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Cranes — Training of slingers and signallers

Appareils de levage à charge suspendue — Formation des élingueurs et des signaleurs

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Foreword

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ISO 23853 was prepared by Technical Committee ISO/TC 96, *Cranes*, Subcommittee SC 5, *Use, operation and maintenance*.

Cranes — Training of slingers and signallers

1 Scope

This International Standard specifies the minimum training to be given to trainee crane slingers and crane signallers to develop the basic slinging skills and to impart the requisite knowledge for competency required for slingers and signallers as defined in ISO 15513.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 15513, *Cranes — Competency requirements for crane drivers (operators), slingers, signallers and assessors*

3 Prerequisite aptitudes and knowledge

Slingers and signallers shall be at least 18 years old. They shall be medically fit for the profession. The following factors should be considered:

a) physical requirements

- adequate sight and hearing to carry out the work correctly;
- no dizziness when slinging and signalling at height;
- no disqualifying ailment or infirmity;
- no drug or alcohol-related problem.

b) mental aptitude

- behaviour under stress;
- mental balance;
- sense of responsibility.

Tests may be used to determine the aptitude of the trainee (manual skill, common sense, self-control, composure, accuracy, motion coordination and reflexes).

Trainees shall be able to read and understand the language in which the documents and information labels of the sling gear are written.

4 Training objectives

The objectives of slinger/signaller training are:

— to provide knowledge about cranes;

— to provide knowledge about slinging equipment;

— to teach safe slinging methods;

— to teach signalling methods;

— to impart safe slinging techniques;

— to provide knowledge regarding job planning, hazard identification and control procedures.

5 Training procedures

The duration and contents of the training procedures shall be sufficient to attain the objectives.

The training shall include both a theoretical programme and a practical programme. In particular, it is important that trainees are taught safe slinging work through case studies of accidents that have occurred during slinging work.

The practical training shall be carried out for a small group of trainees (maximum 10 trainees) by such procedures as follows:

— the training instructor shall demonstrate the aspects of basic slinging work, i.e. preparation of a lift plan, identification of site hazards, determination of the centre of gravity, estimation of the mass of a load, attaching slinging equipment on the load, hoisting, transporting and lowering the load;

— the trainee shall then perform the slinging work according to the demonstration by the instructor and repeat it until he/she becomes skilled. In particular he/she shall learn safe procedures for slinging work;

— the trainee acts as a slinger (or signaller) and one or two other trainees act as assistant(s).

At the completion of training, assessment of the results of the theoretical and practical programmes shall be conducted to confirm whether or not a trainee has achieved the training objectives.

6 Contents of training programme

6.1 Theoretical programme

6.1.1 Knowledge of cranes

The following knowledge of cranes shall be included in the training programme:

a) cranes in general:

— vocabulary;

— crane motions;

— lifting capacity, rated capacity chart.

b) types, outline of structure, purpose of use:

- mobile cranes;
- tower cranes;
- jib cranes;
- bridge and gantry cranes.

c) safety devices, load-lifting attachments, brakes.

6.1.2 Slinging equipment

The following knowledge of slinging equipment shall be included in the training programme:

a) wire rope slings:

- rope construction;
- rope lay;
- working load limit;
- precautions for use.

b) chain slings:

- types of chain slings;
- working load limit;
- precautions for use.

c) types, working-load limit, precautions when using fibre slings:

- fibre rope slings;
- fibre webbing slings.

d) types, working-load limit, precautions when using other slinging equipment:

- pulley (reeving) block;
- slinging gear (clamps, lifting hooks, shackles, lifting beams, lifting nets, eye pieces);
- pads, sleepers.

6.1.3 Checking (inspection) of slinging equipment

The following knowledge of the inspection of slinging equipment shall be included in the training programme:

a) wire rope slings:

- checking of items (number of broken wires, reduction of rope diameter, wear, kink, deformation, corrosion, lubrication, abnormality at connecting part or end fitting);
- discard criteria.

b) chain slings:

- checking of items (elongation, deformation, twist, crack, abnormality at joint section);
- discard criteria.

c) fibre slings:

- fibre rope slings:
  i) checking of items (wear, scratch, cut, corrosion, loose lay);
  ii) discard criteria.
- fibre webbing slings:
  i) damage (wear, scratch, cut of sewing strings);
  ii) outer abnormality (change of colour, colouring, melt, dirt);
  iii) metal fitting (deformation, scratch, crack, corrosion);
  iv) discard criteria.

d) clamps:

- abnormality of clamp body or lifting ring;
- abnormality of throat opening;
- damage, wear or clogging at teeth (knurled part) of cam or jaw;
- function of clamp;
- function of safety latch;
- maintenance;
- discard criteria.

