Chapter 7

Head Pr tecti n f r Carrying Head-l ad

Efficient handling and storing of materials is vital to construction industry Though mechanization at construction site has increased enormously, still the industry depends on many manual activities, which include manual load carrying

The most common materials that are being carried manually may vary with the activities and may include a wide range of materials including cement bags, bricks, lumber, ply woods, steel rods, pipes etc Some of these materials are normally carried on head while handling it across the workplace

Since at construction sites there is always a potential risk of fall of materials / hit by objects it is very important to have an adequate head protection for all workers and hence Safety helmets is considered to be one of the mandatory PPEs

Those who carry head load, find it difficult to use safety helmets as it hinders proper setting of the load on the head Due to this they are unable to wear protective headgear which further intensifies the risk of head injuries

Engineering challenge: It is necessary to find a solution so that head protection can be worn when head load is being carried The existing standard helmets are not designed for carrying any head loads Firstly, the load cannot sit on a circular smooth surface of a helmet Secondly, specified clearance between the helmet shell and the anti-concussion tapes provided inside the helmet, to be maintained for effective impact dissipation If these internals are not suitably designed, the gap between the shell and the head may get reduced due to head load carrying and thereby nullifying the benefit of helmet usage This may require changes in the existing design of the helmet

Helmets are useful as safety gear to prevent injuries in an uncontrolled environment, like construction If a crash or impact cannot be eliminated or prevented, helmet can be helpful in reducing the harmful consequence of the episode However, we need to remember that no helmet can protect against all possible impacts, and the impact may exceed the helmet's protection Helmet

protects only the part of the body that it does cover, so even if the head injury is avoided there could be injury to other places due to fall of material

Head injury can occur by impact of falling material leading to serious harm to the brain As a result, blood vessels and nerves receives a yank Internal blood vessels and nerves too yank parts of the brain in different ways, straining the vessels and nerves in the process

Helmets designed to handle major crash energy generally contain a layer of crushable foam When someone crash and hit a hard surface, the foam part of a helmet crushes, controlling the crash energy and extending your head's stopping time by about six thousandths of a second (6 mili second) to reduce the peak impact to the brain Rotational forces and internal strains are likely to be reduced by the crushing

1 Case Studies

1 Case study 1

In a under-construction building inside a power plant, a sub-station building was being constructed Several teams were working in the building, including roof work at second floor The shift time of each team varies depending on various factors including the amount of work at hand, ranging from 8 hours to 10 hours, sometimes even more A crew member, after finishing the shift-work at the 1st floor was about to leave the site However, he decided to return to construction area to collect his empty lunch box which he kept at the ground floor He parked his cycle on the road near the construction area, kept his helmet on the same and walked towards the lunch box which was kept nearby He possibly assumed that work was over for the day and did not realize the need of wearing helmet at that time However, another group of workers was working on the 2nd floor who were handling steel material for slab supporting work One of the supporting steel component accidentally slipped from the hand of one crew member and hit him on the head He sustained severe injuries on his head leading to serious consequences

2 Case study 2

In a steel plant modernization work, civil work for an electrical control building construction was in progress Reinforcement metal bars of around 10mm diameter, 18 m long were placed near the window edge opening at the first floor Just below, at the ground level, one electrician came out of the temporary pump shed after attending a water pump As he was doing something in the open area, (without covering his head with a protective safety helmet), another worker started handling these reinforcement metal bars kept in the first floor One reinforcement bar got accidentally slipped from the hands of the worker, fell from height and hit the electrician's head causing serious injuries

3 Case study 3

In a construction site, a crew member was operating a "builder's hoist" to vertically transport construction materials from ground floor to various floors Simultaneous work was also in progress at the ground floor where few workers were engaged in concrete mixing activity

While transporting a consignment of concrete bricks from ground floor to 12^{th} floor through the builder hoist, concrete bricks are required to be safely stacked and securely tied As the load was being hoisted, near 10^{th} floor, some bricks got displaced due to the vibration during lifting Few bricks came out of the frame of the hoist and a displaced brick fell down from the frame and hit on the head of a worker on the ground He was not wearing the helmet as he was carrying head load Hence the impact of the fall got fully transferred to his head, sustaining severe injuries

