Chapter 5

Safe Handling f Gas Cylinder at C nstructi n Site

1 Intr ducti n:

Gas cylinder, such as Oxygen, Dissolved Acetylene (DA), Nitrogen, Argon etc could are potential risks site Compressed gas cylinders are heavy (40 kg+) especially when full Compressed gas cylinders generally come at a pressure of 250 psi (DA Cylinder) and 2200 psi (Oxygen Cylinder) contains the kinetic energy equivalent to a small weapon In case of breakage of main valve due to sudden fall, gas cylinder could fly more than 500 m and even penetrate reinforced concrete walls There is a need for safe handling of all gas cylinders including loading and unloading Due to the nature of the construction site, gas cylinders are required to be used at various locations where permanent arrangements of unloading and loading back empty cylinder do not exist

Engineering challenge: In most cases cylinders are transported in conventional carriage, manually handled while loading and unloading which also possess a great threat when they get dropped or hit by objects during this process Still a number of cylinders loading / unloading is manually done and a huge scope of engineering interventions is a scope of improvement in determining an effective control

Construction projects, particularly involving steel structure, pipeline etc are linked with fabrication process which includes cutting as well as joining of metals As we know, fabrication process involves usage of oxygen, fuel gas as well as inert gases in large quantities, varying in proportions

Estimated requirement of oxygen gas for structural steel works is 5 m^3 / mt while requirement of fuel gas (dissolved acetylene) is 166 m^3 / mt Similarly, for piping works the estimated requirement of oxygen gas is 0018 m^3 / inch dia and for fuel gas ie dissolved acetylene it is 0006 m^3 / inch dia

The following illustration aptly highlights magnitude of cylinder handling activity in a composite construction project involving 725000 inch-dia piping,

4735 T structure It involves utilization of 715 Oxygen cylinders, 250 Dissolved acetylene cylinders and 700 Argon gas cylinders

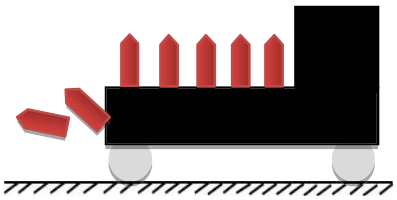
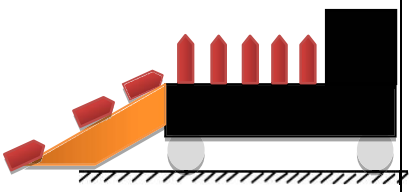
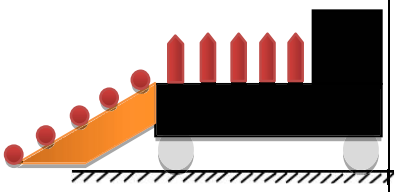
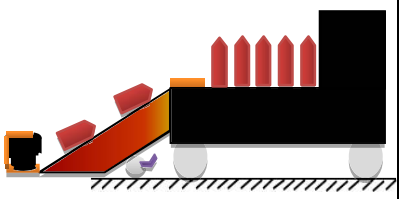
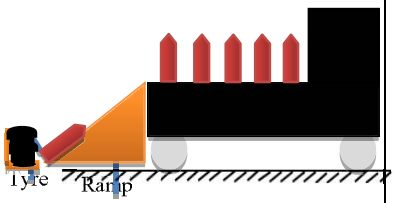
Compressed gas cylinders are transported to site mainly by goods carriage such as trucks / Vans These vehicles are loaded with full cylinder at the vendor's place which gets unloaded at the worksite Generally such compressed gas cylinders are manually handled and dropped to ground level while unloading the same from its goods carriage As of now, the method adopted for unloading is hazardous, in view of the possible consequences

The main hazards associated with gas cylinders are:

- Impact from the blast of a gas cylinder explosion or rapid release of compressed gas;
- Impact from parts of gas cylinders or valves that fail, or any flying debris;
- Fire resulting from the escape of flammable gases or fluids (such as liquefied petroleum gas);
- Impact from falling cylinders

Table 5.1. Various methods for cylinder handling

Legend : Goods Carriage Gas Cylinder Ground Level Metal Strap Tyre Wheel & Stopper

