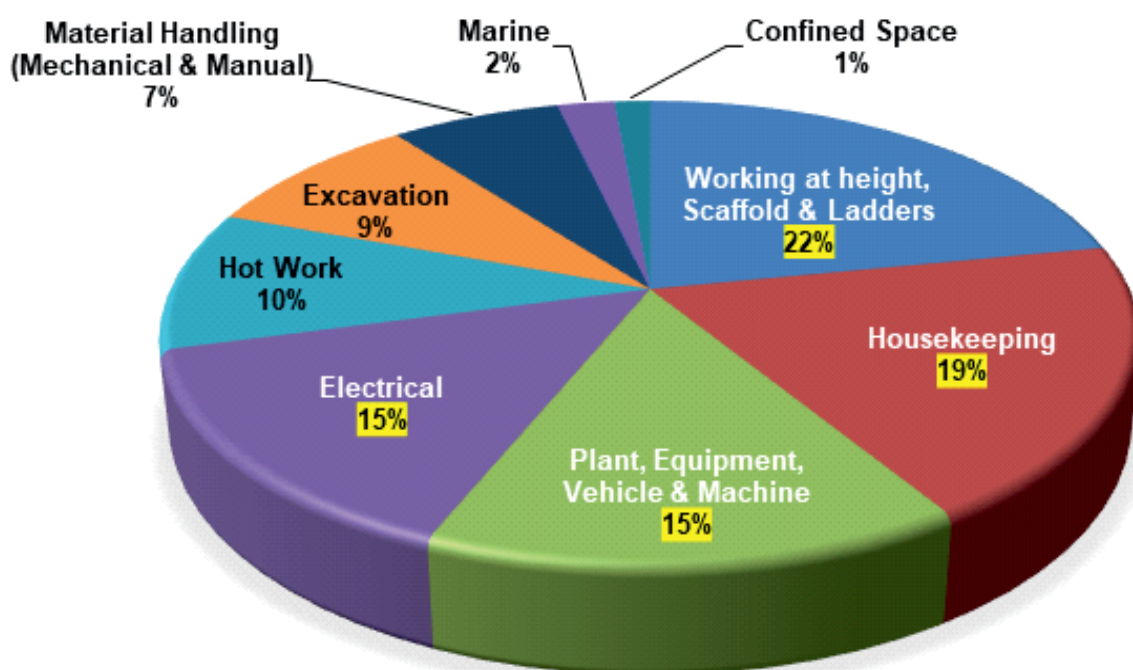
The construction industry remains one of the most hazardous sectors globally, accounting for a significant proportion of workplace injuries and occupational illnesses. As per the ILO, estimated workforce in construction Industry is around 256.82 million globally, which is expected to grow to about 300 million by 2030. Similarly in Asia-Pacific region the workforce is very large due to rapid urbanization and infrastructure investments. Presently in India the construction workforce is 75 million and expected to grow to over 100 million by 2030. In an era of rapid technological advancements, large workforce and increasing complexity of projects, innovation and collaboration have become essential to improving health and safety at project sites.

This paper explores how advancements in technology, innovations, risk management practices, and partnerships between governments, businesses, academia and local communities, can create safer, healthier and more sustainable construction environments.

Introduction

Despite growing awareness and safety initiatives, the construction industry continues to experience a high rate of workplace incidents. As per ILO there is a high rate of fatality in construction sector (between 9.90 to 11.40 per 100,000 workers) as compared to other sectors. These incidents are primarily attributed to a combination of high-risk activities and unsafe practices while working at heights, scaffold & ladders, working with plants, equipment, vehicles & machines (PEVM), temporary electrifications, mechanical & manual material handling, working in confined spaces & deep excavations, working over water, hot works, working on live roads, poor housekeeping etc. Hazards prevailing at sites must be identified with their root cause and promptly attended to prevent its recurrence.

Hazard Analysis of a Construction Company for a Quarter 2025-26



Hazard Analysis (2025 - 26)

Figure-1

Ref. Figure-1 above, highest number of identified hazards during the quarter were related to:

- Working at heights, Scaffold & Ladders (22%)
- Housekeeping (19%)
- Plant, Equipment, Vehicle & Machines (PEVM) (15%)
- Electrical (15%)

Another contributing factor is the intense competition among contractors to secure projects by becoming the lowest bidder (L1). This creates significant pressure to reduce costs by giving work to a sub-contractor and accelerating project timelines. In such scenarios, sub-contractors often prioritize completing work quickly and within tight budgets, sometimes at the expense of essential safety protocols and welfare measures.

