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Australia



# Earth-moving machinery — Lift capacity of pipelayers and wheeled tractors or loaders equipped with side boom



AS ISO 8813:2021

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- University of Queensland

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# **Earth-moving machinery — Lift capacity of pipelayers and wheeled tractors or loaders equipped with side boom**

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## Preface

This Standard was prepared by the Standards Australia Committee ME-063, Earthmoving Equipment.

The objective of this document is to provide a uniform method of calculating, and a test method for validating, rated lift capacity as presented in commercial literature for pipelayers and wheeled tractors or loaders equipped with a vertical-only pivoted, hydraulic or mechanically operated, side boom.

This document applies to machines having a lift capacity greater than 10 000 N when used in lifting applications. It includes pipelayers as defined in ISO 6165 and AS ISO 7136:2021, and wheeled tractors and loaders as defined in ISO 6165, AS ISO 6747:2021 and AS ISO 7131:2021.

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2) Delete as applicable.

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4) See [5.7](#).

## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 8813 was prepared by Technical Committee ISO/TC 127, *Earth-moving machinery*, Sub-Committees SC 1, *Test methods relating to machine performance*, and SC 2, *Safety requirements and human factors*.

[Annex A](#) of this International Standard is for information only.

# Australian Standard<sup>®</sup>

## Earth-moving machinery — Lift capacity of pipelayers and wheeled tractors or loaders equipped with side boom

### 1 Scope

This International Standard provides a uniform method of calculating, and a test method for validating, rated lift capacity as presented in commercial literature for pipelayers and wheeled tractors or loaders equipped with a vertical-only pivoted, hydraulic or mechanically operated, side boom. The rated lift capacity considers hoist mechanism limits, tipping loads and rope factor. After the lift capacity has been calculated and validated, a reduction factor is applied to establish the rated lift capacity for the specific pipelayer or wheeled machine configuration.

This International Standard applies to machines having a lift capacity greater than 10 000 N when used in lifting applications. It includes pipelayers as defined in ISO 6165 and ISO 7136, and wheeled tractors and loaders as defined in ISO 6165, ISO 6747 and ISO 7131.

### 2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 6016:1982, *Earth-moving machinery — Methods of measuring the masses of whole machines, their equipment and components.*

ISO 6165:1987, *Earth-moving machinery — Basic types — Vocabulary.*

ISO 6747:1988, *Earth-moving machinery — Tractors — Terminology and commercial specifications.*

ISO 7131:1984, *Earth-moving machinery — Loaders — Terminology and commercial specifications.*

ISO 7136:1986, *Earth-moving machinery — Pipelayers — Terminology and commercial specifications.*

ISO 9248<sup>1)</sup>, *Earth-moving machinery — Units for dimensions, performance and capacities, and their measurement accuracies.*

### 3 Definitions

For the purposes of this International Standard, the following definitions apply.

#### 3.1 load

External force including the weight of attaching equipment applied at the load hook. See [figures 1](#) and [2](#).

#### 3.2 lift point line

Vertical line through the centre of the load hook.

#### 3.3 outrigger

Extendable or fixed arm attached to the base machine which rests on the supporting surface and defines the tipping line. See [figures 7](#) and [8](#).

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1) To be published.

**3.4**  
**tipping line**  
**balance point fulcrum**  
(See [3.4.1](#) to [3.4.4](#).)

**3.4.1**  
**tipping line (for crawler machines)**  
Outer edge of the outer track link rail on the boom side of the machine. See [figure 1](#).

**3.4.2**  
**tipping line (for wheeled machines with non-oscillating axle)**  
Line connecting the centres of contact of the front and rear tyres with the ground reference plane on the boom side of the machine. See [figures 2, 3](#) and [5](#).

**3.4.3**  
**tipping line (for wheeled machines with oscillating axle)**  
Line in the ground reference plane connecting the centre of contact of the tyre on the rigid axle on the boom side of the machine and the vertical line through the centre of oscillation of the oscillating axle. See [figures 4](#) and [6](#).