Usage of helmet at construction site is also a statutory requirement, due to high risk of fall of material from height A safety helmet protects the head against impact from material falling from overhead locations, by absorbing energy through:

(a) Partial destruction or damage of the shell;

(b) Stretching of the harness/headband; and

(c) Crushing of the protective padding if any

The residual force of the impact is spread over the surface of the head thus reducing the chance of injury To achieve the purpose, stringent performance/test requirements must be applied to safety helmets

While all care must be taken to prevent fall of material, as a standard requirement, usage of helmet at construction site is mandatory In India, still a large amount of construction work is done manually Women workers who are engaged for various supportive roles at site, including shifting of brick and pan of concrete/mortar etc, many a times find it difficult to use the conventional industrial safety helmet due to contour on the top of the helmet, while carrying the head load There could be an argument that the head load itself is a good head protection which is not true It has been seen through time study that around 30% of the time of the day they are walk with the head load as balance is time is spent during the return or waiting time, including other activities Even while carrying the head load, effectively no head protection is available as in case of any hit by falling objects, the impact will get directly transferred to the head which can cause injuries, or even death

2 General design f helmet

A safety helmet consists of two primary components - shell and harness The shell is a dome-shaped covering for the head and made of hard and durable materials The outer surface of the shell should be smoothly finished

It generally includes:

• a brim (a rim surrounding the shell which may include a rain gutter); or/ and

• a peak (a permanent extension of the shell above the eyes)

The harness is the assembly that provides a means of maintaining the helmet in position on the user's head and absorbing kinetic energy within the shell during an impact It basically includes:

• a cradle (the assembly of the parts of the harness in contact with the head to maintain the helmet in correct wearing position and with a suspension system to absorb shock in case of an impact);

• a headband (the part of the harness surrounding the head of the user above the eyes); and

• a nape strap (an adjustable strap normally integrated with the headband to fit behind the head) It may also include:

• a sweatband (an integral or removable strip on the headband that contacts with the user's forehead for removing sweat);

• a chin strap (a strap under the chin to further secure the helmet to the head of the user); or/and • a protective padding (material contributing to the absorption of kinetic energy during an impact)

3 C nstructi nal features

Cradle: The headband shall be fitted with anti-concussion tapes secured at least at 4 anchoring points and forming a cradle The width of the straps shall be not less than 19 mm The straps shall ensure a clearance of at least 30 mm between the top of the wearer's head and the inside of the top of the helmet crown at the smallest size adjustment of the headband and a wearing height (depth of fit) of not less than 80 mm, at the maximum size adjustment of the headband

Safety helmets have to fulfil certain mandatory requirements of international/ national standards on the constructional features These range from the shell profile, the respective clearances between the shell and the harness at various locations, down to minor details such as the range of adjustable increments of headband and nape strap Examples are:

• Elliptical shell configuration on horizontal sections above the headband

• The vertical clearance between the harness and the inside of the shell shall in general be not less than 25 mm and not more than 50 mm

• The horizontal clearance between the headband and the inside of the shell shall in general be not less than 5 mm and not more than 20 mm

• Provision shall also be made by ventilation gaps between the shell and the headband

• The length of the headband or the nape strap shall be adjustable in increments of not more than 5 mm

4 C mm nly used materials f r manufacturing industrial helmet:

The materials for safety helmets should be of durable quality having considered the effect of aging and subjected environments such as sunlight, humidity, temperature and vibration For those parts coming into contact with the wearer's skin, the materials used should not give rise to irritation

For the shell, materials commonly used are:

• High density polyethylene (HDPE) • Acrylonitrile-butadiene-styrene (ABS) • Polycarbonate (PC)

For the harness, materials commonly used are:

• Nylon • Vinyl For the cushioning elements, material commonly used is: • Sponge foam

To overcome this problem, a small plastic pipe of 200 mm dia and 77 mm long pipe was and attached with the helmet After the same was successful, it was molded as an integral part of the industrial helmet (IS 2925)

Efficient handling[56] and storing of materials is vital to construction industry Though mechanization at construction site has increased enormously, still the industry depends on many manual activities, which include manual load carrying

The most common materials that are being carried manually may vary with the activities and may include a wide range of materials including cement bags, bricks, lumber, ply woods, steel rods, pipes etc Some of these materials that are normally carried on head while handling it across the workplace

