Guidance Notes on Classification and Use of Safety Belts and their Anchorage Systems

Occupational Safety and Health Branch
Labour Department

Safety at work

Occupational Safety & Health Council

This Guidance Notes is prepared by the
Occupational Safety and Health Branch,
Labour Department

First edition November 1998

Second edition January 2005

Third edition October 2018 (This edition has been amended mainly to add chin straps to the safety helmets worn by the workers in the illustrations.)

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Contents

I. Introduction

Fall from height is a primitive hazard when a worker working at height. **The provision of a suitable working platform, safe access and egress, as well as proper fencing to a dangerous place are the primary safety measures** that the local safety regulations have asked for. **The use of safety nets and safety belts are only the last resort** when it is impracticable to provide such platforms, access and egress and safe place of work.

Statutory provisions on the use of safety belts are set out in:

(i) it is impracticable to take adequate steps as required under regulation 38B(1) or (1A) of the Construction Sites (Safety) Regulations (CSSR) for preventing any person on the site from falling from a height of 2 metres or more;

(ii) it is impracticable to provide or ensure the use of safe means of support as required under regulation 38C of the CSSR;

(iii) the use of suspended working platforms under regulation 15 of the Factories and Industrial Undertakings (Suspended Working Platforms) Regulation;

(iv) the use of a receptacle of less than 900 mm deep for carrying persons by a lifting appliance under regulation 18B(1) of the Factories and Industrial Undertakings (Lifting Appliances and Lifting Gear) Regulations; and

(v) working in a confined space for underground pipework under section 9(b) of the Factories and Industrial Undertakings (Confined Spaces) Regulation.

Other examples that require the use of safety belts but are not explicitly stated in the law are :-

(i) working on container tops during cargo or container handling under regulation 10B of the Factories and Industrial Undertakings (Cargo & Container Handling) Regulations;

(ii) working at a dangerous place which requires alternative protection under regulation 24(a) of the Factories and Industrial Undertakings Regulations; and

(iii) working at a dangerous place which requires alternative protection under section 6(1) of the Occupational Safety and Health Regulation.

'Safety belt' referred in this guidance notes is a collective name for the following types of harnesses and belts :-

(i) safety harness or fully body harness;

(ii) semi-harness or chest harness;

(iii) rescue harness;

(iv) work positioning belt, pole safety belt or lineman safety belt; and

(v) general purpose safety belt.

It includes a lanyard. When a safety belt works with an appropriate anchorage system, they form a personal fall arresting system.

'Competent person' mentioned in this guidance notes should be a person who has the knowledge and experience to classify and use safety belt, competent in identification and selection of various types of anchorage systems for the use of the safety belt, and capable to check the apparent defect of the belt and its anchorage system.

'Professional Engineer' mentioned in this guidance notes should be an engineer who is a corporate member of the Hong Kong Institution of Engineers within a relevant discipline or the equivalent.

This guidance notes provides information on some configurations of anchorage systems, the types, uses and specifications of safety belts under several national safety standards. **As safety belts are imported from various countries, suitable safety belts or safety belts required under the law are those safety belts which meet the specifications of national safety standards, such as British Standard (BS), European Standard (EN), American National Standard (ANSI), Japanese Industrial Standard (JIS) or Safety Belt Standard of Japan's Ministry of Labour, the People's Republic of China National Standard (GB) or equivalence. Although BS or EN is quoted in this guidance notes, equivalent national or international standards can also be used.**

II. Selection of Industrial Safety Belts and their Anchorage Systems

(1) Consideration to use safety net

When it is impracticable to provide suitable working platform, safe access and egress, safe place of work and fencing of dangerous place where a worker is required to work at height, consideration of erecting safety net is always the secondary option to protect the worker from injury due to falling hazard. It is recommended that EN 1263-1:2002 Safety nets - Part 1 : Safety requirements, test methods be complied with. In addition, the users should seek the opinions of the safety net manufacturers, so that the best net which suits the type of work to be conducted under the prevailing conditions can be chosen. For the siting of safety net (outrigged), EN 1263-1:2002 & 1263-2:2002 should be complied with. Although BS or EN is quoted in this guidance notes, equivalent national or international standards can also be used.

(2) Planning

During the planning process, primary consideration should be given to methods of avoiding the use of the safety belt and tackling the possibility of provision of safe place of work or adopting of a proper safety net as a secondary option.

The use of safety belt and its anchorage system is only the last resort of fall protection if it is impracticable to erect any safety net. In this case, careful planning for the selection of safety belt and choice of anchorage system should be first drawn up before they are put into use by workers.

Prior to the selection of safety belt and its anchorage system, the contractor or proprietor should develop a plan which identifies the following ingredients:-

(i) the activity to be performed by workers;

(ii) the mobility required;

(iii) the workplace conditions;

(iv) availability of anchorage points for the anchorage system;

(v) the environmental factors; and

(vi) the hazards which may be encountered during the activity and the proposed precautionary measures to be taken.

Such plan should be the basis for selecting rigging, using and unrigging of the personal fall arresting system as well as identifying the training needs for users. The plan should be expanded to address how the work activity is to be carried out by the users.

(3) Selection

Prior to selecting the safety belt and its anchorage, the contractor or proprietor should conduct an assessment of the workplace conditions where the equipment is required. Such assessment should, at least, identify the following :-

(i) presence of hot objects and heat-producing operations;

(ii) chemicals and electrical hazards;

(iii) sharp object, abrasive surfaces, moving equipment, unguarded opening, etc.;

(iv) the paths of intended user movement and all fall hazards along such paths, and;

(v) the type of anchorage best fitted the

workplace and the work activity, and the continuous protection offered by the anchorage system.

During the selection of the anchorage system, particular attention should be drawn to the choice and limitation of connectors, fittings, the self locking devices, shock absorbers, lifelines and supports of the anchorage to be used. The weight of the user including his working tools and equipment, and his mobility during his work will need to be determined before selecting the type of appropriate anchorage system. It is important to note that no matter which type of anchorage or fall-arresting system is selected, such system must be able to offer continuous protection throughout the period when the user is exposed to the risk of fall.

In the case where an eye bolt is chosen as fixed anchorage, or an anchorage line for the guided type fall arrester is selected, the design and construction, the strength and stability of the eye bolt and the anchorage line, their fittings and embedded material, should be designed and checked by a Professional Engineer of the structural discipline. The user shall check the markings and the instructions for use of various components of the anchorage system before he uses them.

It is important that full investigation should be conducted before purchase of safety belts in order to identify the aspects of use and to determine the type of belt likely to suit the type of work and the environmental conditions. In the selection of a safety belt for any particular task, care should be taken to ensure that the equipment gives the user, as far as it is practicable in respect to safety and the maximum degree of comfort, freedom of movement and, in the event of falling, the greatest possible security against injury either-

(i) from impact with the ground or with the surrounding structures; or

(ii) from the belt or harnesses as a result of a suddenly arrested fall.

It is strongly recommended that, when a choice of safety belt is possible, a safety harness incorporating buttock straps, as distinct from a general purpose safety belt, should be used.

III. Use of Equipment

(1) Manufacturer's Instructions

Manufacturer's instructions are supplied with each device indicating the method of fitting, adjustment and use. These instructions should be brought to the attention of user who, before using the equipment, should be made aware of the possible adverse effects of an arrested free fall exceeding their specifications. Moreover, special attention shall be addressed to the guidelines in the inspection before use, maintenance procedures, proper storage techniques in accordance with the manufacturer's recommendations and instructions.

(2) Training

Training shall be provided, even with an experienced workforce. The Training should include:-

(i) how to use the equipment;

(ii) how to estimate and limit the maximum arresting force to an acceptable limit for the system;

(iii) proper methods of wearing, adjusting, and interconnecting of the equipment;

(iv) proper attachment locations on the equipment;

(v) intended function and performance characteristic in respect of each item of equipment;

(vi) proper attachment methods including compatibility of the sizes of snap hooks, D-rings, and other connections to reduce the probability of accidental

disengagement;

(vii) what to do after a fall to protect the user from injury;

(viii) emergency rescue planning and execution to include:-

- methods of rescue,
- rescue personnel availability,
- type of equipment available for rescue and effective means to summons rescue personnel;
- drilling of rescue personnel in rescue and evacuation procedures.

A record of training should be kept to register the course content, the name of the user, the type of equipment, the time and duration of the course. A refresher course should be arranged if the user has been absent for a period of time in using a particular system.

(3) Inspection, Examination and Supervision

In order to ensure that the system is functioning properly, the system should be inspected and examined for detecting and controlling against the use of defective, damaged, improperly maintained equipment and misuse of components. The examination should also focus on the construction of the anchorage and the fitness of safety belts so selected. In addition, the inspection should cover for the absence or illegibility of markings, absence of any element, fit or function, and evidence for defects in or damage to hardware.

The user should make a visual inspection prior to using the equipment to ensure that the equipment is in a serviceable condition. The inspection requirements

should follow those set forth in the manufacturer's instructions. They should include the following:

(i) absence or illegibility of markings;

(ii) absence of any elements affecting the equipment form, fit or function;

(iii) evidence of defects in or damage to hardware elements; and

(iv) evidence of defects in or damage to straps or ropes;

When an inspection reveals defects in, damage to or inadequate maintenance of equipment, the equipment should be permanently removed from service or undergo adequate corrective maintenance before return to service.

To provide the maximum degree of safety to users, all safety belts should be thoroughly examined by a competent person periodically, e.g. at periods not exceeding 12 months and in accordance with the manufacturer's instructions. When the safety belts are not in regular use during any 6-month period, they should be examined before use.

The inspection and examination should also focus on the construction of the anchorage and its connectors. Evidence of alteration, absence of parts, or defect in, damage to or improper function of mechanical devices and connectors should be looked for to ensure that the anchorage is fitted for providing support in case of a fall should occur.