There are unique challenges and opportunities in Construction sector and hence there is a need to embrace innovation and collaboration for continual improvement in construction safety.

1.0 Importance of safety in construction

Safety in construction is not just a legal requirement; it's a moral and financial imperative. Poor Safety, Health & Environmental performance leads to:

- 1.1. Human costs:** Injuries, fatalities, illness, long-term health problems.
- 1.2. Financial losses:** Fines, compensation claims, project delays and increased insurance premiums.
- 1.3. Property damage:** Damage to structures, buildings, plants, equipment, vehicles, machines etc.
- 1.4. Environmental damage:** Damage to environment due to air, soil, noise, water pollution.
- 1.5. Reputation damage:** Affecting future contracts. Losing trust of client & consultants.
- 1.6. Legal consequences:** Including criminal liability for gross negligence.

2.0 Key challenges in construction safety

2.1 Lack of availability of experienced & skilled operators & workers:

- The workforce at construction sites in India consists of approximately 19% skilled and 81% unskilled (including semi-skilled) laborers.

- There's a shortage of trained and experienced personnel, especially for handling complex machinery or high-risk activities.

2.2 Risk taking abilities of young construction workers:

- India has one of the world's largest young populations, with a median age of 28.4 years. Around 65% of the population is under 35 years old.
- Younger workers, often new to the job, underestimate risks or overestimate their ability to handle dangerous tasks. They sometimes ignore safety procedures, bypass protective equipment, or act impulsively, leading to more incidents.

2.3 System of subcontracting work to petty contractors:

Petty or small-scale subcontractors often lack the resources, safety trainings, or safety culture necessary for safe and efficient operations. This leads to inconsistent safety standards, poor supervision and exploitation of labor due to cost cutting measures.

2.4 Inadequately maintained Plant, Equipment, Vehicles & Machines (PEVM):

Generally, it has been seen that PEVM hired from external vendors are not regularly inspected or serviced. This increases chances of mechanical failure leading to incidents.

2.5 Lack of awareness to report Near Miss cases:

Workers often ignore or fail to report near misses, fearing they might be blamed or held responsible. They miss opportunities to learn and prevent future, possibly more serious, incidents. Awareness training to be conducted by sharing case studies.

2.6 Language barriers in conducting trainings:

Many workers come from diverse linguistic backgrounds and may not understand the contents of training if not delivered in their native language. This may result in misunderstanding safety procedures and increased risk of incidents.

2.7 Increased use of cell phones at site:

A survey report of 2024 shows that around 87 to 92% of construction workers use cell phones at site. For administrative talks, viewing project documents, design drawings, access reports, reporting incidents, click & report unsafe behaviour, unsafe conditions etc.

Distraction from smartphones is becoming a serious safety hazard, especially in hazardous work zones. It diverts attention from surroundings and tasks, leading to slips, trips, falls, machinery accidents, falls from heights or exposure to moving equipment & vehicles. Cell phone policy need to be prepared and strictly monitored.

2.8 Adverse weather & environmental conditions:

Construction activities often continue in poor weather (extreme heat, cold, rain, snow, wind), which can create unsafe conditions. This leads to wet or slippery surfaces, heat stress, poor visibility and create unsafe working conditions.

3.0 Strategic Approaches To Construction Safety

3.1 Leadership Commitment & Safety Culture:

- Top management of the company must lead by example in promoting safety, health & environment.
- Empower supervisors and safety officers with authority, responsibility, accountability and resources for AI and technological improvements.
- Foster a proactive safety culture & not just compliance based.
- EHS performance to be regularly reviewed by Top & Senior Management.

3.2 Comprehensive Safety Policies & Procedures

- Have a site specific HSE Policy covering climate change mitigation and adaptation. Also consider AI & digitisation.
- Establish clear roles, responsibilities, authority & accountability for all levels of staff & contractors.
- Include risk assessment, hazard control, PPE requirements, and emergency procedures.