**3.4.4**  
**tipping line (for machines with outriggers)**  
Line in the ground reference plane connecting the centres of contact of the outrigger pads on the boom side of the machine. See [figures 7](#) and [8](#).

**3.5**  
**load overhang**  
Horizontal and perpendicular distance from the tipping line to the lift point line. See  $W12$  in [figure 1](#) and  $WW12$  in [figures 2](#) to [8](#).

**3.6**  
**moment acting to overturn machine**  
Product of a force acting through the lift point line and the load overhang.

**3.7**  
**moment acting to resist overturn of machine**  
Product of the weight of the machinery and the distance from the centre of gravity to the tipping line.

**3.8**  
**balance point**  
(See [3.8.1](#) and [3.8.2](#).)

**3.8.1**  
**calculated balance point**  
Moment acting to overturn the machine at a specific load overhang which is equal to the moment acting to resist overturning.

**3.8.2**  
**measured balance point**  
(See [3.8.2.1](#) to [3.8.2.3](#).)

**3.8.2.1**  
**measured balance point (for crawler machines)**  
Moment acting to overturn the machine at a specific load overhang that will not cause any track roller on the track opposite the boom side to lift more than 6 mm from the track link.

**3.8.2.2**  
**measured balance point (for wheeled machines)**  
Moment acting to overturn the machine at a specific load overhang that will not cause any tyre on the side opposite the boom to lift more than 2 mm from the ground reference plane.

**3.8.2.3****measured balance point (for machines with outriggers)**

Moment acting to overturn the machine at a specific load overhang that will not cause any tyre or outrigger pad on the side opposite the boom to lift more than 2 mm from the ground reference plane.

**3.9****tipping load**

Vertical load applied at the load hook at a specific load overhang which achieves the balance point.

**3.10****rope**

Wire rope used for the boom support or the load line.

**3.11****rope factor**

Rope breaking strength divided by rope load.

**3.12****draw works**

(See [3.12.1](#) and [3.12.2](#).)

**3.12.1****mechanical draw works**

Drums and mechanical drive systems that operate the boom position and the load hoist lines.

**3.12.2****hydraulic draw works**

Hydraulic pumps, motors, valves, lines and cylinders that position the boom and operate the hoist line.

**3.13****hydraulic pressure**

(See [3.13.1](#) and [3.13.2](#).)

**3.13.1****working circuit pressure**

Nominal pressure applied to the specific circuit by the pump(s).

**3.13.2****holding circuit pressure**

Maximum static pressure in a specific circuit, limited by a relief valve pressure that is measured at a flow no greater than 10 % of rated circuit flow.

**3.14****lift mechanism lift capacity**

Load that can be lifted at the load hook by a force generated by any combination of mechanical or hydraulic power to the draw works and/or hydraulic cylinder(s), at a specific load overhang without exceeding any of the following limits:

- tipping load;
- hydraulic working or holding circuit pressure in any circuit;
- rope factor in either the load or boom hoist line.

Some of the possible combinations of power to the lift mechanism include:

- a) mechanical draw works power to the load and boom hoist line;
- b) hydraulic draw works power to the load and boom hoist line;

- c) mechanical power to the draw works for the load hoist line and hydraulic cylinder(s) for the boom hoist line;
- d) hydraulic cylinders for the load and boom hoist line.

The lift mechanism powers may be sub-defined as in [3.14.1](#) to [3.14.3](#).

#### **3.14.1**

##### **mechanical draw works lift capacity**

Lift capacity obtained by applying mechanical power to the load and boom hoist draw works without exceeding tipping load or rope factor.

#### **3.14.2**

##### **hydraulic lift capacity**

Lift capacity obtained by applying working circuit pressure to the hydraulically actuated draw works and/or lift cylinder(s) without exceeding the holding circuit pressure in any circuit, the tipping load, or the rope factor.

