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RECENT IMPACT OF GLOBAL SAFETY CULTURE ON FALL MANAGEMENT

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1. INTRODUCTION

Working at height has been part of worker requirement to fulfill man's aspirations to reach the heavens, from time immemorial, even perhaps pre-dating the Tower of Babel (200BC to 2700 BC, 200 m to 2500 m high), ever galloping to increasing heights as technology advances.

The current record for tall structures is held by Taipei-101 at 508 m, in two years to be overtaken by the Burj-Dubai Tower at 705 m, and in 2020 planned to be beaten hollow by the Shanghai Bionic Tower reaching 1228 m. The three tallest buildings in Singapore are all 280 m.

Already millions are living and working in tall buildings, and thousands are dying erecting them.

Construction of these skyscrapers has always been – and will continue to be – a dangerous task. Engineers and developers can and must continually evaluate the risks and find better and surer ways of eliminating and mitigating the dangers of working at heights.

It is well known that in the highly accident beset construction industry, falls from heights is among the most common causes of injuries and deaths. Even if and where they are not the cause of the highest accident rate, falls result in the highest severity of accidents.

This situation is not confined to any specific geographical region or directly related to the technologically developed status of a country. Some of the highest rates of fall injuries occur in quite well developed nations. The problem is truly global, and so will the solutions be.

In this paper, the author will focus only on three specific topics related to this worldwide problem, touching on relatively recent developments, to wit:

- Methods of fall prevention and management
- Fall prevention systems
- Impact of communication and culture

2. METHODS OF FALL PREVENTION AND MANAGEMENT

2.1. Background Review

In the last few decades, advancing technology and improving regulatory control have indeed reduced the risks of working at heights. Yet as injuries and deaths continue, the search for measures to improve conventional methods of scaffold erection, ladder and crane use, etc. goes on, quite successfully reducing accidents, but not completely eliminating injuries and deaths.

Spurring this search are the increasingly stricter regulations governing the design, erection, use, and dismantling of the temporary structures that form essential parts of high-rise construction.

It had been recognised that the stick often works faster (if not always better) than the carrot. Hammurabi, ruler of Babylon (1795-1750 BC), had 282 laws detailing rules for professionals and punishments for violations of proper conduct. Rule 229 reads: "*If a builder build a house for some one, and does not construct it properly, and the house which he built fall in and kill its owner, then that builder shall be put to death."* That must have been a pretty good deterrent!

Even in today's more enlightened times, apart from the profit motive for the developers of new

technology and products, it is often the potential for loss and/or the threat of penalty resulting from construction accidents that drives the pursuit for the better scaffold.

Singapore MOM in its new Workplace Health and Safety Act has at least in part adopted the strategy of stricter enforcement and increased penalties. To improve the nation's record of workplace accidents in general, MOM has also combined heavier penalties with a fairer distribution of accountability for accidents to all stakeholders, which will certainly have a big impact on the management of hazards of working at heights.

Scaffolding companies came into existence in the 1860s. Suspended scaffolding has been in use for many centuries, but came into formalized and regulated use in the 1900s. Steel tubular scaffolding became common by 1920.

Scaffolds in ancient times

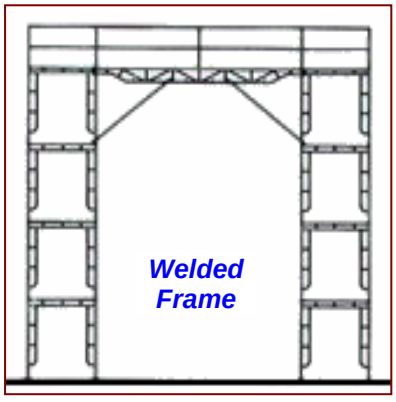
Cantilever scaffolds were merely a matter of anchoring cantilevers to an already constructed higher level so as to support the scaffold for higher floors, and came into wide use with the use of improved materials and construction methods. Some of the developments discussed below have already been adopted in Singapore.