Sl	Detail	Description	Implication	Remarks
1	Manually dropped 	- Truck loaded with compressed gas cylinders - Manually rolled from the carriage and dropped on the ground	- Causes damages to valve - Damages shell - Dropped cylinders are vulnerable to leaks	- Unsafe and such practice to be immediately stopped
2	Vertically slid on mobile ramp made of steel 	- Truck loaded with compressed gas cylinders - Steel ramp is provided for unloading cylinders - Manually rolled from the carriage - Cylinders slid vertically on the steel ramp	- Due to metallic interfaces it greatly damages the shell of cylinder - Due to straight plane surface of the ramp, probability of side fall is very high	- Dropping of cylinder is avoided; still the practice is not safe
3	Horizontally slid on mobile ramp made of steel 	- The description is same as mentioned in Sl 2; however the additional factor is the horizontal rolling of the cylinders on the steel ramp	- Since being slid horizontally the kinetic energy of cylinder when slid on ramp is very high	- Horizontal sliding of cylinder is unsafe and should not be practiced
4	Mobile ramp made of steel with tyre damping 	- Slid on a steel ramp vertically - Surface of ramp fixed with fire proof tarpaulin and metal to metal interface is avoided - The Sliding ramp has got a slot on its plane so that the cylinder slides down safely - Ramp are also being provided with wheel and stopper - End point of ramp are provided with rubber tyre as damping material	- Using steel slope with tyre damping has no significant negative implications - Metal to metal interface is avoided - Damping material provided in the end which prevents any shock / impact on the cylinder	- This is a safe method for unloading a cylinder and will be very useful even to be used at construction site where work place is highly dynamic
5	Fixed concrete ramp with tyre damping 	- Cylinders are unloaded from truck manually on a strong concrete ramp - Cylinders would be slid on vertically ramp which lands on a rubber tyre as damping material and later rolled keeping it in upright position	- Though this is a good method, It would be useful in handling cylinders in stores / other permanent setups	- Safe method of unloading will be very useful for unloading cylinders at stores / warehouse

- Manual handling injuries;

Compressed gas cylinders are heavy (40 kg+) especially when full Compressed gas cylinders generally come at a pressure of 250 psi (DA Cylinder) and 2200 psi (Oxygen Cylinder) contains the kinetic energy equivalent to a small weapon In case of breakage of main valve due to sudden fall, gas cylinder could fly more than 500 m and penetrate even reinforced concrete walls There is a need for safe handling of all gas cylinders including loading and unloading Due to the nature of the construction site, gas cylinders are required to be used at various locations where permanent arrangements of unloading and loading back empty cylinder do not exist Manual loading and unloading of cylinders leaves us with a large scope of engineering interventions

2 Meth ds:

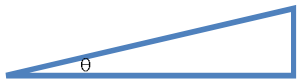
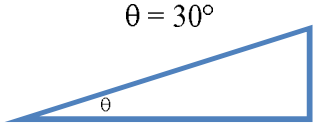
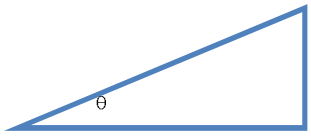
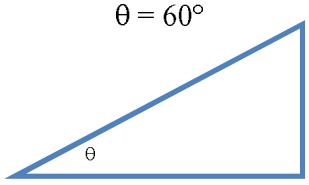
Conventional method of gas cylinder unloading from goods carriage poses inherent hazards Existing unloading arrangements are studied in depth to assess the risks related to various types of unloading processes as well as respective consequences It was evident that some of the existing unloading methods do not represent safe handling of cylinders

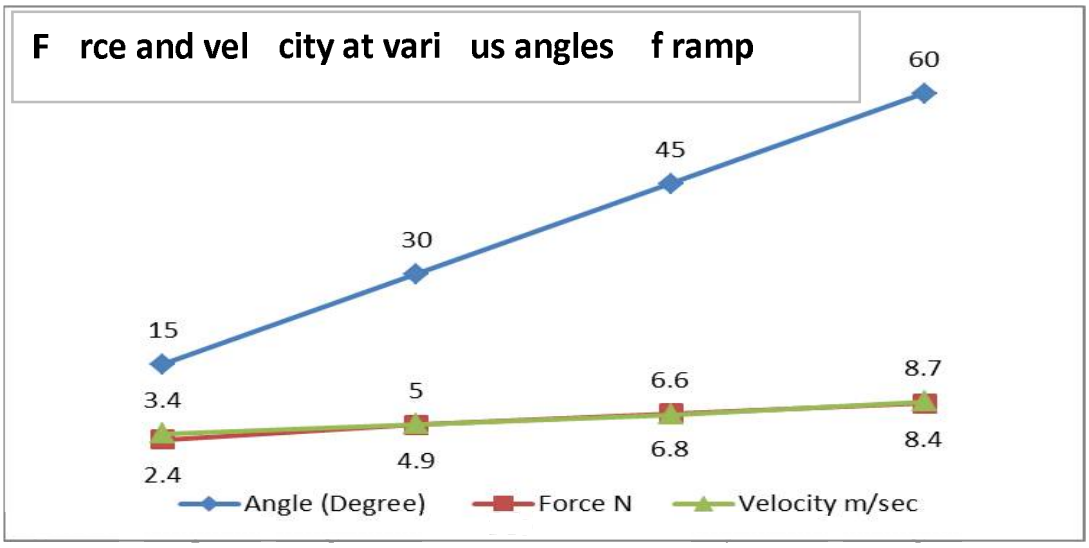
Hazards of Dropping a Gas Cylinder - While reviewing the existing practice it was noted that manual dropping of a 40 kg gas cylinder from 13 m height has a potential to exert 4900N force to the ground