Supervision on the wearing of safety belts, proper attachment of lanyard to connectors, and correct position of snaphooks etc. should also be conducted by a competent person. If abnormal situation and/or mal-practice are observed by the competent person, measures should be taken to stop the using of the fall arresting system, and to provide additional training or retraining to the user.

(4) Safety Notes

When using a safety belt and an anchorage, the following points should be noted:

Anchorage

* Selection and inspection of suitable anchorage points should be the subject of particular care. A suitable anchorage point must be strong enough. Reinforced concrete beam or column, or structural steel beam should be used for anchoring lifelines preferably after their strength have been checked by a Professional Engineer of the structural discipline.

* The anchorage point should be as nearly vertical as possible directly above the place of work to reduce the liability to swing. Where the possibility of swing in the event of a fall is unavoidable, the user should use a second line to limit the swing.

* It is undesirable to use a structural member with sharp edges as an anchorage for a rope lifeline. If it is unavoidable, then the lifeline must be protected by suitable packing.

* Each lifeline should be used by one person only at any particular time.

Before use

* Check that each safety belt should be accompanied with clear instructions for fitting, adjustment for use, markings of the national standard, name of manufacturer, serial number, year and month of manufacture in the product packing. Do not use the safety belt from unknown source and unknown standard.

* Only safety belt which is free from defects should be used. Faulty equipment must be marked 'defective' and

handed over to a competent person for replacement.

* Users should check for correct assembly and function of the safety belt before trusting weight to the equipment.

During use

* All safety belts should be fitted and used in accordance with the manufacturer's instructions.

* Attach the snaphook at higher level than user's waist.

* Fasten the belt firmly around the user's waist.

* Protect the lanyard and the belt from coming into contact with acids and alkalis.

* Keep the lanyard and the belt away from spark, heat or heated structure.

* Never hooking two lanyards together.

* Do not wrap a lanyard around any sharp edge. Forces exerted during a fall could cut the lanyard.

* Do not trail the lanyard. It may result in improper function of the safety catch and abrasion of the lanyard.

* Detach the lanyard from the anchorage point only while the user reaches a safe place.

* If the equipment has been used to arrest a free fall, the equipment should be withdrawn from service and referred for inspection by a competent person.

After use

* Safety equipment should always be carefully handled to ensure parts are not damaged. Metal items such as snap

hook latches are particularly vulnerable.

* After use, the equipment is to be stored away from direct sunlight in a cool, dry place.

* Keep the safety belt on the wall in the shade where it is exposed to the fresh air.

* Ensure that the safety belt will not be deformed or damaged under piled goods.

* Mop up the sweat, dust and oil on the belt or lifeline with a dry cloth.

* Mop up the sand, dust and water on the metal parts, such as buckle and snap hook, and lubricate the movable part.

IV. Classification of Safety Belts

Safety belts can be classified under various national standards as :-

(i) safety harness or full body harness;

(ii) semi-harness or chest harness;

(iii) general purpose safety belt;

(iv) work positioning belt , pole safety belt, or linesman safety belt; and

(v) rescue harness.

These safety belts work with lanyards, fixed anchorages, independent lifelines, or fall arresters. It is important that full investigations be conducted before purchase of safety belts and selection of anchorage system to determine the correct type of appliances that most suit the class of work and the environmental conditions.

(1) Safety Harness or Full Body Harness

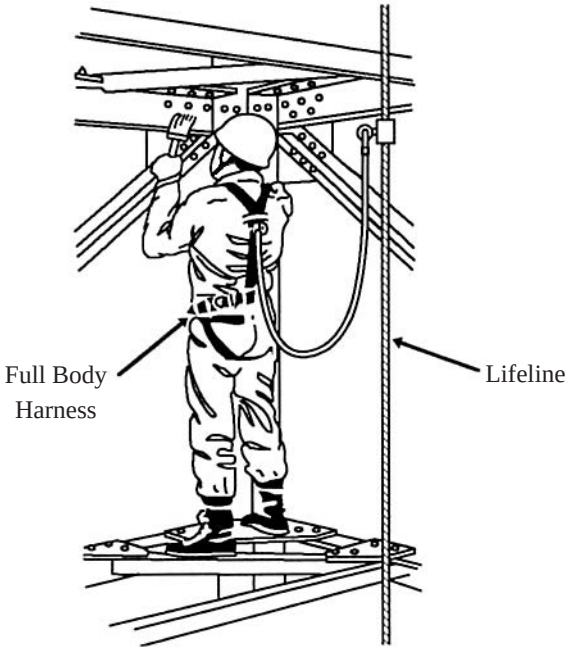


Figure 1 Full Body Harness attached to independent lifeline

General safety harnesses are harnesses incorporating thigh straps and shoulder straps used in conjunction with safety lanyards, for attachment to anchorage points. All straps and any waist belt shall be capable of adjustment to fit the user and mean of adjustment shall be provided. The harness may be incorporated within a garment. The harness should provide support for the body around the lower chest, over the shoulders and around the thighs. The D-ring or other equivalent facility provided for the attachment of the lanyard is located in the upper part of the harness so that angle formed between the spine of a suspended user and the safety lanyard does not exceed a certain angle specified by the national standards. A typical full body harness was shown in Figure 1.

The specifications of full body harnesses can be found in European Standard (EN 361:2002), American National Standard (ANSI A1O.14-1991), Australian Standard (AS/NZS 1891.1:1995), the People's Republic of China National Standard (GB6095-85), and Safety Belt Standard of Japan's Ministry of Labour.

Please see Appendix 1 for the description of this type of harness under various standards.

(2) Semi-Harness or Chest Harness

Chest safety harnesses are used in connection with safety lanyards for attachment to anchorage points. It incorporates a chest belt with shoulder straps, linked together by a strong fabric, either at the front or at the rear, capable of providing support for the body of the user. A 'D' ring or rings is provided on the harness be capable of accepting two safety lanyards .

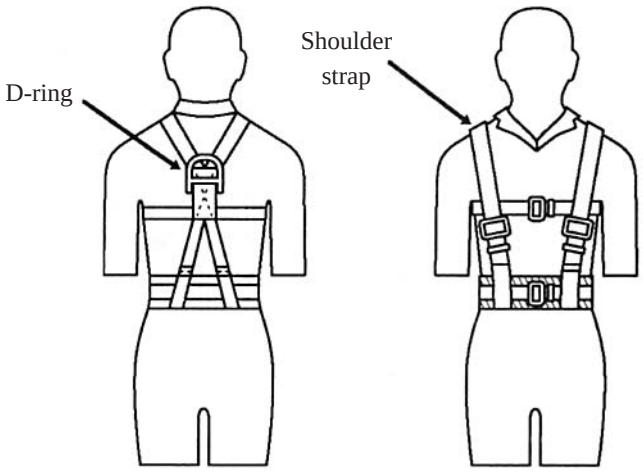


Figure 2 Semi-Harness or Chest Harness

They are intended to limit the drop to a specified distance by the combined effects of the position of the anchorage, the length of the lanyard, the attachment point on the harness and the length of any extensible webbing.

Chest harness was defined in BS1397:1979 which was withdrawn in 1993. At present, specifications on chest harnesses can only be found in American National Standard.

Chest harness is known as semi-harness safety belt in Japan. It meets the test requirement of the Safety Belt Standard of Japan's Ministry of Labour. A typical chest harness is sketched at Figure 2.

Please refer to Appendix 2 for the description of this type of harness under various standards.

(3) General Purpose Safety Belt

General purpose safety belts are belts used in conjunction with safety lanyards incorporating attachment devices, for attachment to anchorage points. It consists of a body belt provided with one or more D-rings for attachment to a safety line or anchorage.

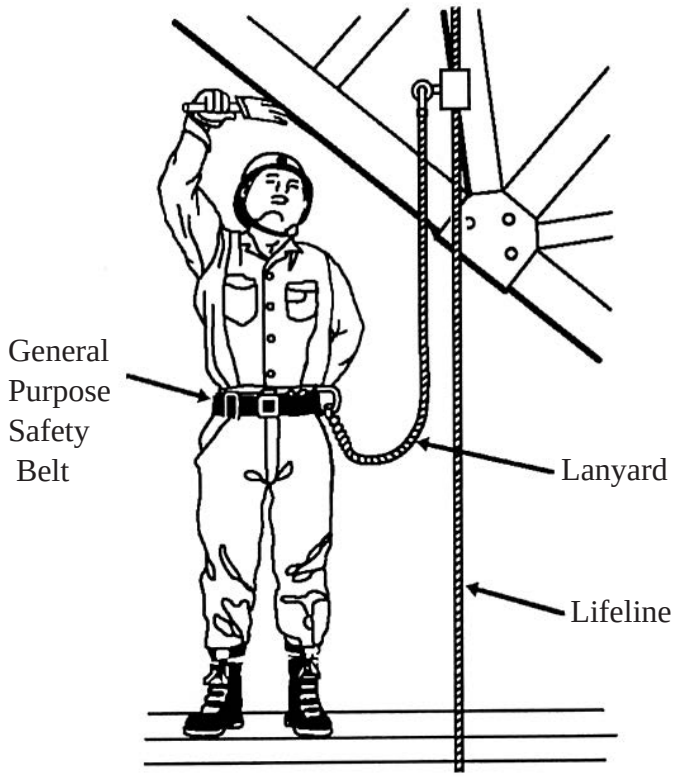


Figure 3 General Purpose Safety Belt

Depending on the specifications of various national standards, the length of lanyard varies from 1.5 m to 3.0 m.

Before 1992, general purpose safety belts were defined in British Standard BS1397:1979. However, the standard was withdrawn in 1993. General purpose safety belt was no longer covered by the BS or EN.

General purpose safety belt was also withdrawn from the AS/NZS 1892.1:1995 which says that there is ample evidence to show that even for relatively short unrestrained falls, the wearing of a belt only can lead to injuries such as broken ribs, or damage to the kidneys, spleen, or lung.