3.3 Prevention through Design & Methodology

- Involves incorporating safety measures during the Design Phase rather than post-construction. (Eg: Design scaffold staging, guardrails for elevated work platforms, safer scaffolding access etc.)
- Prepare Stepwise detailed Methodology for each activity & sub-activity.

3.4 Hazard Identification & Risk Assessment (HIRA) & Job Safety Analysis (JSA)

- Identifying risks early in the project lifecycle enables timely mitigation.
- Break down each task to determine specific hazards and appropriate safety controls.

Hazards can be broadly divided into:

3.4.1 Occupational Health Hazards

- Smoke, Gases, Radiation
- Dust, noise, vibrations
- Extreme weather (Hot, Cold & Wet during Rains and snow)
- Ergonomical
- Psychological

3.4.2 Occupational Safety Hazards

- Falls from height
- Slips, trips & falls
- Caught in between or Struck by an object
- Electrical
- Lack of Oxygen, Toxic gases
- Fire & Explosion
- Biological hazards
- Radiation
- Chemical

3.4.3 Environmental Hazards

- Pollution due to improper Storage, Handling & Disposal of hazardous & other waste.
- Spillage of Oil, Fuel & other Chemicals
- Dust & fumes

3.5 HSE Trainings and Competency development

Train – Assess – Retrain is the continuous cycle for creating Safety, Health & Environment awareness amongst employees.

- Induction for new workers, staff and visitors.
- Communicate associated hazards, Risks & precautions to be taken in the Toolbox Talk, Pre-work briefing before starting any activity.
- To increase the effectiveness of training collaborate with training institutes & experts from consulting agencies.
- View clips & arrange practical demos for better understanding.
- Focus on Behavioral Based Safety (BBS) to develop safety culture.
- Communicate Emergency Preparedness and Response Procedure, Assembly point & Emergency contact numbers.

3.5.1 KIOSK for Safety Training –

- Use KIOSK for imparting training in Hindi & other local languages with audio & video.
- Excellent for Safety Induction, Do's & Don'ts for activities.
- Artificial Intelligence (AI) based Safety Training Program creator– create & convert your PPTs, Photos, Videos etc. into Safety Trainings.
- Easier to keep & track record of effectiveness and training evaluation.

3.5.2 Skill based training & Practical demonstrations –

- Provide skill-based training to operators, drivers, lifting supervisors etc.
- Develop Safety Park to educate workers.
- Organise Defensive driving, Heavy equipment and machine operators training etc.
- On-site demonstrations are crucial for effective safety training, helping to reduce the high rate of incidents in the construction industry.

3.5.2 Feedback & Measuring Effectiveness:

- Take feedback from workers after each training / TBT, to make sure they have understood the subject by asking them simple questions.

- Measure the effectiveness of training conducted for continual improvement.

3.5.3 Virtual Reality (VR) in Training

- Virtual Reality (VR) in construction sector provides immersive training for workers to experience and respond to real-life hazards & risks. This certainly improves awareness, safety preparedness & taking required precautions at site.

3.6 Monitoring, Audit & Inspections

- Carry out regular EHS Inspections and Audits (Internal & External).
- Monitor that the Permit to work system is strictly followed.
- Third party inspection and testing of equipment, lifting tools and tackles.
- Check compliance to all applicable Legal and Other Requirements (Legal Register).

3.7 Focus on Leading Indicators for Health, Safety & Environment –

As per experts, companies tracking leading indicators are 75% more likely to reduce incidents year-over-year compared to those only using lagging indicator data. Leading indicators are Proactive & Lagging indicators are reactive. The most effective safety strategies use both leading and lagging indicators together.

- HIRA / Job Safety Analysis for activities & sub-activities.
- No of Hazards identified (SWA) & measures taken
- EHS Trainings / TBT conducted
- No. of Inspections / Audits carried out
- Near-miss incidents reported
- Safety Committee Meetings conducted
- Mock Drills – for all emergencies
- Environmental Monitoring (Ambient air & stack height, Noise, Lux etc.)
- Reward / Recognition to staff and workers
- Safety Alerts / Safety magazines published
- Innovations, Initiatives & Campaigns done

3.8 Medical checkup of workers

Test like - Blood pressure, heart rate, temperature, Vision, Hearing Test, Lung Function Test (especially for those working with dust or fumes),

Musculoskeletal Assessment, Drug & Alcohol Screening (if required), General Physical Examination, Fitness Certificate Issuance.