6.1.4 Slinging methods

The following knowledge of slinging methods shall be included in the training programme:

a) determination of the centre of gravity and estimation of the mass of loads;

b) choice of slinging method corresponding to shape of load:

- direct lifting;
- basket-hitch lifting;
- choke-hitch lifting;
- clamp lifting;
- lifting of unevenly shaped loads (non-symmetrical loads);
- lifting by a lifting beam (spreader);
- use of tagline.

c) selection of slinging equipment corresponding to the mass of loads and the lifting angle;

d) transportation of the lifted load.

6.1.5 Signalling

The following knowledge of signalling shall be included in the training programme:

a) hand signals;

b) flag signals;

c) radio communication (voice signals).

6.1.6 Safety rules

6.1.7 Job planning

The following knowledge of job planning shall be included in the training programme:

a) job sequence;

b) path of travel of the load;

c) access and egress;

d) ground or supporting surface condition;

e) location of personnel involved in slinging work;

f) coordination with other site personnel.

6.1.8 Hazard identification and control procedures

The following knowledge of hazard identification and control procedures shall be included in the training programme:

a) hazards associated with the use of cranes and slinging practices:

- crushing hazards, such as falling load, load collapse, caught between moving load and other object;
- cutting hazards, such as broken wire rope, sharp-edged load;
- impact hazards, such as load sway, load collapse, flying objects;
- entanglement hazards, such as with wire rope sling, tagline;
- hazard of falling from height.

b) potential hazards to be taken into consideration at lifting operation site:

- overhead power lines;
- overhead service lines, such as steam, gas, telephone;
- trees;

— uneven and/or unstable ground;

— allowable floor loading as appropriate;

— surrounding buildings/vessels/structures/equipment;

— hazardous materials;

— corrosive substances;

— barricades;

— inadequate lighting;

— radio interference;

— inclement weather.

6.2 Practical programme

6.2.1 General

The practical programme shall include various steps for slinging work, such as safe procedures for slinging work, signalling, determination of the centre of gravity, estimation of the mass of loads, selection of slinging equipment, checking (inspection) of slinging equipment, attaching slinging equipment on the load and the hook, hoisting, transporting and lowering the load. With regard to the slinging methods, trainees shall learn at least the techniques required for basket-hitch lifting, choke-hitch lifting, clamp lifting and lifting of unevenly shaped loads.

6.2.2 Safe procedures for slinging work

Practice in the following procedures for slinging work shall be included in the training programme:

a) proper clothing, use of personal protective equipment;

b) safety confirmation by finger-pointing and calling-out.

6.2.3 Signalling

Practice in the following procedures for signalling shall be included in the training programme:

a) hand signals;

b) flag signals;

c) radio communication (voice signals).

6.2.4 Determination of the centre of gravity and estimation of the mass of loads

Practice in the determination of the centre of gravity and estimation of the mass of loads shall be included in the training programme.

6.2.5 Selection of slinging equipment

Practice in the selection of slinging equipment shall be included in the training programme.

6.2.6 Checking (inspection) of slinging equipment

Practice in the checking (inspection) of slinging equipment shall be included in the training programme.

6.2.7 Slinging

6.2.7.1 Attaching slinging equipment

Practice in the following procedures for attaching slinging equipment shall be included in the training programme:

a) determination of the centre of gravity and points for attaching slinging equipment;

b) guiding the hook above the load and lowering the hook;

c) attaching slinging equipment on the load and the hook;

d) confirmation of the safety of slinging condition.

6.2.7.2 Trial lift and hoisting the load

Practice in the following procedures for trial lift and hoisting the load shall be included in the training programme:

a) precision hoisting and stop;

b) safety confirmation;

c) hoisting the load.

6.2.7.3 Transporting the load

Practice in the following procedures for transporting the load shall be included in the training programme:

a) planning the path of travel of the load;

b) cross over (space shared with other cranes);

c) signalling the transporting course and lowering position to a crane driver;

d) guiding the load.