The technical specifications of the general purpose safety belts are contained in either the ANSI, JIS or the Safety Belt Standard of Japan's Ministry of Labour. It is worth to note that after December 31, 1997, body belts was only acceptable by the Occupational Safety and Health Administration of United States of America as part of positioning devices. Figure 3 shows the general shape of such a belt.

Please refer to Appendix 3 for the description of this type of belt under various standards.

(4) Work Positioning Belt, Pole or Linesman Safety Belt

Figure 4 Work Positioning Belt

It consists of a waist strap, a back support, a buckle, two 'D' rings for attachment of a lanyard. Some belts can be equipped with adjustable shoulder and sitting straps. The lanyard accompanies with a rope adjuster to keep its length to a specified dimension.

It is designed for use of linesmen and other required to work on poles or similar structures in conditions where the belts are continuously loaded. Figure 4 shows a general shape of such a belt.

Pole safety belt has different configurations and names under different national standards. The famous ones are those under EN 358:2000, AS/NZS 1891.l:1995, JIS T8165-1987, and GB 6095-85.

Please refer to Appendix 4 for the description of this type of belt under various standards.

(5) Safety Rescue Harness

Safety rescue harnesses are worn by persons working in confined spaces where there is a risk of being overcome by noxious gases or fume, such as oil tanks, sewage manhole and the like, where there is the danger of suffocating by immersion in the material on which they are standing. Rescue harnesses, although primarily intended for withdrawal in the event of an accident, are intended also for a drop or for use with a rescue line where there is no risk of free fall.

It is similar in design to a safety harness and has the D-ring mounted so that the user will remain in an upright position while being lifted with rescue line.

In order to provide easy exit from an opening of less than normal shoulder width, a wrist strap is provided. This provides for one of the user's hands to be automatically raised above his head during rescue.

Safety rescue harnesses were specified in BS 1397:1979 which was withdrawn in 1993. The construction of the harness can be found in AS/NZS 1891.1:1995 which emphasizes the followings :-

(i) the harness shall comply with the requirements of the fall-arrest harness;

(ii) the wrist straps shall enable the user's arms to be raised above the head to facilitate rescue and which shall be readily detachable from the wrist;

(iii) lifting attachment points fitted to the harness in a manner that will retain the user in a head-up position when being lifted; and

(iv) where practicable, the design of the harness should be such that all adjustments can be made with the hand.

V. Anchorage of safety Belt

The requirement of an anchorage is clearly stated in various statutory provisions when a safety belt is required.

Under regulation 15(1) of the Factories and Industrial Undertakings (Suspended Working Platforms) Regulation, the owner of a suspended working platform used for carrying persons shall provide each person using it with a safety belt and an independent lifeline or an anchorage with fittings.

Under regulation 38H(3) of the Construction Sites (Safety) Regulations, safety belts shall not be considered as suitable and adequate unless they are attached continuously to a suitable and secure anchorage.

Under regulation 18B(1) of the Factories and Industrial Undertakings (Lifting Appliances and Lifting Gear) Regulations, where a person is carried in a boatswain's chair or other similar plant or equipment less than 900 mm deep, a suitable safety belt attached to an independent lifeline is securely suspended.

Safety belts are used with their lanyards attached or connected to anchorages to either limit or arrest the fall or restraint the user at work level. Anchorages can be of a fixed anchor, or an independent lifeline, or a fall arresting system.

The selection of the type of anchorages will depend on the nature and location of the task and the type of construction of the building or supporting structure. Prior to selecting an anchorage, an assessment of the workplace conditions should be made by a competent person. The equipment and anchorage point must match the work situation and workplace environmental factors. Reference should be made to EN 795:1997 for requirements and testing of the anchorage point.

(1) Fixed Anchorage

Fixed anchorage is used for direct attachment of the lanyard of the safety belt to prevent fall from height. Fixed anchorage can be a built-in eye bolt, a rigid beam or a strong column of a building. When a fixture is chosen as a fixed anchorage for safety belt, its strength and stability should be assessed by a Professional Engineer of the structural discipline. **It is not recommended to anchor the lanyard of a safety belt to railings or any member of a temporary scaffolding, bamboo scaffolding, or in any section of water, gas and drainage pipes as these structures are not designed to withstand sudden shock load or impact force.**

If eye bolts are embedded into concrete or masonry to serve as fixed anchorages, their strength and stability should be designed and checked by a Professional Engineer of the structural discipline. Reference should be made to BS 7883:1997 for requirements and testing of the fixed anchorage.

Fixed anchorages should be selected and located so that

(i) the lanyard can be attached before the user moves into a position where he would be at risk from a fall;

(ii) the anchorage is of a material strong enough to take the shock load of the arrest of a falling person; due regard should be paid to possible deterioration of anchorages, e.g. that caused by atmospheric conditions;

(iii) the length of fall is restricted so that a person wearing a safety belt will not fall through heights specified by the specifications of the belt;

(iv) unless they are specially designed or are in steelworks, anchorages should not be placed so as to allow a pull on them in an axial direction;

(v) where anchorages are to be installed in an existing building, the types of wall should be checked to ascertain the nature and thickness of the structural materials, and appropriate anchorages should be selected. The installer should follow the manufacturer's fixing instruction;

(vi) fixed anchorage in a wall of building should be tested after it has been constructed under the supervision of a Professional Engineer of the structural discipline. The tested anchorage should be identified and marked to enable the user to locate and use it afterwards; and

(vii) all anchorages should be designed to withstand a minimum pull-out force of 5 KN.

Examples of fixed anchorages are illustrated in the Figure 5-7.

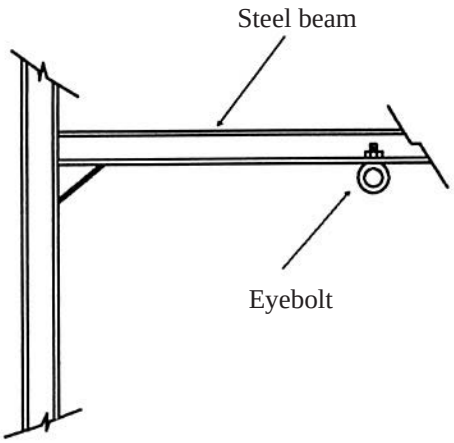


Figure 5 Eyebolt in steel beam

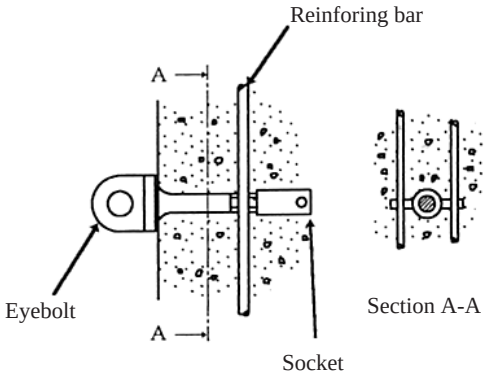


Figure 6 Use of eyebolt and its cast-in concrete slab

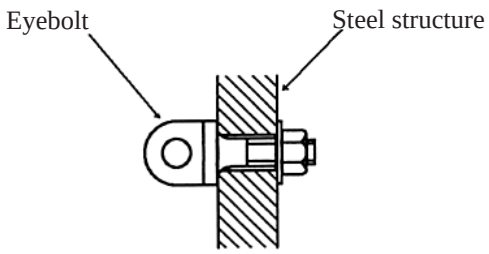


Figure 7 Eyebolt in steel structures

(2) Vertical Independent Lifeline

The use of independent lifeline is a very common safety precaution to prevent a person wearing safety belt from falling from height. Independent lifeline works with a lanyard and a positioning devices such as a rope chuck, rope grab or rope adjuster, the upper end of which is securely attached to a structural anchorage point. Figure 8 shows the use of a vertical independent lifeline.

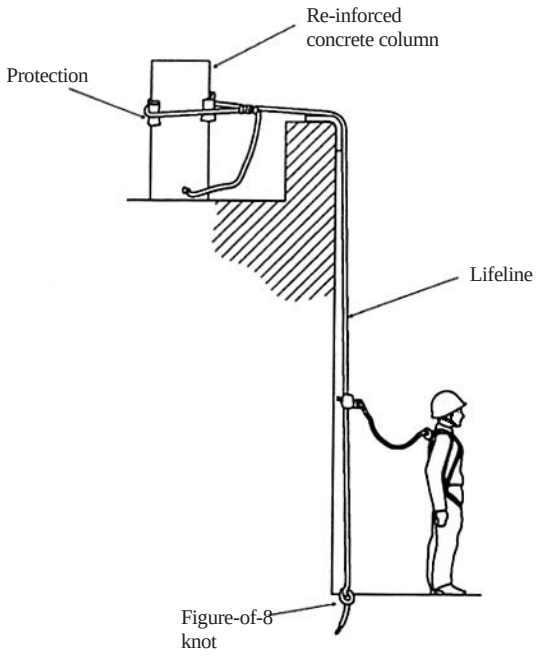


Figure 8 Vertical Independent Lifeline

The lifeline can be of fibre rope or metal cables. The minimum diameter of a fibre rope lifeline is 15.9 mm under ANSI. Metal cables used for lifeline shall have a minimum diameter of 8 mm and a minimum static breaking strength of 25 KN when tested in accordance with EN 12385-1:2002.

Fibre rope and metal cable lifeline shall be fitted with an end stop. On fibre ropes, a figure-of-8 knot would be acceptable. Wire rope shall not be used where electrical hazards are present. Lifeline shall be of a single continuous line. It shall suspend freely from its anchorage point without contact with structure along its length or other objects which would adversely affect its function in conjunction with other components of the safety belt.