Various methods explored for cylinder handling was studied in detail as highlighted in Table 18

While sliding gas cylinders from the ramp, it was tested for different configurations of ramp angles The impacts at various configurations were studied including force and velocity The compilations of various findings are as given in Table 52

2 Force and velocity variations at various angles of ramp

Sl	Angle f Ramp (θ)	F rce (N)	Vel city (m/sec)	bservati ns
1	θ = 15° 	24	34	- Sliding velocity of cylinder was still not matching with the requirement A push was required to propel the slide of cylinder - Height of the ramp is 610mm and not matching with the carriage of vehicle
2	θ = 30° 	49	5	- Sliding velocity of cylinder was perfect and safe - Height of the ramp is 1200mm and was matching with the carriage of vehicle
3	θ= 45° 	68	66	- Sliding velocity of cylinder is very high and becomes difficult to manage once when landed on ground level - Height of the ramp is 2278mm is not matching with the carriage of vehicle
4	θ = 60° 	84	87	- Sliding velocity of cylinder is too high and mostly tilts when landed on ground level - Height of the ramp is 3945mm is very high and not matching with the carriage of vehicle

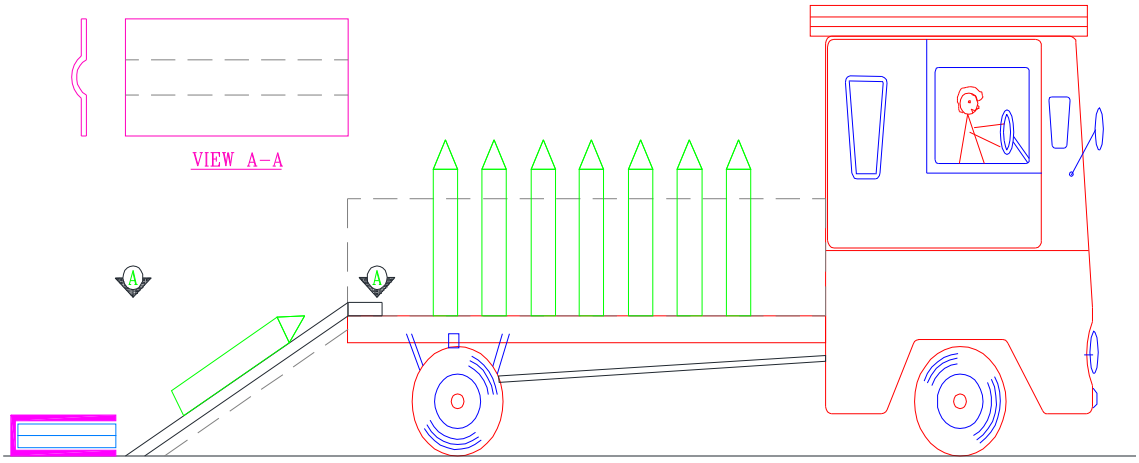


From the table 52 it was found that ramp angle with 30° will be best suited for unloading cylinders