- Ensure all workers are medically fit for construction work.
- Provide health screening to prevent on-site medical emergencies.
- Educate workers about safety procedures, site rules, and company policies.
- Promote a culture of safety, health, and responsibility.

4.0 Opportunities for Improvement

4.1 Objective & Targets for improvement of HSE –

Companies should take (Long term & short term) Health, Safety & Environment related objective and target keeping Innovation & Leading Indicators in mind. Management should track it for successful completion.

4.2 Install Reverse Camera & Parking Sensors on equipment & vehicles –

- Providing reverse & monitoring camera on cranes, excavators, backhoe loaders, rollers, trailers, dumpers, Transit mixers helps to safeguard workers and other equipment & vehicles around.
- Machineries to be fitted with Digital Safety Features like ASLI, Reverse horn, Limit Switch, Human Sensors, Earth Leakage Relay.

4.3 Provide Inclinometer on Dumper / Tipper trucks –

Providing inclinometer on tipper/ dump trucks will prevent it from toppling. It gives alarm and will automatically disengage from operation as soon as it reaches the threshold limit.

4.4 Provide Cut-off limit switches on batching plant –

It is essential to provide cutoff limit switches on the batching plant mixing drum, gate at conveyor belt area near bottom roller, loading hoppers & aggregate bins.

4.5 Standardisation of –

- Workers' Accommodation
- Welfare facilities for well-being of workers
- Rest shelters
- First aid centre
- Sedimentation tank construction (as per the size of plant)

- Man, material lifting & rescue basket
- Quality of Personal Protective Equipment (PPEs)
- Fire points etc.

4.6 Improve consultation, participation of workers –

Ensure workers consultation & participate in incident investigation, safety committee, NSD & WED celebrations etc.

4.7 Ergonomical initiatives –

4.7.1 Access ladder on Silos –

Straight vertical ladders on silos are difficult to climb, and workers have to use fall arrestor device. Providing circular stair around silos are ergonomically safe.

4.7.2 Bar straightening machine –

Straightening of rebar manually is very laborious task. Now bar straightening machines are available, that straightens rebar from 8mm to 25 mm, with ease. Productivity increases and helps in preventing injuries.

4.7.3 Use of Equipment for working safely –

- Man-lifters for safe working at height.
- Trench cutters for deep trenches.
- Table for welders and gas cutters to seat and work.

5.0 Use Of Artificial Intelligence (ai) & Innovations

AI is revolutionizing construction by automating tasks, improving safety, and enhancing project management across the entire lifecycle, from initial design to on-site monitoring.

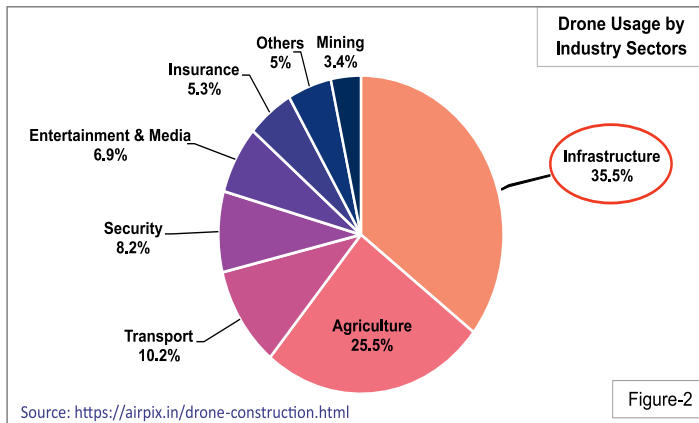
5.1 AI at Construction sites –

AI is construction safety that enhances hazard detection and predicts risks through real time data analysis it helps prevent incidents by monitoring unsafe behaviour and ensuring compliance immediately.

5.2 Use of AI Drone & CCTV Camera for Monitoring of activities & inspections -

Surveillance by Drone enhances construction safety by providing real time aerial monitoring and identifying unsafe behaviour & conditions. It reduces manual inspections in hazardous areas, aiding quick

incident investigation, emergency response, minimizing human risk and improved security.



(Ref: Figure-2) Presently Infrastructure is the topmost sector using Drone (35.5%) during various stages for the safe execution of project.