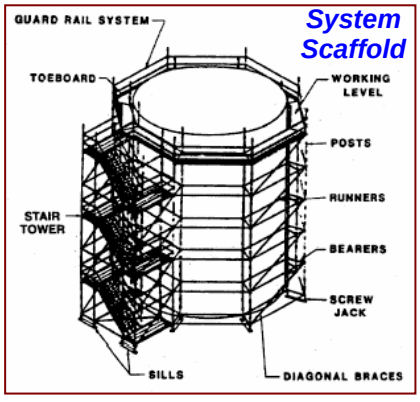
2.2. Improvements

Improvements in scaffold technology in the last few decades include the following:

(a) Welded framed scaffold units:

In the 1940s, welded framed scaffolding was developed and companies started patenting various configurations. They eliminated the need for braces in the plane of the frame, and allowed passage of men and materials through them. They are quite common nowadays.

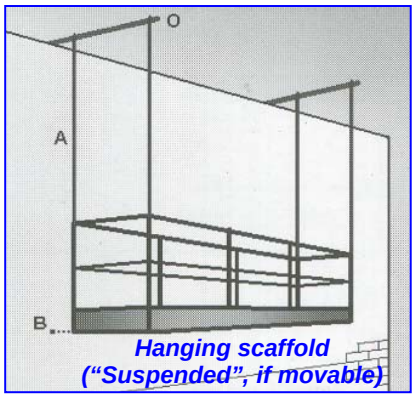


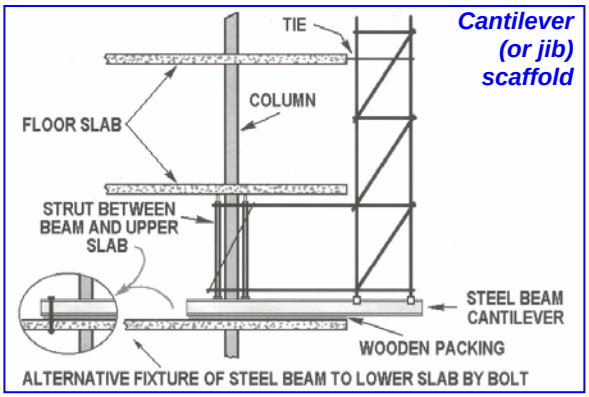


(b) System scaffolds:

As a further extension of the framed scaffold, special purpose proprietary scaffold systems with completely prefabricated units of frames, couplers, connectors, etc. for specific configurations and loadings have become quite common for larger projects. While expensive, they are fast and efficient, especially where modules repeat and the project is large.

(c) Hanging or suspended scaffolds, and (d) Cantilever scaffolds

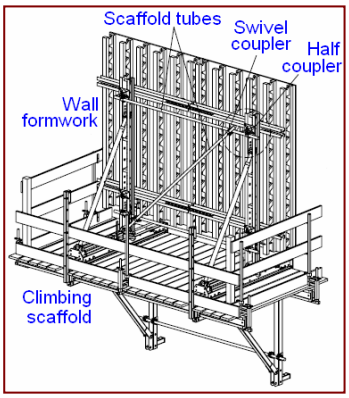




2.3. Innovations

Innovations, in the sense of a new approach, different from the conventional method of erecting from the ground up, or suspending from the roof include the following:

(a) Climbing formwork and scaffold:

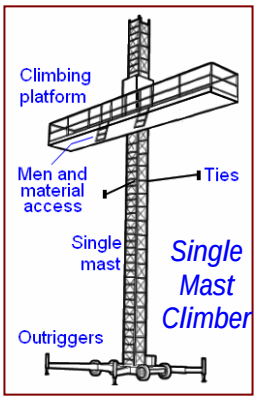


This combination of three functions, namely formwork for the concrete, falsework to support the formwork, and scaffold to support workers and receive materials, has had a tremendous impact on the speed and efficiency of construction work. The complexity and size of cast segments have been steadily increasing over the years.

Some recent climbing scaffolds have been automated so that at the end of one lift they can open and jack themselves up to the next level.

The extra risk in this method is the strength of the anchorage at the previous lift to bear the loads from the new lift.

(b) Mast climbers:



Also called "elevating scaffolds", these are work platforms that move vertically up and down on single or double masts, eliminating the need for all the supporting structure from the ground, work platforms and barriers at intervals, as well as access from the ground all the way up. In use in the West since the sixties, they are now fairly common in other parts of the world also.

With climbing masts, men and materials may be transported to the work level by separate gondolas from the ground up to the working level. Apart from doing away with elaborate support and structural systems, mast climbers have many advantages including speed and

economy, and versatility of configuration and loading, in addition to extra safety.