6.2.7.4 Lowering the load

Practice in the following procedures for lowering the load shall be included in the training programme:

a) evaluating ground or supporting structure surface condition;

b) guiding the load to the lowering place and preparing sleepers;

c) lowering the load and stop lowering;

d) precision lowering, grounding the load and confirmation of the stability;

e) removing the slinging equipment from the hook and the load;

f) checking the slinging equipment and storing it at a designated place.

7 Assessment

7.1 General

After the completion of the training programme, the knowledge and practical competence of the trainee shall be assessed in accordance with ISO 15513. Any trainee who does not meet the competence standards shall undergo further training.

7.2 Knowledge assessment

The knowledge assessment shall evaluate the competence of the trainee for subjects 6.1.1 through 6.1.8. In order to demonstrate an acceptable level of competence, the trainee shall score at least 50 % of the marks possible for each topic and 60 % of the total marks. Further training shall be undertaken if these marks are not achieved.

7.3 Practical assessment

The practical assessment shall determine whether the trainee has acquired the skill to perform procedures 6.2.2 through 6.2.7. The pass mark shall be 70 % of total marks possible. The trainee who is unable to achieve this level shall be required to undertake retraining.

Annex A
(informative)

Practical training aids

A.1 Mass estimation of actual loads

For practical training in mass estimation, trainees estimate the mass of actual loads using the theoretical techniques learned earlier. Trainees are required to calculate the mass by measuring the dimension of the loads and calculating its volume, then multiplying the volume by the specific gravity using information such as illustrated in Table A.1. Initially, trainees measure the dimensions with a tape measure, but the final goal is for them to acquire the technique for estimating the volume correctly by measuring the dimension of the loads using only their hands (hand span, arm span), feet (stride length), etc.

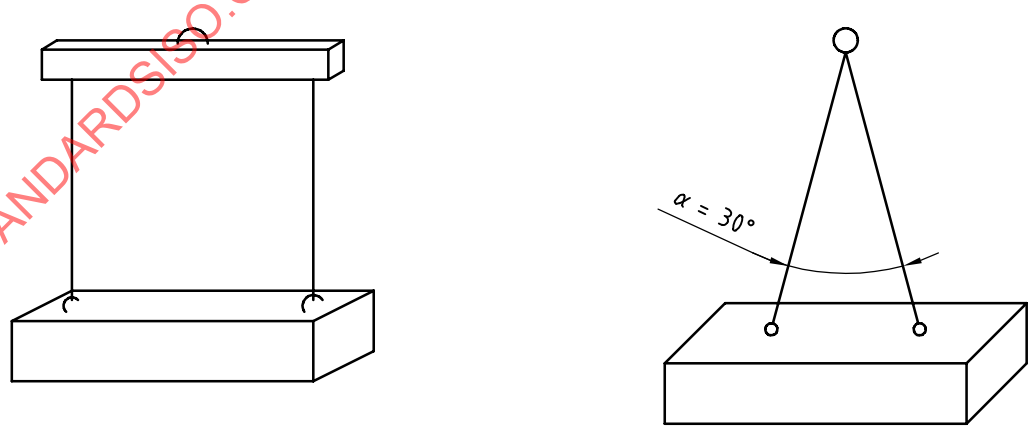
A.2 Selection of wire rope sling

A.2.1 General

Through practical training in the selection of wire rope slings, trainees learn to select the wire rope slings appropriate to the lifting conditions, such as the mass of the load, number of legs of the wire rope slings and the lifting angle.

A.2.2 Two-legged slinging

For lifting a load by two-legged slinging as shown in Figure A.1, trainees are required to determine the appropriate wire rope diameter for the given mass and lifting angle, according to Table A.2 and Table A.3, and select the proper one from a random selection of actual wire ropes, as shown in Table A.4. The objective of this practical training is to teach the trainees to visually select the target diameter of the wire rope sling.



a) Lifting angle 0° (mass = 5 t)

b) Lifting angle 30° (mass = 7 t)