It shall be extended to or below the lowest level to which the user is expected to travel. Each worker shall be provided with a separate lifeline and only one person is

allowed to anchor his safety belt to one lifeline. When a lifeline works with a fall arresting device, correct fitting and adjustment shall be carried out as recommended by manufacturer.

The anchorage point for the lifeline shall be structural safe. Reinforced concrete beam or column, structural steel member are suitable anchorage points for securing the lifeline preferably after their strength have been checked by Professional Engineer of the structural discipline.

It is not recommended to fix the upper end of a lifeline to any temporary work such as scaffolding member, window frame, roof pipes etc. Protection against sharp edge of steel beam and wall shall be considered where the lifeline passes over such edges during its fixing to the structure.

(3) Horizontal Lifeline (Guide rope)

To enable a workman to walk along beams, steel girders or other similar dangerous structure at height in construction sites, shipyards, mines etc., horizontal lifeline with a rope stretcher and a safety belt form another fall protection system. The lifeline is mounted between two supports to waist level. According to American National Standard ANSI Z359.1:1992, it is tighten up to a tensile force of 0.75 - 1.0 KN for the anchorage of a lanyard and is capable of supporting a static load of at least 2280 kg per employee using the lifeline, applied anywhere along the lifeline.

Anchorage for horizontal lifeline shall be of reinforced concrete columns or structural steel member, and shall be of a strength capable of sustaining the above loads. The angle of sag, and pre-tensioning of the lifeline shall be considered when installing the anchorages and the horizontal lifeline system. The installation should be erected in accordance with the manufacturer's specifications and monitored and checked under the supervision of a competent person.

It is important to note that horizontal lifeline should be used by one person at one time between supports. Figure 9 shows a horizontal lifeline.

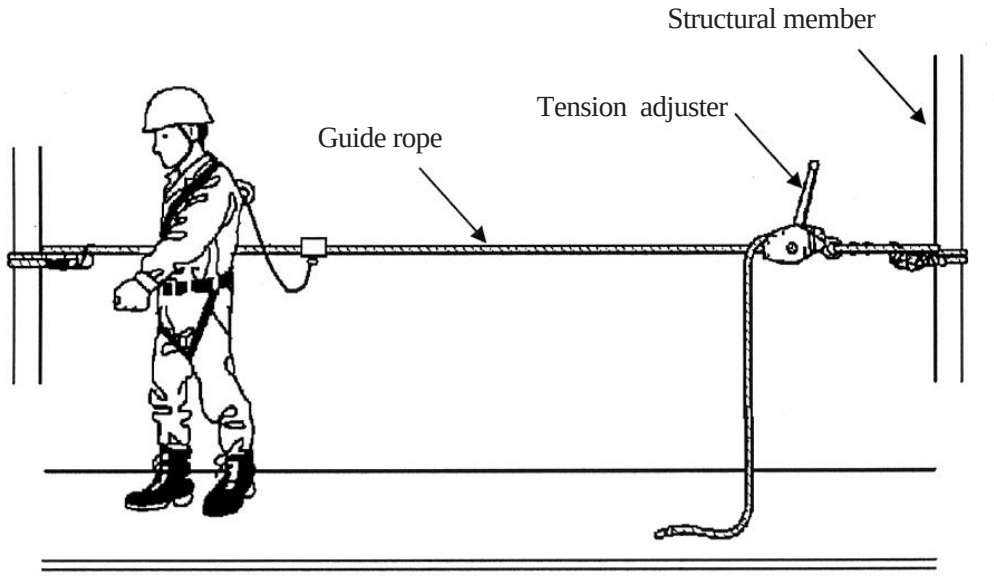


Figure 9 Horizontal Lifeline

(4) Fall Arrester

Mechanical devices have been developed for use with safety belts that will extend the working distance of the users from structural anchorage points to work level. Fall arresters become the major components of a fall arresting system. They work with lifelines, guide rails or energy absorbers to protect the user from body injury during a fall.

Under ANSI, AS/NZS and EN, fall arresters are recommended to be used in connection with safety harnesses, but not for general purpose safety belts.

Two types of fall arresters are commonly used : retractable type fall arrester, guided type fall arresters either on a rigid anchorage line or on a flexible anchorage line.

A fall arrester and its accessories shall only be used if the system complies with the requirements of a national standard and the specifications issued by manufacturer. The selection of the type of fall arrester will depend on the nature and location of the task and the structural environment. The erection must be conducted under the supervision of a competent person who should inspect the system before each use.

The user of a fall arresting system should follow all manufacturer's instructions regarding the inspection, maintenance and storage of the equipment. Suitable training should be provided to each user before he is allowed to use the system.

(a) Retractable Fall Arrester

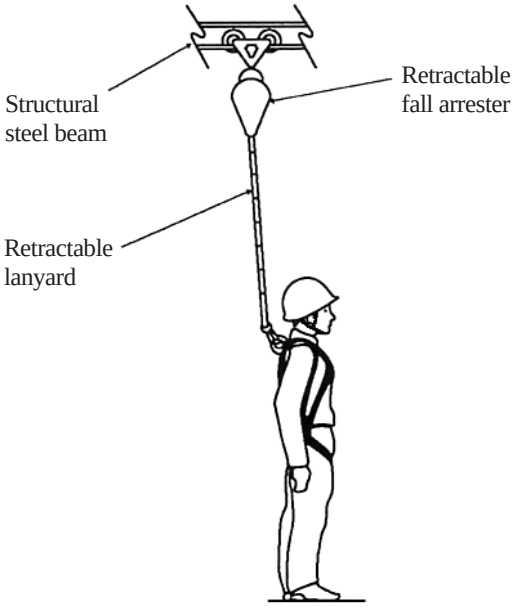


Figure 10 Retractable Fall Arrester

The retractable fall arrester system consists of an anchorage point, a retractable type fall arrester with a retractable lanyard such as an inertia reel, and a safety belt which is a safety harness required under BSEN or ANSI. The arrester has a self-locking function and an automatic tensioning and return facility for the lanyard. It may comprise of a drum around which the retractable lanyard reels or unreels, or a return pulley with counter weights.

Because a retractable type fall arrester is designed and tested so as to be a complete connecting system for fall arresting purposes, an energy absorber shall not be attached to the connector of the retractable lanyard.

The system requires a reliable anchorage point and a necessary minimum clearance below the user which can be estimated from the arrest distance. The anchorage point should be either a trolley on a steel I-beam, or hooked to a shackle which is secured to a reinforced concrete beam or column by means of wire rope after the strength of the supporting structures has been checked by Professional Engineer of the structural discipline. Railings of temporary scaffoldings, water or gas pipes on the roof of a building, window frames, or any drainage system should not be used for anchoring the arrester.

The performance and test requirements, and locking condition are defined in either EN 360:2002 or ANSI Z359.1-1992. A sketch of the system is at Figure 10.

(b) Guided type fall arrester on a rigid anchorage line

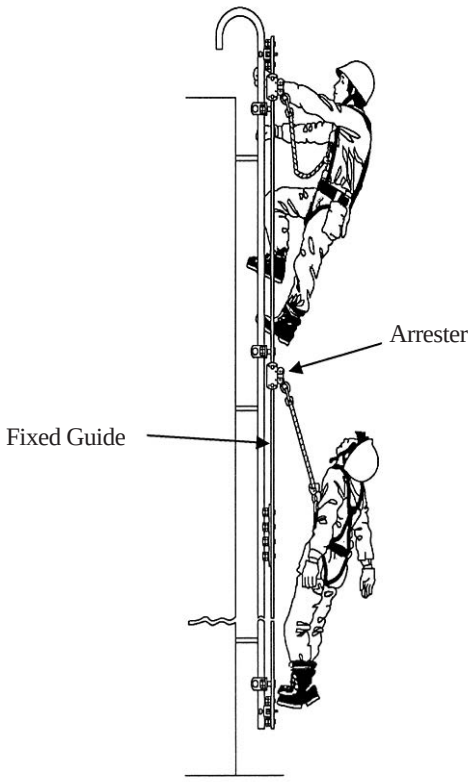


Figure 11 Guided Type Fall Arrester

It is an arrester with a self-locking function and a guide facility. The arrester works on a rigid anchorage line and a lanyard. An energy dissipating element may be incorporated in the guided type fall arrester.

It travels along an anchorage line, accompanies the user without requiring manual adjustment during upward or downward changes of position and locks automatically on the anchorage line when a fall occurs.

The anchorage line may be a rail or a wire rope and is secured to a structure in such way that lateral movements of the line are limited.

The arrester shall meet the performance, dynamic and static test requirements under EN 360:2002 or ANSI Z359.1-1992, both of which recommend to work with full body harness. In Japan, the arrester works with a general purpose safety belt. Figure 11 shows the system.

(c) Guided type fall arrester on a flexible anchorage line

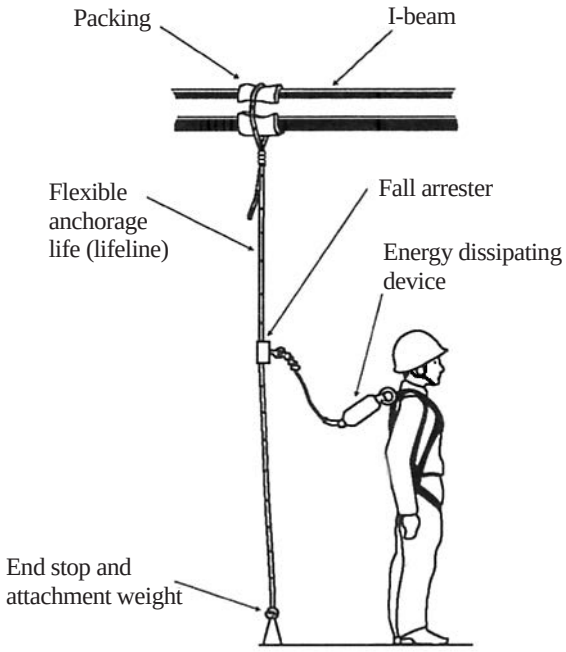


Figure 12 Flexible anchorage line

This system consists of a flexible anchorage line, a self-locking guided type fall arrester which is attached to the flexible anchorage line and a lanyard. The arrester travels along the anchorage line, accompanies the user without requiring manual adjustment during upward or downward changes of position and locks automatically on the anchorage line when a fall occurs. The anchorage line may be a synthetic fibre rope or a wire rope and is secured to an upper anchorage point. An energy dissipating

element may be incorporated in the guided type fall arrester, in the lanyard or in the anchorage line. Figure 12 shows the system.