Major additional risks in this method are the need for better ties of the mast to the structure as the work level rises, and the increased dependence on mechanical and electrically controlled features of the system. Single masts need more attention to ground support and load balancing. Dismantling procedure is critical. Workers and inspectors also need more training.

2.4. Alternatives

Human ingenuity is such that when we cannot go through a tough spot, we find ways to go around it. There are always possibilities to eliminating scaffolding hazards completely or to a great extent by adopting alternative modes of erection. It is here that developers, architects, and designers can take the lead in promoting safety. Some approaches are as follows:

(a) Pre-fabrication of as large units as can be safely transported and moved:

(i) Pre-cast concrete walls, floors, bathroom units, entire rooms, etc.

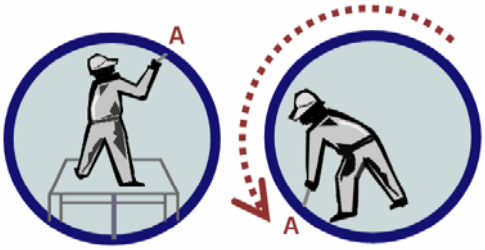
(ii) Shop welding and field bolting

The American mobile home is a classical and successful example of prefabricated habitats, in common use for many decades. Singapore authorities have been encouraging this aspect of construction by awarding points for "buildability", which promotes greater use of prefabricated, modular and standardized building components.

(b) Preparation in safe position and then moving to desired position:

(i) Preparing (casting) horizontally and standing the component up vertically ("Tilt-up")

(ii) Rotating weld object by desired angle to permit downward welding.



Rotation of airplane fuselage by 180° to enable downhand welding

(c) Erection at ground (or other stable) level and shifting it to final location:

(i) Lift slab (or, jack up floor slabs)

(ii) Cantilevering out over the span

(d) Basket/cage at the end of crane jib:

This could be a convenient solution for short or temporary jobs but not for long-term, sustained load jobs.

(e) Embedment of safety accessories, for post construction work:

(i) Rails for movement of cages

(ii) Anchors and ties for next stage, as in climbing scaffolds

(iii)Eyes for attachment of lanyards or suspension of cages

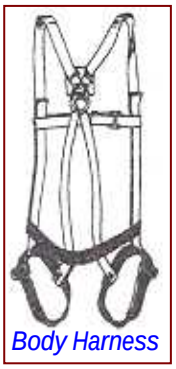
3. FALL PROTECTION SYSTEMS

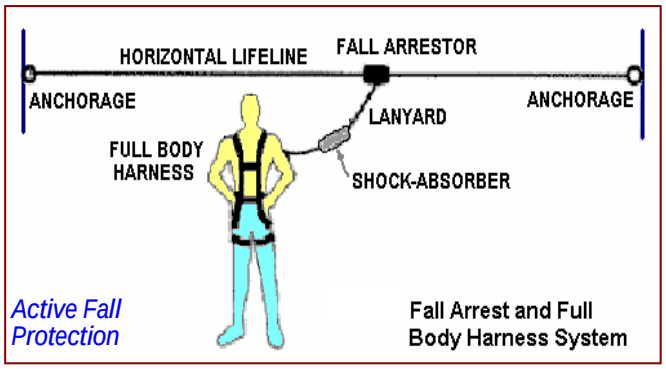
3.1. Passive Fall Protection

Passive fall protection consists of barriers, netting etc., which do not depend on the worker for its usefulness. Barriers and guardrails are commonplace in the construction industry, and are well established as safeguards against falling hazards. Inspection standards are also very strict.

Many vertical debris nets may also be designed to catch and hold workers if they should fall over the side.

But horizontal netting to catch falling workers does not seem to be so common in Asia. It is not new, and apart from its obligatory use in all circuses, it has been used for many important projects, including the Golden Gate Bridge in USA; during its construction from 1933 to 1937, nineteen lives were saved by the net, although two others died when the net gave way. Its increased use needs to be considered on a case by case basis.





3.2. Active Fall Protection

Active fall protection consists of Personal Protective Equipment (PPE) which the worker or other staff member at site should wear and use. Fall protection PPE is an active fall arrest system, and it is the worker who has to check and use the PPE together with all the associated equipment such as lifelines, lanyards, and fall arrest systems.

We have come a long way from the 1930s when a worker simply wore overalls and a sunshade and carried a lunchbox to work. Although PPE should be the last resort, it still remains the best line of defence when nothing else can be done, or everything else fails.