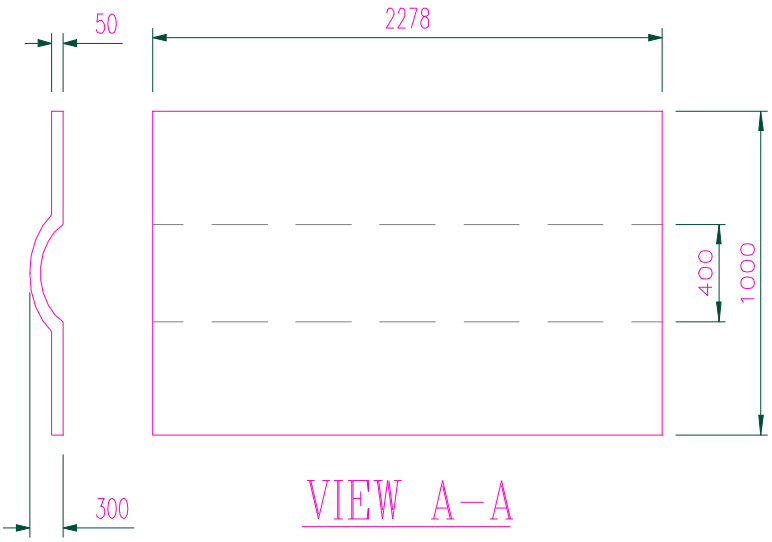
3 Discussi n

It was found that the usage of mobile ramp made of steel with tyre damping would be the most preferred options due to the following reason:

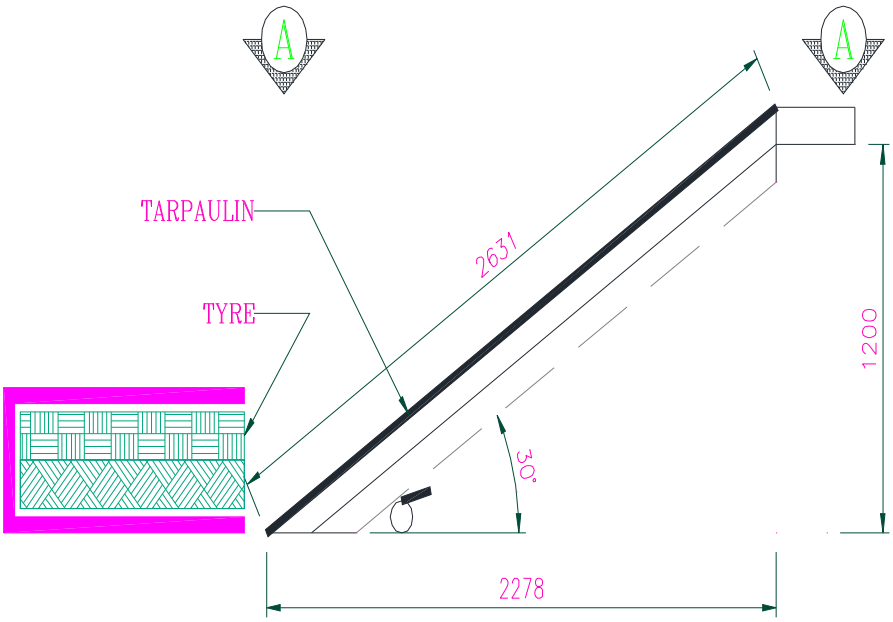
- Severity of manual material handling being reduced
- Special ramp designed for unloading gas cylinders
- Simple and quick fix solutions which can be moved to any part of the location
- Facilitates safe transport of cylinders
- Lesser damages to cylinder valves and shell
- Safe operations of Gas cutting / welding by the end-users