In EN, AS/NZS and ANSI standard, this system works with full body harness only. However, a general purpose safety belt may connect to this arrangement if recommended by Japanese manufacturers who sell fall arresting device. In view of the possibility of injuries to the users, the use of general purpose safety belt with the fall arrester is not recommended.

Flexible anchorage line shall be secured to an upper anchorage point and shall be either fitted with an end stop to prevent the arrester from running off the anchorage line. If a guided type fall arrester has a manual locking feature, the lower end of the flexible anchorage line shall be secured, e.g. by an attached lower termination or an attachment weight. Flexible anchorage wire ropes shall have an attached lower termination or an attachment weight in every case.

The requirements, performance and test procedure are outlined in either EN 360:2002 or ANSI Z359.1-1992.

VI. Practical Examples of using Safety Belts and their Anchorage

(1) Example of using Fixed Anchorage

Photo 1 - windows cleaning work using full-body harness and fixed anchorage

Photo 2 - an eye-bolt as the fixed anchorage

(2) Vertical Independent Lifeline

Photo 3 - external window panel installation work using rope chuck and vertical independent lifeline

Photo 4 - bamboo scaffolding erection / dismantling using rope chuck and vertical independent lifeline

Photo 5 - metal scaffolding erection / dismantling using rope chuck and vertical independent lifeline

(3) Guide Rope

Photo 6 - e1ectrical t o w e r assembling work using guide rope, rope grab and rope adjuster

Photo 7 - the rope tension adjuster used in tensioning the guide rope

(4) Retractable Fall Arrester

Photo 8 - inertia reel (retractable fa11 arrester) used in container handling work

(5) Guided Type Fall Arrester on Rigid Anchorage Line

Photo 9 - guided type fall arrester on a rigid anchorage line used in power generation plant

Appendix 1

Safety Harness or Full Body Harness

(a) Full Body Harness under EN 361:2002

Under the European Standard, EN 361:2002, it is a body support for fall arrest purpose, i.e. a component of a fall arrest system which is to support the whole body of a person and to restrain the user during a fall and after the arrest of a fall. It consists of shoulder strap, sit strap, thigh strap and back support for work positioning. The width of sit strap and shoulder strap shall be at least 40mm. Straps shall not migrate from position and shall not loosen by themselves. The fall arrest attachment element such as D-ring, may be placed so as to lie, during the use of the full body harness, in front of the chest, at the center of gravity, at both shoulders, and/or at the back of the user. Figure 13 shows a full body harness under this standard.

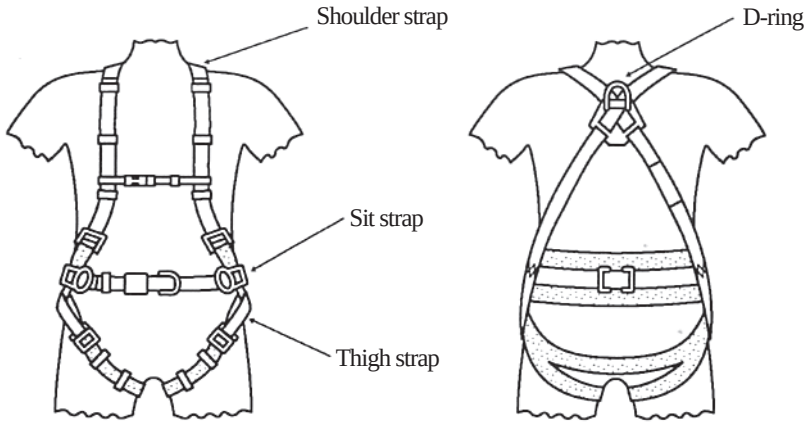


Figure 13 A Full Body Harness (EN)

In the standard, it specifies that during the drop test, the torso dummy shall be arrested in a head-up position and the angle between the longitudinal axis of the dorsal plane of the torso dummy and the vertical shall be a maximum of 50 degree.

When it works with a lanyard, the length of lanyard, including energy absorber, if applicable, and termination, e.g. connectors or eyes, shall not exceed 2 metres.

(b) Safety Harness under AS/NZS 1891.1:1995

Under Australian/New Zealand Standard, AS/NZS 1891.1:1995, safety harness under this standard is known as fall-arrest harness which comprises of a single assembly of interconnected shoulder and leg straps. The harness may incorporate a body belt or other horizontal straps designed to provide a bearing area on the body to prevent the user falling out of the harness during a fall. The shoulder straps is positioned so that, when the person is suspended, they shall not transmit undue pressure to the area of the body under the armpits.

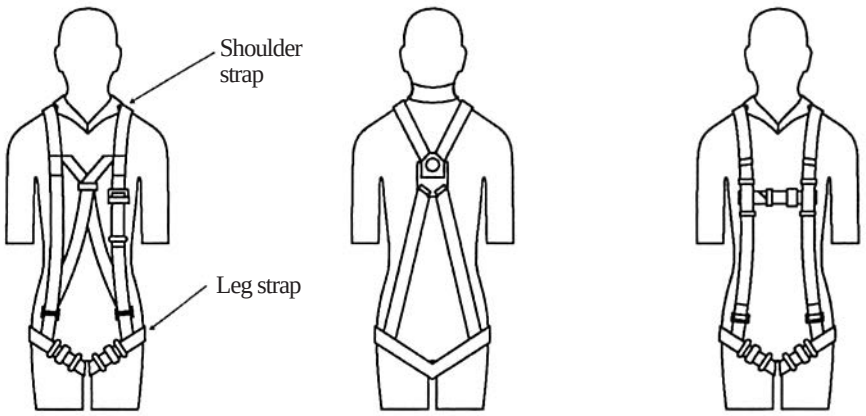


Figure 14 Full Body Harness without horizontal straps (AS/NZS)

The harness incorporates attachment hardware for attachment to the lanyard assembly. The hardware locates in such a position that the user, whether conscious or unconscious, is retained in the head-up position in the event of fall. A typical fall-arrest harness is illustrated in Figure 14 and Figure 15.

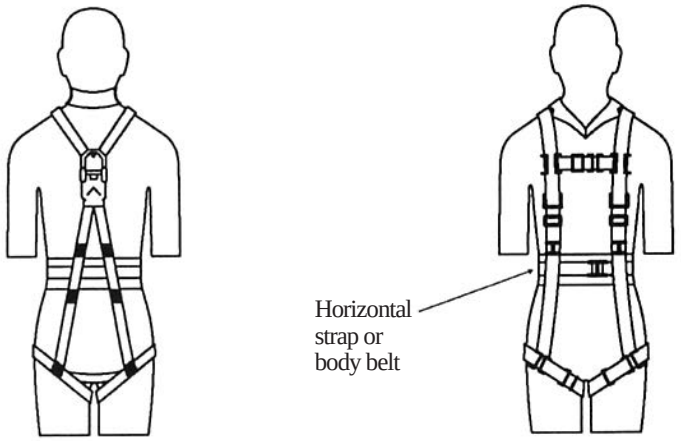


Figure 15 Full Body Harness with horizontal strap (AS/NZS)

(c) Safety Harness under ANSI A10.14-1991

Under the American National Standard, ANSI A10.14-1991, it is called body harness. It consists of straps that are secured about a user in a manner that distributes the arresting forces over at least the thighs, shoulders and pelvis, with provisions for attaching a lanyard, lifeline or deceleration device.

The waist strap shall be a minimum of 44 mm nominal width and strap ends shall be finished so as to prevent fraying. Figure 16 shows a harness under this standard.

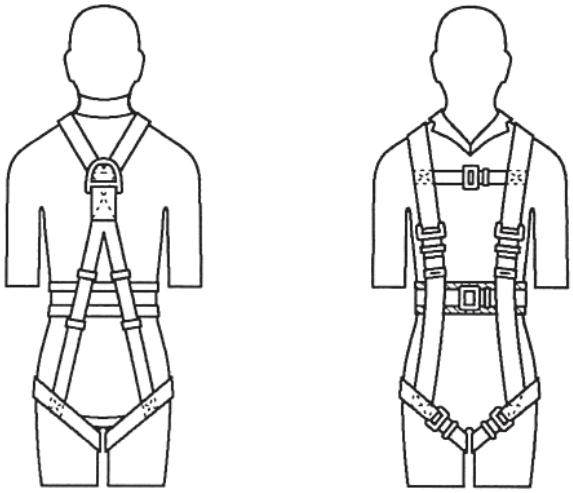


Figure 16 Full Body Harness (ANSI)

The body harness is used for restraint and/or fall arrest and where vertical free fall hazards exist, to reduce the probability of falls or known as Type I equipment. During a performance test, the angle at rest measured between the torso vertical center line and the vertical shall not exceed 30 degrees after the test torso comes to rest.

When more than one attachment element exists on a harness, such as D-rings, the purpose and limitations of each element shall be designated by the manufacturer.

The harness shall carry the following information, either indelibly print or stamp, onto the device or a tag securely attached on the harness : -

(i) Manufacturer Name or Trade Mark

(ii) Model Number

(iii) Date of Manufacture

(d) Safety Harness under GB 6059-85

Under the People's Republic of China National Standard, GB 6095-85, there are three types of full body harnesses. They have similar shape of shoulder straps but with different forms of lanyards and thing/leg straps. The width of the waist strap shall be between 40mm and 50mm.