PPE has evolved along with improvements and changes in other aspects of safety. Equipment and procedures which once were considered absolutely the best have been found to have certain deficiencies. Not only were some found to be ineffective, but also were others found to be positively risky, contributing and triggering consequences worse than the original hazard.

A case in a point is the waist belt for scaffold workers. It was thought necessary and sufficient for a worker to wear a good strong belt around his waist and then anchor it to a robust support or life line with a lanyard incorporating energy absorbing devices.

But soon in a typical “operation was successful but the patient died” scenario, it was discovered that the victims of falls were found externally intact hanging from their belts, but their insides – intestines, kidneys, liver, spleen, and whatever else was in the way – had been mashed into pulp at the end of the fall, by the very belt which they were depending on to save them.

Thus was the full body harness developed, which could resist the forces via the two major bone masses in the human body, namely the hip/thighs and the shoulders, and leave the soft midriff undamaged. This became law in the USA only in 1998, and in Singapore in 1999.

As with the earlier belt, attention should focus not only on the harness itself, but also on anchor points, cable strength, cable lengths, and lanyards and their clamps to complete the protection.

A different facet of PPE is that in spite of the best equipment and training, fall injuries and deaths will happen if the equipment is not maintained, worn and used correctly. Strict inspection is very essential if PPE has to ensure positive results.

Is the problem solved with the use of the body harness? Well, solving one hazard often creates a new one. Here, the new condition is that the fallen person must be rescued from the hanging

position within quarter to half an hour, to avoid pooling of blood in the legs and overstraining the heart. Even after rescue, letting the victim turn upright too soon can also overstrain the heart with the rushing blood, and cause an attack! This then is a high-tech medical emergency.

4. IMPACT OF COMMUNICATION AND CULTURE

In the last two decades, the world has shrunk faster and more drastically than before, bringing together many cultures into competition and cooperation in almost every developed and developing nation. Construction workforce is no exception, and in fact one of the leading contributors to migration.

Along with this migration comes numerous benefits to both the native and the immigrant population, but at the same time some new problems also arise.

The problems can be broadly divided into communication and culture, although both are closely related. The following discussion summarises documented findings mainly in the USA, and in certain underdeveloped countries.

4.1. Communication

Communication between various peoples gathering at one place is also an age-old problem.

Communication has two aspects: The first is dissemination of information which must permeate not only to different sub-groups at the same professional level (as between engineers or between workers), but also between different professional levels (as between the management and workforce).

The second is the actual language of communication. Again referring to the Tower of Babel, as the name itself suggests, even from early times, there were too many languages spoken for any one person or group to understand what was going on. That was why they could not complete the tower planned to reach up to the heavens.

(The story goes that God did not want them to develop a common language because then they would build the tower right up to heaven, and He did not want them to take that kind of short cut to salvation. But even if He had wanted, it would have been a near-impossible task to ensure good communication between them all!)

In Singapore, there are four official languages (English, Mandarin, Malay, and Tamil), and all safety documents, information and warning signs are expected to be – and generally are – in all four languages. But recently workers from North India, Pakistan, Bangladesh, Indonesia, Myanmar and other countries in the region have been coming in, and communications have had to be developed in those other languages also to cater to needs of the workforce as needed.

It is interesting to note that in the last two decades, USA, a country where one would have expected the least problem with language, has been having increasing accident rates and severities with the suddenly increasing workers from Mexico. After some analysis, the problem was traced to the Latino workers' lack of understanding of written English, and lack of comprehension of the spoken language, particularly with somewhat differing local accents.
While the construction safety record for native and English-speaking workforce is improving, the record for the non-English-speaking personnel is worsening. Meanwhile the immigrant workers are also increasing in number sharply. America has met this problem head-on, and in 2002, OSHA initiated the following steps to address the concerns:

- Establishing an Hispanic Workers Task Force
- Creating an 800 [toll-free] number accessible to Spanish-speaking individuals
- Initiating a national clearinghouse for training programs in Spanish (includes videos, written publications and other training materials)
- Creating a Spanish-language website for employees and employers
- Compiling a list of fluent Spanish speaking employees in Federal OSHA and State Plan States and OSHA-funded, on-site consultation agencies (119 Federal, 38 state and 22 consultation)
- Strengthening OSHA offices' contacts with police and emergency responders to ensure that OSHA receives referrals when an injury is work-related

These measures have begun to yield positive results.