Figure A.1 — Two-legged slinging

Table A.1 — Example of estimation of the mass

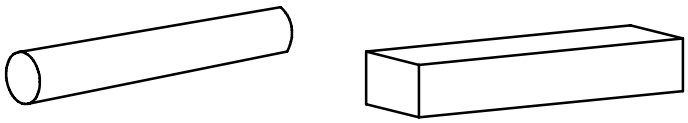
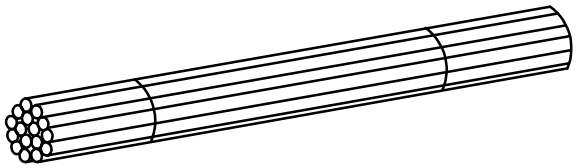
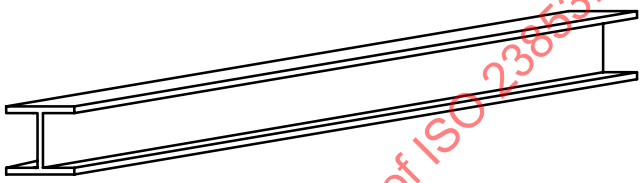
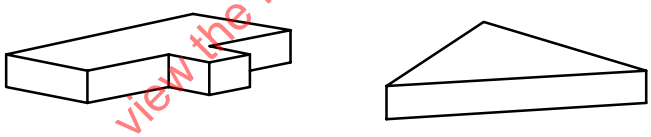
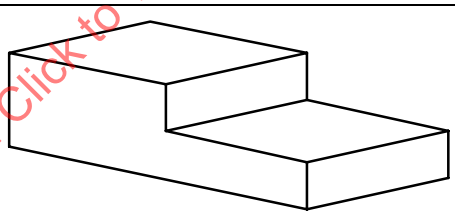
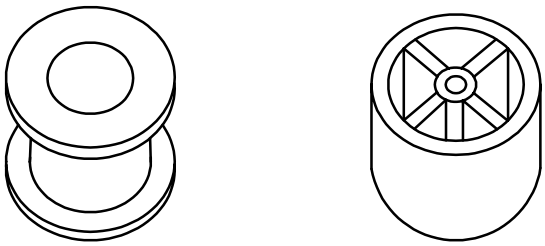
Load	Mass t	Density kg/m^3	Shape
Steel bar	⩾ 0,5	7,8	
Bundle of steel bars	⩾ 0,5	7,8	
H-section steel	⩾ 0,5	7,8	
Steel plate	⩾ 0,5	7,8	
T-shaped steel and triangular steel	⩾ 0,5	7,8	
Non-symmetric load	⩾ 0,5	Steel: 7,8 Concrete: 2,3	
Wheel or cylindrical load	⩾ 0,5	Steel: 7,8 Concrete: 2,3	

Table A.2 — Factor for calculating the working-load limit (WLL) for two-legged slings

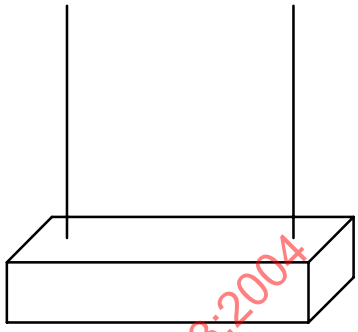
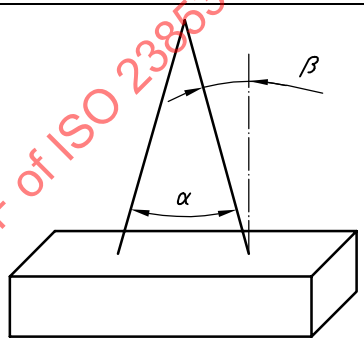
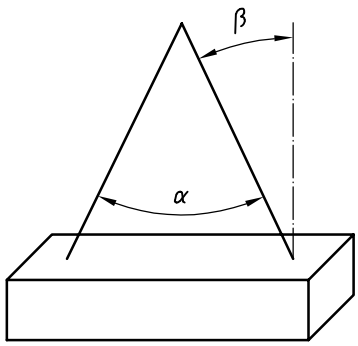
Lifting angle degrees	Calculation factor for WLL	Two-legged slings
$\alpha = 0$	2,0	
$0 < \alpha \leqslant 30$ $0 < \beta \leqslant 15$	1,9	
$30 < \alpha \leqslant 60$ $15 < \beta \leqslant 30$	1,7	