The shapes of these full body harnesses are shown in Figure 17, 18 & 19.

The best performance, packing details and instructions for use are specified in the standard.

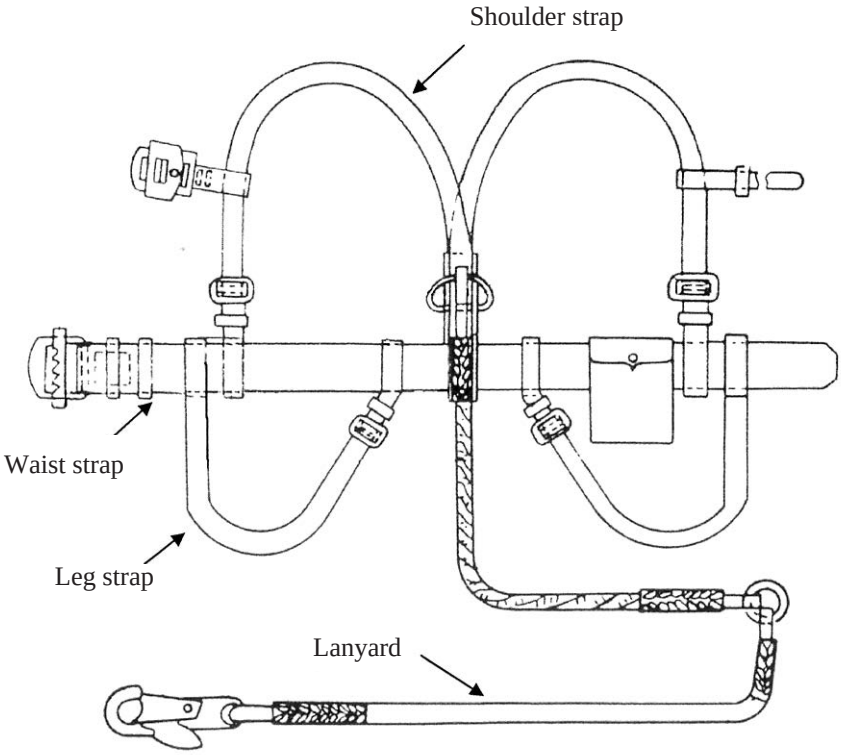


Figure 17 T_2XB Full Body Harness (GB)

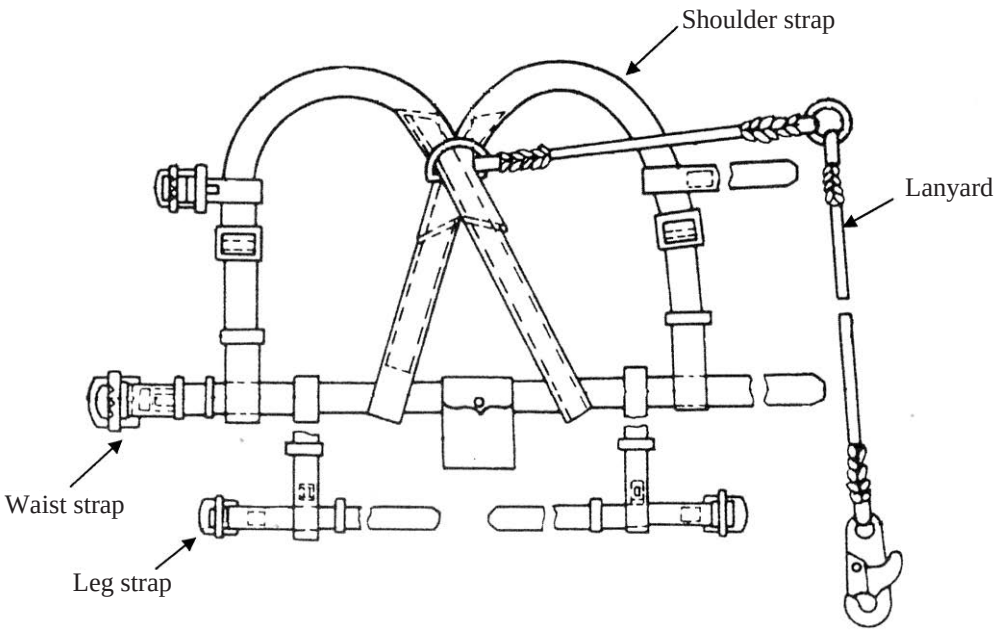


Figure 18 T_3XB Full Body Harness (GB)

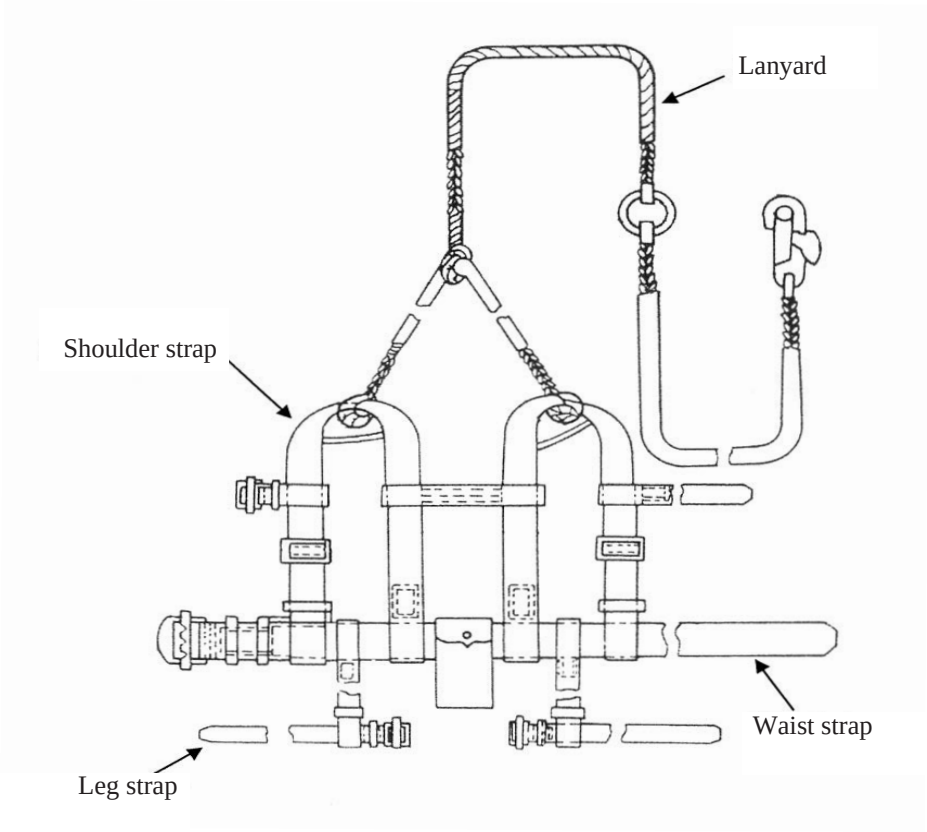


Figure 19 T_4XB Full Body Harness (GB)

(e) Harness Safety Belts from Japan

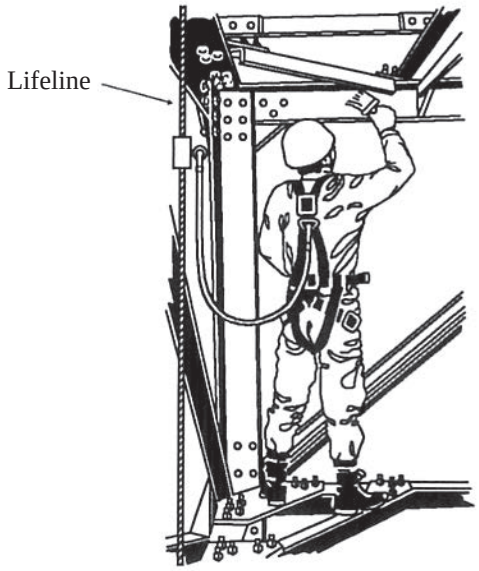


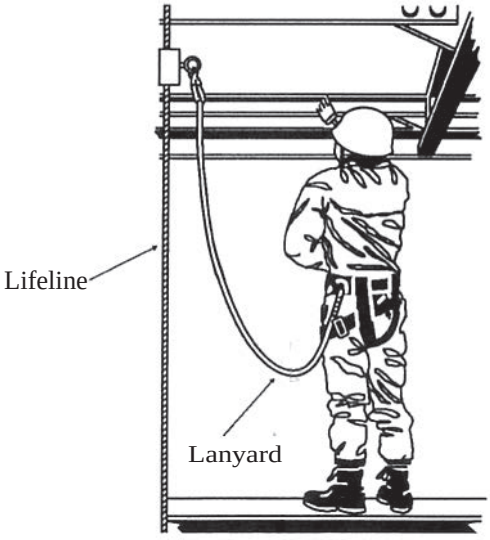
Figure 20 Full Body Harness (Japan)

In Japan, safety harness is called harness safety belt. Its design and mechanical strength have to conform to the test requirements of the Safety Belt Standard of Japan's Ministry of Labour. The harness is designed to protect worker working at height against free fall. The drop impact, should a fall occur, is minimised by distributing the force over the shoulder, chest, back, waist, thighs and buttocks of the body. The typical width of nylon belt is 50 mm, with a lanyard which is 14 mm in diameter and 2.0 m long. The lanyard can be connected to the D-ring on the back or the waist. Figure 20 shows a typical harness from Japan.