#### **3.14.3**

##### **rope factor lift capacity**

Lift capacity, limited so that the rope factor is not less than 4, or under special provisions, not less than 2,5. See [6.1.2](#).

#### **3.15**

##### **rated lift capacity**

Maximum load that can be raised without exceeding the rated tipping load lift capacity, the rated lift mechanism lift capacity, or the rated rope factor lift capacity. See [clause 7](#).

#### **3.16**

##### **operating mass of the machine**

(See definition 2.4 in ISO 6016:1982.)

Note 1 to entry: Equipment such as dozers and buckets, if included in the manufacturer's specifications, are in the transport position recommended by the manufacturer when assessing operating mass.

## **4 Lift capacity calculations procedure**

### **4.1 Machine preparation**

All lift capacity calculations shall be made with adjustable counterweights fully extended and with the machine on a firm level surface.

### **4.2 Attachment variations**

Because of the number of attachment variations possible, the manufacturer shall publish revised lift capacity charts if these variations decrease the machine rated lift capacity by more than 5 %.

### **4.3 Tipping load calculation**

This calculation is made, in accordance with [4.3.1](#) to [4.3.3.2](#), at a given load overhang position to determine the tipping load. Sufficient load overhang dimensions shall be used to develop the lift capacity chart. See [figure 9](#).

#### **4.3.1 Pipelayers**

Calculations shall be made at standard machine configuration.

### 4.3.2 Wheeled machines

Preliminary calculations shall be made using load overhang lines defined in 3.5 with the machine steered straight ahead, steered fully left, and steered fully right. These preliminary calculations shall be used to select the steering position that results in minimum tipping load. The steering position that results in minimum tipping load for both oscillating axle and non-oscillating axle configurations shall be used to develop the lift capacity chart.

### 4.3.3 Machines with outriggers

Tipping load calculations for machines equipped with outriggers shall be made to develop lift capacity charts both with and without outriggers being used, in accordance with 4.3.3.1 and 4.3.3.2.

**4.3.3.1** When making calculations for machines not using outriggers, the requirements of 4.3.2 apply.

**4.3.3.2** When making calculations for machines using outriggers, the steering position that results in minimum tipping load shall be used to develop the lift capacity chart.

## 4.4 Lift mechanism lift capacity calculations

This calculation is made at a load overhang to determine the load that can be lifted at the load hook when the load from the lift mechanism (defined in 3.14) is less than the tipping load. Sufficient load overhang dimensions shall be used to develop the lift capacity chart. See figure 9.

## 5 Verification testing, test results and validation of calculations

### 5.1 Test site

The test site shall consist of a firm and level horizontal concrete, steel or equally firm surface and shall be level within 1 %.

#### 5.1.1 Dead weight test site

The load shall be applied by lifting on a fixed anchor (the "dead weight") and adjusting the lifting force to achieve the balance point.

#### 5.1.2 Live weight test site

The load shall be applied by a weight of known mass (the "live weight") with the load overhang adjusted to achieve the balance point.

### 5.2 Test equipment

**5.2.1** Force transducer of sufficient capacity or weights of known mass.

**5.2.2** Means to measure the load overhang distance.

**5.2.3** Means to determine that the lift point line is perpendicular to the ground reference plane.

**5.2.4** Means to monitor pressure in all hydraulic circuits that will be under pressure during the lift capacity tests.

### 5.3 Test equipment accuracy

Accuracy of the instrumentation for the relevant parameters measured, as listed in 5.2, shall be as specified in ISO 9248.

### 5.4 Test conditions

5.4.1 Lift capacity shall be determined under static conditions.

5.4.2 The machine used for the tests shall conform in all significant aspects with the machine specifications used for calculation.

5.4.2.1 Wheeled machines shall be tested at the steering position that resulted in the minimum tipping load as established in 4.3.2.