Table A.3 — Working-load limit (WLL) of two-legged slings

Rope diameter mm	WLL t					
	Lifting angle					
	$\alpha = 0°$		$0° < \alpha \leqslant 30°$		$30° < \alpha \leqslant 60°$	
	Wire rope construction					
	6 × 24	6 × 37	6 × 24	6 × 37	6 × 24	6 × 37
10	1,4	1,8	1,3	1,7	1,2	1,5
12	2,0	2,6	1,9	2,5	1,7	2,2
14	2,8	3,6	2,7	3,4	2,4	3,1
16	3,6	4,8	3,4	4,6	3,1	4,1
18	4,6	6,0	4,4	5,7	3,9	5,1
20	5,6	7,4	5,3	7,0	4,8	6,3
22	6,8	9,0	6,5	8,6	5,8	7,7
24	8,2	10,8	7,8	10,2	7,0	9,2
28	11,0	14,6	10,5	13,9	9,4	12,4

NOTE The values of WLL are derived from the formula as given in ISO 7531:1987, 4.4[6]. The minimum breaking force is assumed to be that of the 6 × 24 and 6 × 37 fibre core groups, equivalent to 1 570 N/mm^2 and 1 770 N/mm^2 nominal tensile strengths respectively, as given in ISO 2408.

A.2.3 Three-legged slinging

For lifting a load by three-legged slinging as shown in Figure A.2, trainees are required to determine the appropriate wire rope diameter for the given mass and lifting angle, according to Table A.5 and Table A.6, and select the proper one from a random selection of actual wire ropes, as shown in Table A.4. The objective of this practical training is to teach the trainees to visually select the target diameter of the wire rope sling.

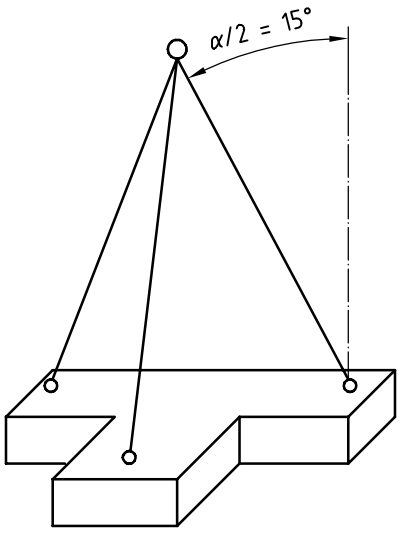
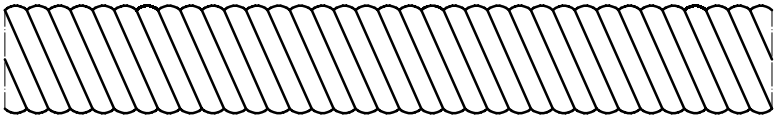
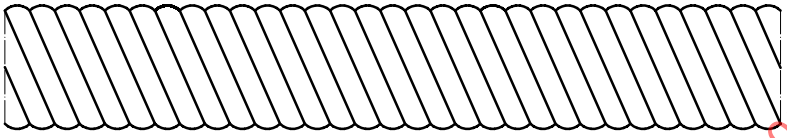
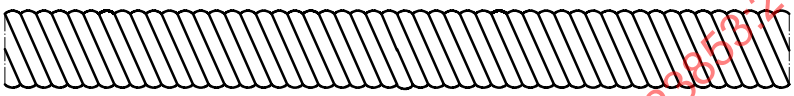
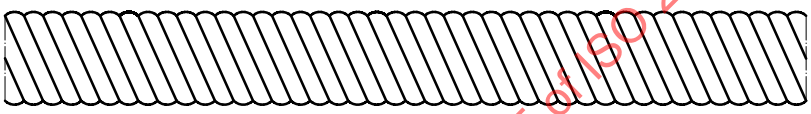
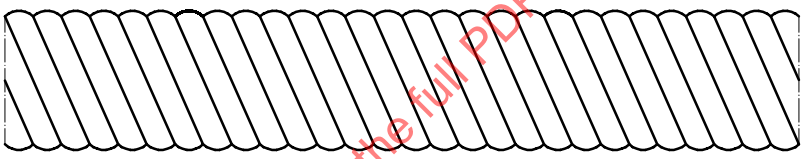
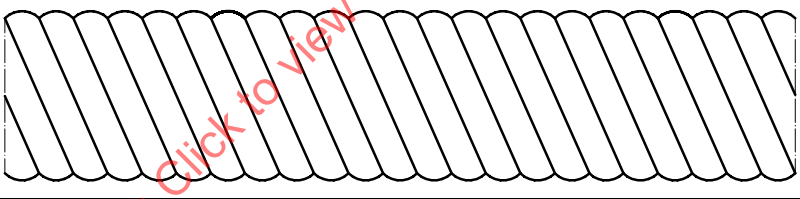
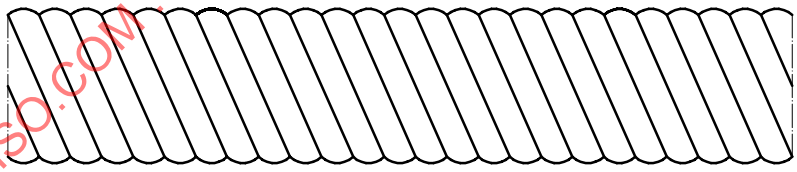
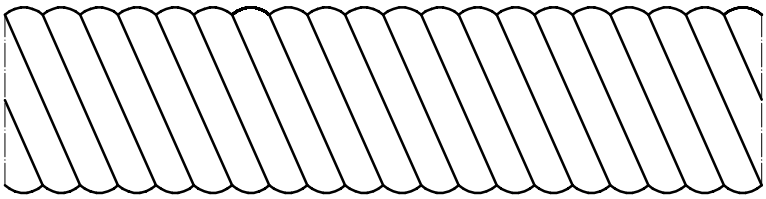
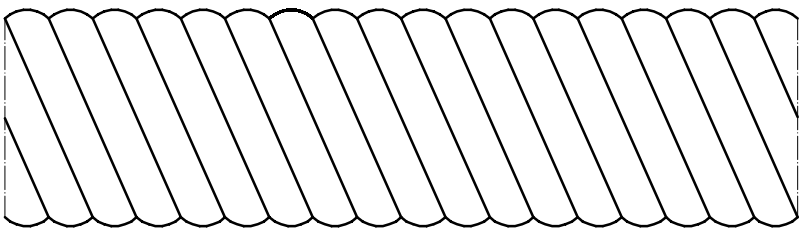