Appendix 2

Semi-Harness or Chest Harness

(a) Chest Harness from Japan



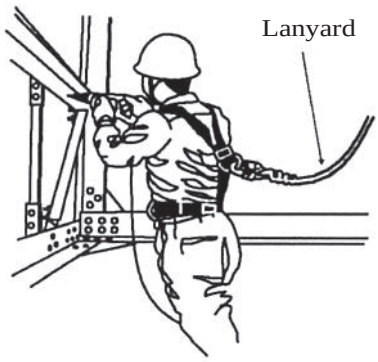


Figure 21 Semi-Harness Figure 22 Chest Harness

In Japan, the chest harness is called semi-harness safety belt. There are two types of semi-harness safety belts : semi-harness safety belt with thigh straps and semi-harness safety belt with shoulder strap. Its mechanical property conforms to the test requirements of the Safety Belt Standard of Japan's Ministry of Labour.

Semi-harness safety belt with thigh straps is suitable to use at construction sites, tanks and manholes. Figure 21 shows a harness with thigh strap.

The body is supported mainly by the thighs which permits working at ease. The shock or impact of a fall, should it occur, can be distributed over the waist, thighs and buttock to minimize the effects against this limited area of the body. The waist strap is 50 mm wide, with a lanyard which is 2.0 m long.

Semi-harness safety belt with shoulder strap is for use in work at construction sites, shipyards, mines and steel construction work. The load is distributed to the upper half of the worker's body such as shoulder, back and waist, so the user can work at ease. The waist strap is also 50 mm wide with a 2.0 m lanyard. Figure 22 shows the shape of such a harness.

(b) Chest Harness under ANSI A10.14-1991

Under the American National Standard, chest harness is an equipment which is used for restraint but is not for use where any vertical free fall hazard exists or known as Type II equipment. It consists of straps secured only around the chest with shoulder straps to assure proper chest strap positioning. The waist strap should be at least 44 mm width. When it works with a lanyard and an anchor, it is to keep the user at the work level or limit any free fall to a maximum of 0.6 m from the work level. The harness shall be marked 'Type II', either indelibly printed or stamped onto the device or a securely attached tag.

(c) Scaffolding Safety Belt under GB 6095-85

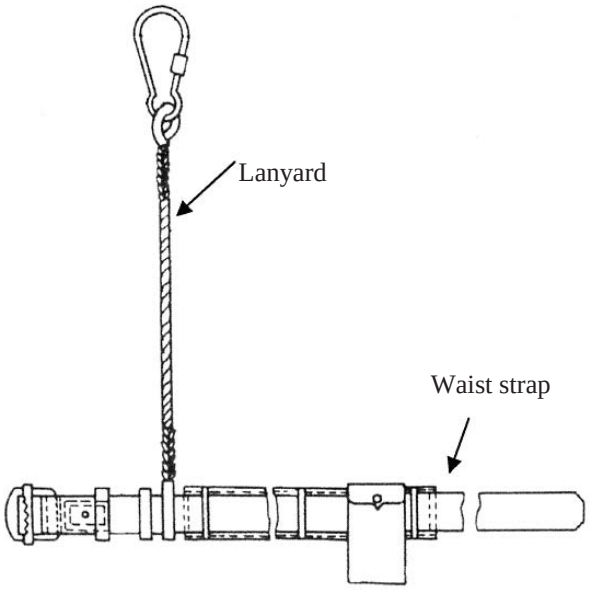


Figure 23 J_1XY Scaffolding Safety Belt (GB)

There are two types of scaffolding safety belts under the People's Republic of China National Standard GB 6095-85. They have similar waist straps but with different forms of lanyards. The shapes of these two types of safety belts are shown in Figures 23 & 24.

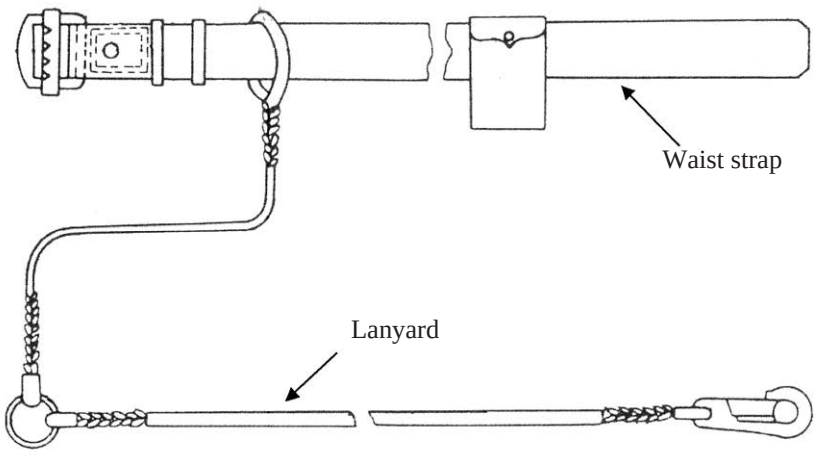


Figure 24 J_2XY Scaffolding Safety Belt (GB)

Appendix 3

General Purpose Safety Belt

(a) 'Body Belt' under ANSI A10.14-1991

The general purpose safety belt is called 'Body Belt' in the American National Standard for construction and demolition. It composes of a 44 mm strap that both secures around the waist and attaches to a lanyard, lifeline or deceleration device.

'Body Belt' is used for restraint and/or fall arrest where vertical free fall hazards exists, and reduce the probability of falls. When it works with a lanyard, it shall limit the fall to 1.5 m or less.

It is worthy to note that after December 31, 1997, 'Body Belts' is acceptable by the OSHA as part of positioning devices as studies have proven that 'Body Belts' can cause back injury, internal injuries and create the possibility of the user falling out of the belt.

(b) Industrial Safety Belt under JIS M7624

Under the Japanese Industrial Standard (JIS), the safety belts for miners are safety belts of body-bind type used to prevent a worker from a free fall while he is performing works on a height or sharp slope such as mining, quarrying or civil engineering works. It consists of a body-bind belt of not less than 50 mm in width, a buckle with anti-corrosion treatment, a lanyard of less than 1.5 m excluding the hook, one or two D-rings, a hook, a carbines or a grip. The belt can carry an auxiliary belt which is more than 75 mm in width for reinforcing twisted or chinked portions of the body-bind belt coupled with it.

The belt can be fitted with a longer lanyard. Even when it is necessary to use a longer lanyard due to the nature

of work, the length shall be limited to 2.5m. Under this standard, the belt without auxiliary belt is classified as Class 1A, and the belt fitted with an auxiliary belt is called Class 2A. Both safety belts also meet the requirements of the Safety Belt Standard of Japan's Ministry of Labour and are commonly used in the construction industry in Hong Kong. Figure 25 and Figure 26 shows the configurations of Class 1A & 2A belts.

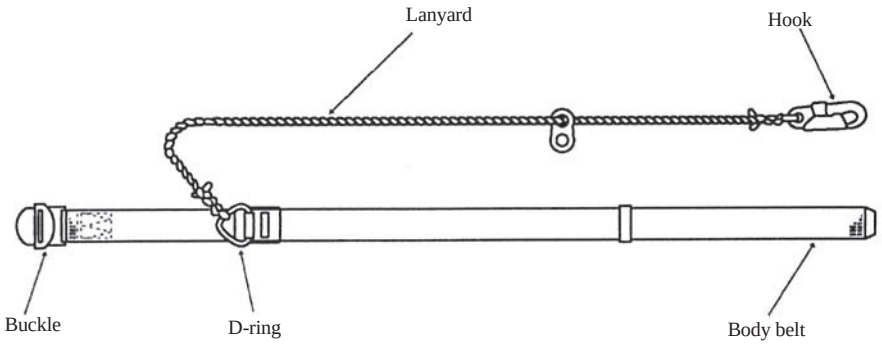


Figure 25 Class 1A General Purpose Safety Belt (JIS)

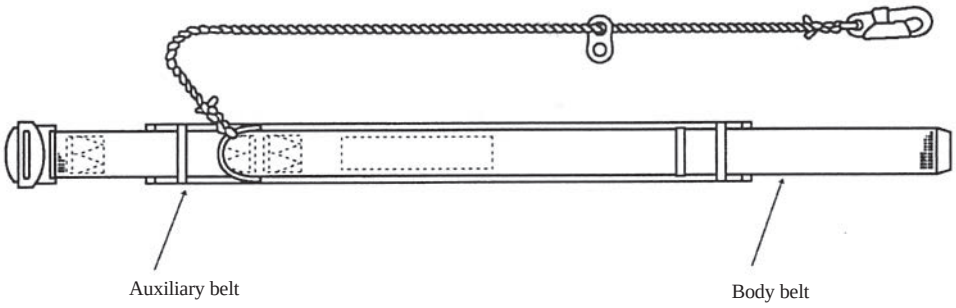


Figure 26 Class 2A General Purpose Safety Belt (JIS)

Appendix 4

Work Positioning Belt, Pole or Linesman Safety Belt

(a) Work Positioning Belt under EN 358:2000

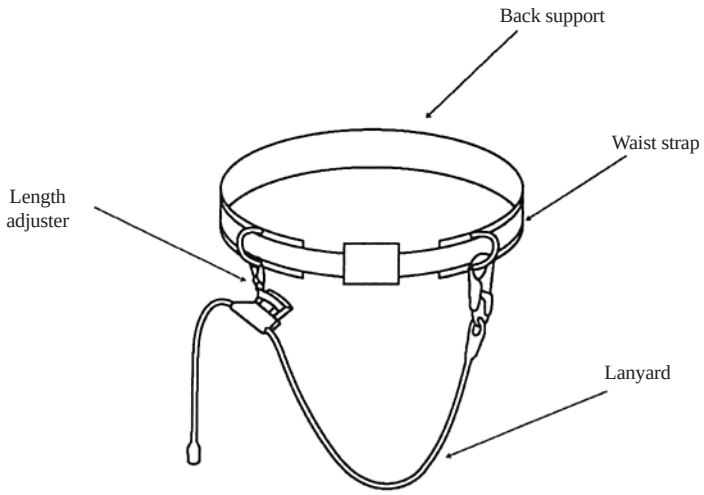


Figure 27 Work Positioning Belt (EN)

The design, construction, static and dynamic strength and test of a work positioning belt are defined in this European Standard, i.e. EN 358:2000. The waist strap shall be not less than 43 mm wide and the back support not less than 100 mm. It can be equipped with adjustable shoulder and sitting straps. The lanyard shall be equipped with a length adjuster and shall have a maximum length of 2 m under all normal circumstances. When purchase, clear instructions for fitting, adjustment and use are supplied with each belt. Markings with the number of standards, name of manufacturer, serial number, year and month of manufacture are available in the product packing. Figure 27 is a work positioning belt.