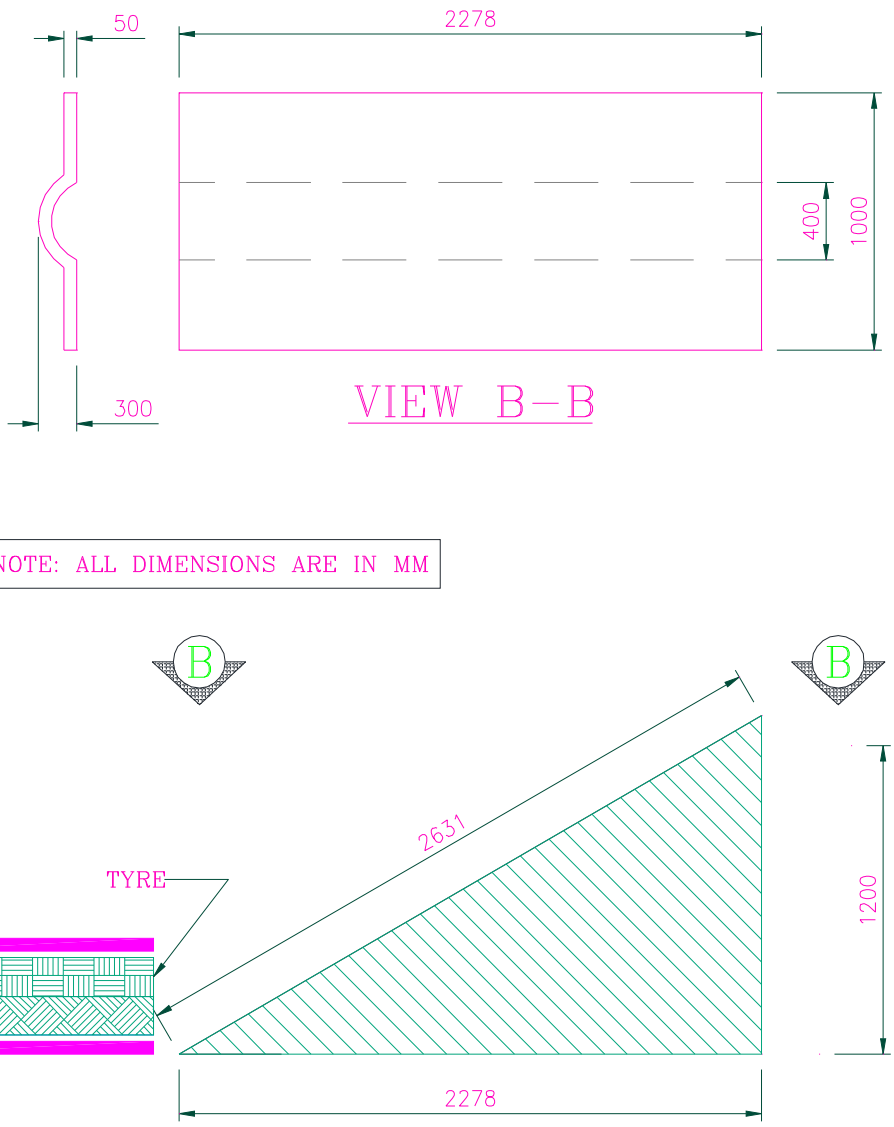
Schematic layout of unloading arrangements for gas cylinder



NOTE: ALL DIMENSIONS ARE IN MM



Layout of unloading arrangements for gas cylinder using mobile ramp made of steel with tyre damping



Schematic Layout of unloading arrangements for gas cylinder using fixed ramp with tyre damping

Various conventional unloading options of gas cylinders at project sites are evaluated in terms of hazards and risks associated with the process of unloading of cylinders

While mitigation of the hazards is taken in to view, various alternative options were considered keeping the dynamics of construction projects including diverse demand of various types of activities and situations

Accordingly designs of alternative options were conceptualized through brainstorming by a team including HSE and site operations It was arrived that gas cylinder unloading arrangements using metallic slope and tyre damping will be best suited for any construction sites including temporary establishments Similarly unloading arrangements for gas cylinder using fixed ramp with tyre damping will be best suited for permanent setups like stores / warehouse etc