Figure A.2 — Three-legged slinging (lifting angle 30°)

Table A.4 — Examples of wire rope used in slings

Symbol	Randomly arranged wire ropes used in slings
C	
D	
A	
B	
E	
G	
F	
H	
J	

Diameters of the wire ropes are:

A = 10 mm, B = 12 mm, C = 14 mm, D = 16 mm, E = 18 mm, F = 20 mm, G = 22 mm, H = 24 mm, J = 28 mm.

Table A.5 — Working load limit (WLL) of single-legged sling with eye splices

Rope diameter mm	WLL t	
	Rope construction	
	6 × 24	6 × 37
10	0,7	0,9
12	1,0	1,3
14	1,4	1,8
16	1,8	2,4
18	2,3	3,0
20	2,8	3,7
22	3,4	4,5
24	4,1	5,4
28	5,5	7,3

Table A.6 — Factor for calculating WLL for three-legged sling

Lifting angle, α degrees	Calculation factor for WLL
30	2,9
See Figure A.2.	

Annex B
(informative)

Training sheet

B.1 General

For practical training in slinging work, several types of load are provided, such as a steel bar, a bundle of steel bars, a steel plate, a T-shaped steel, etc., with individual mass of about 0,5 t, as well as necessary slinging equipment such as wire rope slings, shackles, clamps, sleepers, etc. The slinging method and the load transport course are indicated. The training instructor demonstrates the aspects of basic slinging work, i.e. confirming or identifying the mass of the load, determining the centre of gravity, checking the slinging equipment, attaching wire rope slings to the load and hook, trial lift and hoisting, transporting and lowering the load, and putting the slinging equipment in order upon completion.

After the demonstration, trainees perform each step of the operation one at a time, under the instructor's supervision, until they master each operation. During training, trainees learn not only how to perform sling work safely, but also safe working practice such as giving hand signals correctly, finger-pointing and calling-out actions, etc. When they have become proficient in each step, they perform all the steps combined, i.e. start-to-finish slinging work. The training may be performed by a team of three trainees, i.e. one acts as trainee slinger and other two act as his assistants. The following sheets give examples of slinging procedures.