(b) Pole Safety Belt under AS/NZS 1891.1:1995

Under this Australian/New Zealand Standard, work positioning belt is replaced by work positioning harness. The work positioning harness is used in conjunction with a restraint line or pole strap only in situations where there is not a risk of free fall. Where there is a risk of a fall, the harness is used in such a way that under working conditions the pole strap or restraint line is always in tension. The working positioning harness comprises an assembly of an adjustable waist strap or body belt connected to a pair of leg loops by means of front straps, and other straps such as a sitting strap which passes under the pelvis so as to support the lower part of the body in a sitting position, e.g. a 'sit' harness. The harness may include back support or shoulder strap, which may be incorporated within a garment. The harness may be used with a short lanyard in such a way that a free fall of greater than 600mm is not possible.

(c) Linemen's Safety Belt under JIS T8165-1987

The design, construction and configuration of a linemen's safety belt are described under Safety Belt Standard by Japan's Ministry of Labour and Japanese Industrial Standard (JIS). There are two types of linemen's safety belts, i.e. single-line suspension and U-shaped suspension. Single-line suspension allows the snaphook to anchor onto the lanyard while U-shaped suspension requires the snaphook to clamp onto the D-ring of the belt. The length of lanyard varies from 2.0 m to 3.5 m. The waist strap is 40 - 50 mm wide and the back support shall not be less than 75 mm in width. The thickness of the strap is not less than 2 mm. Each safety belt is required to be marked on its conspicuous portion the manufacturer's name, the year and month of manufacture. Figure 26 illustrated the two types of belts.

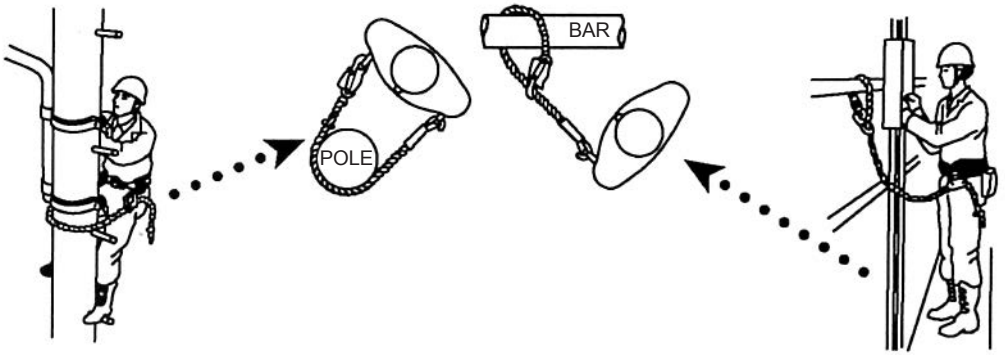


Figure 28 Linemen's Safety Belt (JIS)

(d) Pole Safety Belt under GB 6095-85

Under the People's Republic of China National Standard GB 6095-85, there are a number of pole safety belts including general pole safety belts, electrician safety belts and signalman safety belts. Each of these safety belts works with a pole strap wrapping around a pole to support the weight of the worker. They have different forms of waist straps and lanyards. In addition to a waist strap, only one of these safety belt types (DW_1F Electrician Safety Belt) is provided with a chest strap. Its configuration is shown in Figure 29. An example of pole safety belts without chest strap (DxW_2Y Signalman Safety Belt) is illustrated in Figure 30.

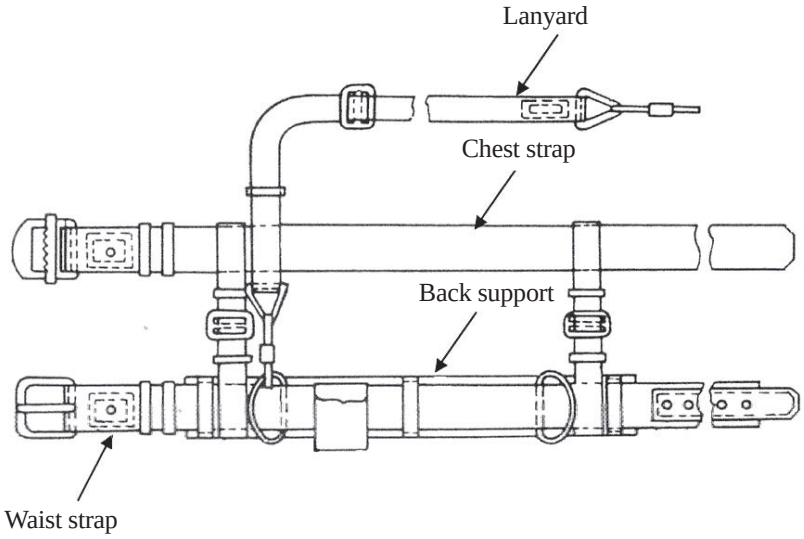


Figure 29 DW_1F Electrician Safety Belt (GB)

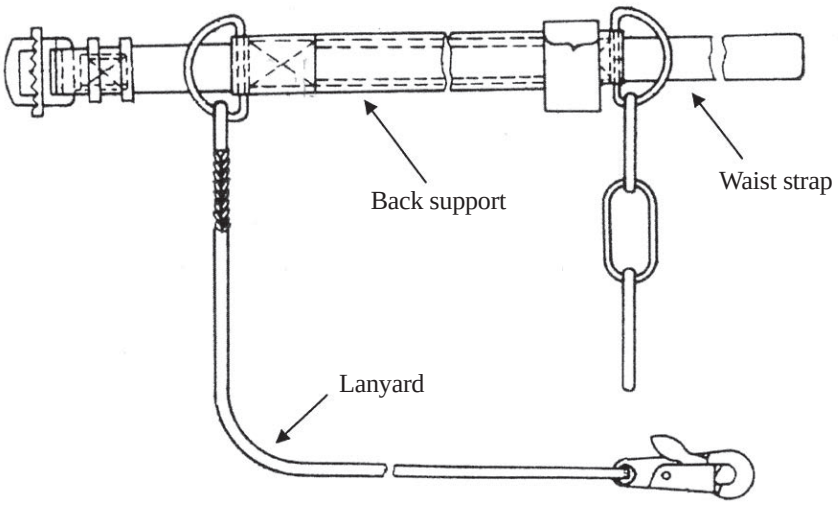


Figure 30 DxW_2Y Signalman Safety Belt (GB)

List of Reference

1. European Standard, EN 353-1 and EN 353-2: 2002
   Personal protective equipment against falls from a height : guided type fall arresters.

   Part 1. Guided type fall arresters including a rigid anchor line

   Part 2. Guided type fall arresters including a flexible anchor line

2. European Standard, EN 360 : 2002
   Personal protective equipment against falls from a height - retractable type fall arresters.

3. European Standard, EN 361 : 2002
   Personal protective equipment against falls from a height - full body harnesses.

4. European Standard, EN 795 : 1997
   Protection against falls from a height - Anchor devices - Requirements and testing

5. British Standard, BS 1397 : 1979
   Specification for industrial safety belts, harnesses and safety lanyards.
   (Note: this standard was superceded by EN 354, 355, 358, 359, 361, 362, 363, 364 & 365)

6. British Standard, BS 5845 : 1991
   Permanent anchors for industrial safety belts and harnesses
   (Note: this standard was superceded by EN 795 : 1997)

7. British Standard, BS 6858 : 1987
   Specification for manually operated positioning devices and associated anchorage lines for use with industrial safety belts and harnesses.

8. British Standard, BS 7883 : 1997
   Code of practice for Application and use of anchor devices conforming to EN 795

9. American National Standard, ANSI Z359.1 : 1992
   Safety requirements for personal fall arrest systems, subsystems and components.

10. American National Standard, ANSI A10.14 : 1991
   Construction and demolition operations --- Requirements for safety belts, harnesses, lanyards and lifelines for construction and demolition use

11. Japanese Industrial Standard, JIS M7624 : 1994
   Safety belts for miners

12. Japanese Industrial Standard, JIS T8165 : 1987
   Safety belts for line-men

13. Ministry of Labour Notification No. 67,
   Safety Belt Standard of Japan's Ministry of Labour, September 1975.

14. Australian/New Zealand Standard, AS/NZS1891.1 : 1995
   Industrial fall arrest system and device.
   Part I : Safety belt and harness

15. German Standard, DIN 7470
   Protective equipment against fall --- safety belts, safety requirements, testing.

16. 中華人民共和國、國家標準，GB6095-85
   安全帶

Enquiries

If you wish to enquire about this Guidance Notes or require advice on occupational safety and health matters, please contact the Occupational Safety and Health Branch of the Labour Department through:

Telephone : 2559 2297 (auto-recording service available outside office hours)
Fax : 2915 1410
E-mail : enquiry@labour.gov.hk

Information on the services offered by the Labour Department and on major labour legislation is also available on our website at http://www.labour.gov.hk.

For details on the services offered by the Occupational Safety and Health Council, please call 2739 9000.

Complaints

If you have any complaints about unsafe workplaces and work practice, please call the Labour Department's occupational safety and health complaint hotline at 2542 2172. All complaints will be treated in the strictest confidence.

Published by the Occupational Safety and Health Branch, Labour Department
Printed by the Government Logistics Department

10/2018-3-B78