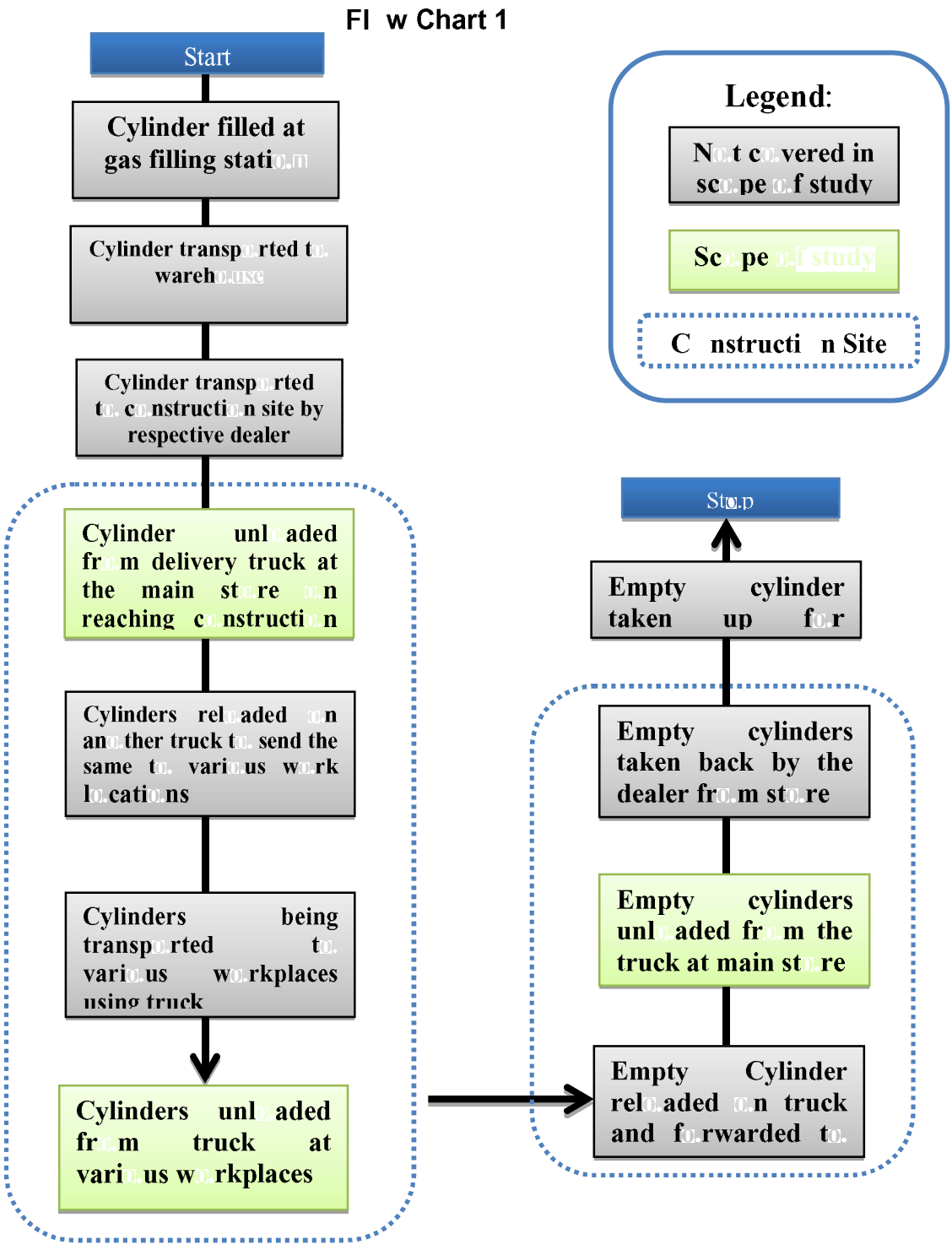
4 Discussi n

While working on safe handling of gas cylinder in construction project it became evident that the matter require detailed study of various aspects associated with this apparently innocuous but potentially high hazardous work In this connection consideration of various inter-related factors including transient nature as well as dynamic phases of construction activities are taken note of Other factors, such as number of gas cylinders to be handled and human factors like risk awareness of the workmen on associated risk and precautions to be taken

During the study, in line with the scope of his paper, various methods of handling gas cylinders at construction site are studied

This study covers handling of compressed gas cylinder after it reaches the stores within the construction site premises Once the gas cylinder reaches the stores of a construction site, they are required to be transported to various work locations, depending on requirements of work

The flow chart provides here an overview on complete cycle involved in gas cylinder handling which covers steps right from production, logistics and dispatch to constructio



5 Flowchart of gas cylinder handling

This study focuses specifically on unloading of gas cylinder at construction site from the truck and subsequent handling of the same The details of coverage of research are shown in the flow chart shown above

While exploring various methods of gas cylinder unloading following practices were studied:

1. Manually dropped from truck
2. Horizontally slid on mobile ramp made of steel
3. Vertically slid on mobile ramp made of steel
4. Mobile ramp made of steel with tyre damping
5. Fixed concrete ramp with tyre damping

From this study it was found that the following are safer options for the respective

a) mobile ramp made of steel with tyre damping for work locations at site

b) fixed concrete ramp with tyre damping for Stores

During the study of various configurations of ramp angle, considering velocity as well as force on gas cylinders, 30° inclination was found to be suitable Relevant details highlighted in Table 51 and 52

It is concluded that with a ramp angle of 30° for unloading gas cylinders through a mobile ramp made of steel with tarpaulin sheet on its surface aided with tyre damping will be well suited for unloading cylinders at various work locations in project site On the other hand for unloading gas cylinders at project Stores, fixed concrete ramp with tyre damping will be the best suited option

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