B.2 Training sheet for double-wrap basket-hitch lifting

B.2.1 Training materials

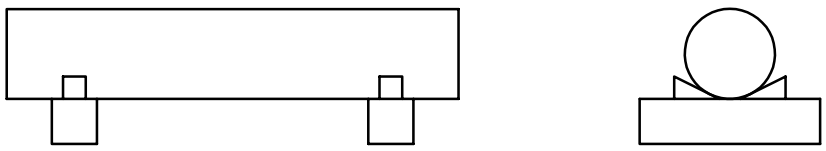
The following materials will be needed for the training:

a) load to be used: steel bar, bundle of steel bars, steel pipe or bundle of steel pipes, about 3 m in length and of mass 0,5 t to 1 t;

b) slinging method: four-legged lifting with double-wrap basket hitch;

c) slinging equipment: wire rope slings with eyes at both ends (2 pieces, nominal diameter 10 mm, length 5 m), and sleepers (4 pieces, profile 150 mm × 250 mm, length 1 m).

B.2.2 Example of a training procedure for double-wrap basket-hitch lifting

Step No.	Step	Slinging action
1	Load	
	Start	The instructor directs the slinging work to start.
	Confirm the mass and centre of gravity	A slinger trainee performs the finger-pointing and calling-out actions to confirm the mass of the load and mark the centre of gravity, e.g "The mass 0,5 t, the centre of gravity, OK!"

2	Check wire rope slings	a) The trainee directs assistants to place 2 wire rope slings neatly on the floor and confirms their lengths are the same and their diameters are 10 mm. b) The trainee checks wire rope slings and their eyes for damage or defects, and calls out e.g. “Wire rope slings, OK!”
3	Summon the crane and guide the hook	a) From a safe position, the trainee signals the crane driver to move the crane above the load, while pointing to the position of the load (the slinger trainee also acts as a signaller trainee). b) The trainee guides the hook above the load by giving signals, and confirms that the hook is directly over the load as seen from two directions, i.e. travelling and traversing, by calling out e.g. “Hook position, OK!” for each direction. If the hook is not directly over the load, the trainee guides the hook again.
4	Attach wire rope slings	The trainee determines and marks the attaching positions and, together with assistants, wraps wire rope slings twice around the load, and confirms that slings are wrapped correctly and at the right position.
5	Hitch eyes onto the hook	a) The trainee signals to lower the hook to a height where sling eyes can easily be hitched onto the hook. b) The trainee hitches the sling eyes onto the hook side-by-side so as not to overlap. c) The trainee confirms that the sling eyes on the hook are in order, sling eyes and wire rope slings do not overlap, and that the two wire ropes on the load are equidistant from the centre of gravity. Confirms by calling out, “Eye-hitching, OK!”
6	Prepare the trial lift	a) The trainee gives a signal for precision-hoisting, while assistants guide (support, but never hold) the sling ropes so that they do not shift from their set positions. b) The trainee signals to stop hoisting just before the wire ropes are fully taut. c) The trainee orders and then confirms that assistants have removed their hands from the sling ropes and have moved to a safe place. d) The trainee confirms that sling eyes on the hook are in order, sling eyes and wire ropes do not overlap, wire rope slings are equidistant from the centre of gravity, the lifting angle is not greater than 60°, the hook is directly over the centre of gravity and the wire rope slings are equally taut, by calling out e.g. “Everyone safe, OK!” or “Slinging, OK!”
7	Trial lift	a) The trainee gives a signal for precision-hoisting and a signal for stop-hoisting when the load is suspended 100 mm to 200 mm above the sleeper. If the lifted load tilts, the trainee lowers the load, readjusts the wrapping positions and carries out precision-hoisting until the load can be hoisted horizontally. b) The trainee confirms the stability of the load by calling out e.g. “Trial lift, OK!”
8	Hoist and transport	a) The trainee directs assistants to place sleepers and stoppers at the unloading position. b) The trainee gives signals to hoist the load, and to stop hoisting when the load has been raised about 2 m. c) The trainee indicates the transport route and the unloading position to the crane driver. d) The trainee gives a transport signal, guides the load while escorting it from the front, and stops it above the unloading position.