5.3 Camera in drivers' cabin -

The camera continuously monitors driver at the wheel & if there is any changes in alertness and concentration found in driving, camera immediately detects and sends warning signals to his supervisor and simultaneously cautions driver by sounding alarm.

5.4 Digital Tools –

- Digital EHS tools streamline safety process such as work permits, TBT, pre-start briefings, EHS inspections (QR Code), audits
- Easy & faster reporting of incidents including near-miss case (QR Code).
- Use safety management software for incident tracking, compliance & analysis.
- Analyze root causes and share learnings across project sites to prevent similar incidents in the future.
- Occupational health screening can be done through App. And various tests can be carried out, and data of each employee can be preserved for future.

5.5 Smart Inspect App -

Smart inspect app is a digital platform used for Plant & Machinery (P&M) inspection and monitoring to ensure operational safety and compliance. It helps in real-time tracking and access record of preventive maintenance of equipment.

6.0 Environmental & Sustainability Initiatives

6.1 Use of Low Carbon Material in Construction & resource efficiency -

- Use of GGBS or Fly ash in concrete, as a replacement to cement in concrete.
- Aerated Cement Concrete blocks & Fly ash bricks replacing earthen bricks.
- Using low carbon steel for structural works.

6.2 Reuse of steel -

Use old steel, removed from dismantled steel structures to minimise use of virgin steel.

6.3 Use of Renewable Energy -

Replacing renewable energy by providing solar panels for streetlights and on the roof top of offices, workshops, stores etc.

6.4 Save energy by using Natural light -

Using Natural light by providing translucent sheets in the roof of workshop, stores thereby saving electrical energy.

6.5 Recycling of wastewater -

Recycling wastewater from sedimentation tank, Reverse Osmosis (RO) plant and using it for dust suppression, wheel wash and gardening purpose.

6.6 Waste Management Practice -

Reuse materials like empty drums, scrap steel, plastic, aluminium, GI sheets, leftover concrete etc.

6.7 Recycle Waste -

Recycling used batteries, E-waste, plastic waste, mix steel scrap, used oil, wooden scrap, used tyres, cut pieces of electric cables etc.

6.8 Organic Waste Composter (OWC) -

Install OWC machine or drums for treatment of organic waste from kitchen.

6.9 Environmental Monitoring -

Carry out ambient air quality monitoring, DG stack monitoring, ambient noise monitoring, testing and analysis of drinking water, wastewater, sea water etc.

7.0 Welfare and wellbeing of Employees

- Provide occupational health screenings for all.
- Provision of recreation facilities in workers accommodation.

- Portable water for drinking and cooking
- Create awareness and maintain proper health hygiene and cleanliness in Kitchen, canteen & washrooms.
- Ensure round the clock First aid and medical facilities
- Transport vehicle from accommodation to site & back
- Address fatigue, heat stress, and mental health.

8.0 Personal Protective Equipment (PPE) and Safety Nets

- Use only good quality IS approved PPEs.
- PPE & Non-PPE zone should be clearly demarcated at site. Use of PPE should be strictly monitored.
- Train workers on Selection, Use and Maintenance of PPEs.
- Safety helmets available with Camera, light & fan etc.
- Provide double containment Safety nets on vertical faces and inclined fins in the building and structures to prevent fall of material and persons.

9.0 CELEBRATIONS, AWARDS & APPRECIATIONS

- Celebrate National Safety Day & Week, Road Safety Week, involving staff, workers and other stakeholders.
- Celebrate World Environment Day involving employees & societies.
- Address Staff and Workers on EHS issues.
- Award best employee, contractor & workers.
- Award innovative ideas & safe behaviour

10.0 Conclusion

The construction industry is at a pivotal moment. Innovation offers transformative tools, and collaboration ensures that these tools are effectively applied. Together, they form the foundation of a safer and healthier construction sector. One that not only builds infrastructure but also safeguards lives, promotes well-being, and contributes to global sustainability. By prioritizing safety, health, and cooperation, construction can lead the way in shaping a world where progress and protection go hand in hand.

Develop Safety Culture to achieve the Goal of “Zero Harm”.



References:

- ILO - <https://www.ilo.org/meetings-and-events/>;
- AIRPIX - <https://airpix.in/drone-construction.html>
- Cemindia Company Report - www.cemindia.co.in/report