Since at construction sites there is always a potential risk of fall of materials / hit by objects it is very important to have an adequate head protection for all workers and hence Safety helmets is considered to be one of the mandatory PPEs

Those who carry head load, find it difficult to use safety helmets as it hinders proper setting of the load on the head Due to this problem they choose not to wear protective headgear which further intensifies the risk of sustaining head injuries

Table Comparison of various standards

Parameter	Bureau f Indian Standards IS 2925	British Standards BS EN397:2012	Australia/NZ AS/NZS 1801:1997
Shock Absorption Rate (KN)	5	5	5
Width of chin strap	>19 mm	>10 mm	-
Electrical resistance	Leakage < 3mA	Resistance up to 440 V	< 3 mA
Internal clearance	> 30 mm	-	30 mm
Horizontal clearance between head band and inside of shell	> 5 mm	-	-

There may be slight variation in the value of the parameters mentioned above and some of the aspects are clearly mentioned For example, Hong Kong Standards (as per the guidance note by Occupational Safety and Health Branch, Labour Department, Oct 2004) is as given in the table 72

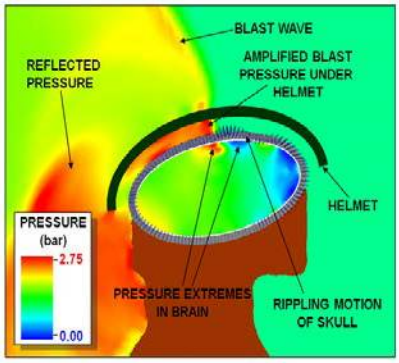
Table Helmet clearances as per Hong Kong standards

Parameters	H ng K ng
Internal clearance (mm)	25 - 50
Horizontal clearance between head band and inside of shell (mm)	5 - 20

5 Engineering challenge: It is necessary to find a solution so that head protection can be worn when head load is being carried The existing standard helmets are not designed for carrying any head loads Firstly, the load cannot sit on a circular smooth surface of a helmet Secondly, specified clearance between the helmet shell and the anti-concussion tapes provided inside the helmet, to be maintained for effective impact dissipation If these internals are not suitably designed, the gap between the shell and the head may get reduced due to head load carrying and thereby nullifying the benefit of helmet usage This may require changes in the existing design of the helmet

Helmet without load carrying facility

Risk Percepti n Survey Exp sure Type			
Activity Type	Material handling	Housekeeping	Waiting time
Excavation	High	Low	Low
Concreting	High	High	High
Structural Work	Low	Low	High
Other Work	High	High	High



Modified helmet with a “seat” for head-load

6 Safe Practices t be f ll wed

• Safety helmets should be free from defects The safety helmets if damaged must be handed over to a responsible person for replacement and discarded The helmets should be marked 'defective'

• Safety helmets should be checked before use All parts of the safety helmet must be operational and undamaged, in particular the correct assembly of the shell and harness In case of any doubt, the manufacturer should be consulted

• Safety helmets should be adjusted to fit the size of the users' heads for adequate protection

• Applying paints, solvents or adhesives may weaken the shells without any visual damage Where names or other markings are to be applied on the safety helmets, advice from the manufacturer should be sought

• Where accessories are being used, they should be fully compatible to the safety helmet worn Use of original manufacturer's accessories is recommended

• Chin straps should be used if a job involves work in windy conditions or needs frequent bending or looking upward /downward

• Safety helmets should be worn in the correct way - In summer time, some workers wear straw hats between safety helmets and their heads in order to reduce the exposure of sunlight Such practice however significantly reduces the protection of safety helmets and should be prohibited

• Safety helmets should not be transferred by throwing as the helmet may accidentally fall on the floor receiving a severe impact that weakening its strength as a result

• Safety helmets should not be used for other purpose than that they are designed, such as seats, receptacles and steps, etc

• After use, the users should place their safety helmets in a safe place that may be provided by the employers or contractors

• The shell and harness should be periodically cleaned to remove dirt, dust, grease or mud, etc The sweatband should also be cleaned regularly or replaced

7 Discussi n

While head load carrying should be avoided for ergonomic and other reasons, it is necessary to ensure that head protection is made available to all workers, irrespective of their work assignments When head load carrying is unavoidable, suitable head protection as described in this chapter, could be implemented