4.2. Cultural Barriers

Often workers are afraid to speak out about unsafe or unhealthy conditions for fear of losing their jobs or being deported. OSHA emphasises to them that their reports will be kept confidential, they are taught their workplace rights under the law, and they will be provided whistle-blower protection from dismissal or other employer retaliation.

A buddy system of attaching new immigrant workers to workers from the same foreign country with more familiarity with the local language and customs, as well as more experience with the job, is also in place.

The foreign workers will typically:

- Not complain about long hours or hard work
- Not turn over broken tools for repair or replacement
- Not report teasing, ragging, cheating, underpayment, non-payment, bad living conditions etc.
- Not show ignorance, fear or hesitation about an unfamiliar or obviously hazardous job
- Not worry about injury or death as much as local workers, and instead, risk life and limb with either a macho outlook, or a submissive, fatalistic view

Many employers take advantage of these cultural differences to get cheap labour and cut corners on safety implementation and investment.

4.3. Local and Regional Situation

In Singapore, the author has come into contact with many foreign workers and their supervisors during his site visits and in his training courses. He has also had occasion to share experiences in this regard with other professionals in the field.

By and large, because of the already prevalent and successfully functioning multi-language and multi-ethnic culture in Singapore, immigrant workers here are reasonably well integrated into the workforce without long-term or large differences, or serious repercussions. Employers also cannot and normally do not take advantage of immigrants' handicaps.

Hence, unlike the Americans to whom such a language and cultural divide is a new experience, the Singapore construction industry has a much less critical situation on their hands.

However, the author has found that many immigrant workers demonstrate very much the same

work attitudes as the Latinos in America. Further, some workers still are slow to absorb the knowledge base, and keep working with gaps in their safety awareness and preparedness.

Even when supervisors and inspectors do check carefully, and advise erring workers to correct their ways, some staff hesitate to go all the way and punish or dismiss workers who do not learn or reform even after being sufficiently warned and briefed.

Author has met workers with 15 to 20 years of experience, mostly from outside Singapore (but some even local) who follow the procedures of safety behaviour superficially without knowing exactly why, and do not follow the intent of the rules. They would wear the harness but would not tighten the buckles. They would belt up the lanyard, but not clamp its end to the post, because the adjacent platform was only a metre away.

Until a few decades ago, American workers exhibited macho behaviour, working at heights with little or no passive or active fall protection. Much of it was because the hazards had not been analysed and managed. But in due course, labour unions recognised the value of workplace safety in the overall scheme and in the long run, and are now the leaders in the pursuit of safety.

In Asia and many Western underdeveloped nations, many workers are not so enlightened about their role in industrial safety, and many old feudal attitudes remain. In Hong Kong, workers putting up tall scaffolds of any height (even 70 storeys) would not wear any PPE, and the passive fall protection system would also be minimal. Deaths and major injuries were rampant and rising because the traditional rigid and compulsory family apprentice system was gradually deteriorating with the break-up of the joint families which specialised in bamboo scaffolding.

A few years ago, the Hong Kong authorities decided to check this and formalise bamboo scaffolding. Along with strength and size standards for the bamboo construction, it also established clear and strict criteria for worker training and safety for bamboo scaffolding along the same lines as for metal scaffolding. Soon the accident rates and impacts stabilised.

In Singapore, such blatant macho attitudes are not a real problem. At the same time, many foreign workers still may not appreciate the importance of taking care of themselves individually and of following all the safety measures. Further they may not realise the impact of one worker's negligence or carelessness on the health and safety of other workers and on the organisation.

5. CONCLUSION

After the recent shake-up of the entire workplace safety issue, Singapore is well poised to improve its safety record and continue to be a regional role model. The author has raised some flags here more to share global impacts and responses to certain recent and common hazards while working at heights, than to present any dramatic breakthroughs in this age-old problem of falls while working at heights, or to point out any major weakness in the prevailing system.

The few local risk factors highlighted are relatively minor and can be easily taken care of by suitable corrective action and improved communication with the workers, and by better briefing and training of supervisors and inspectors. The management also needs to be better informed of the worker level problems – and in fact about construction safety itself in many cases – and motivated to tailor their safety plans to suit these special and changing needs.

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