5.4.2.2 Machines with outriggers shall be tested with and without the outriggers being used, and in the configurations established in 4.3.3.

5.4.3 Tyres on wheeled machines shall be inflated and ballasted in accordance with the manufacturer's recommendations.

5.4.4 Track tension on crawler machines shall be adjusted to the manufacturer's recommendation.

5.4.5 Prior to test, the machine shall be cleaned, in operating condition, and operated until the engine and lifting component fluids are at normal operating temperatures.

5.4.6 All lifting systems, rope and reeving shall be in accordance with the machine manufacturer's specifications. If hydraulic lift mechanisms are used, the working and the holding circuit pressure(s) shall be checked for compliance with the manufacturer's recommendations.

5.4.7 Safety precautions shall be observed while conducting the tests. This includes following all operating instructions furnished by the manufacturer of the machine to be tested and the test equipment used. Means shall be provided to prevent the machine from overturning during the tests but shall not appreciably influence the test results.

### 5.5 Verifying test methods

5.5.1 All static lift capacity tests shall be run with adjustable counterweights in the extended position.

5.5.2 For dead weight tests, the boom shall be in the prescribed overhang positions to verify the calculations. The magnitude of the force and the overhang distance that achieves the balance point or the lift mechanism force limit shall be measured. The load lift line shall be kept vertical within  $\pm 0,25^\circ$  during the test.

5.5.3 For live weight tests, the load shall be applied by a weight of a known mass and the load overhang be adjusted to verify the balance point or lift mechanism force limit. The live weight should be kept less than 0,5 m from the ground reference plane while conducting the test, to reduce the possibility of the machine overturning.

5.5.4 Pipelayer lift capacity tests shall be conducted at the following overhang positions, if applicable:

- a) 1,25 m ( $\pm 10\%$ ) or at minimum overhang distance obtainable if greater than 1,25 m;
- b) within 1 m of the maximum load overhang distance;

- c) if the lift mechanism lift capacity is reached before the tipping load, that load shall be used in place of b).

**5.5.5** Wheeled machine lift capacity tests shall be conducted at the following load overhang positions, if applicable:

- a) 1,25 m ( $\pm 10\%$ ) or at minimum overhang obtainable if greater than 1,25 m;
- b) mid-range load overhang;
- c) within 1 m of the maximum load overhang;
- d) if the lift mechanism lift capacity is reached before the tipping load, that load shall be used in place of b) or c).

**5.5.6** Machines equipped with outriggers shall be tested both without outriggers being used and with outriggers being used in their most favourable position.

## **5.6 Test results**

The test results and data from the machine tested shall be recorded on a test summary sheet similar to that shown as [clause 9](#).

## **5.7 Validation of calculated values**

The measured loads at the measured overhang distances should be within 95 % of the calculated values. If not, the calculated values shall be adjusted based on a correction factor determined from the measured values.

# **6 Performance requirements**

## **6.1 Rope factor**

**6.1.1** Rated lift capacity shall not create a rope factor (as defined in [3.11](#)), for ropes that wind on drums or pass over sheaves, that is less than 4 unless the special provisions of [6.1.2](#) are applied. The rope factor shall be determined based on the manufacturer's approved rope, reeving, the nominal breaking strength of new rope, and with load and boom stationary.

**6.1.2** When the rated lift capacity creates a rope factor for ropes that wind on drums or pass over sheaves exceeding 2,5 but less than 4, the following special provisions shall be met and included in the operator's manual:

- a) an inspection of the rope and hook shall reveal no deficiencies;
- b) the load shall be handled at a speed which minimizes dynamic effects;
- c) the inspection and lifting shall be made by a competent person.

## **6.2 Hoist mechanism**

**6.2.1** A positive locking device to prevent inadvertent lowering of the boom and an automatic means to stop the boom motion when the maximum permissible height is reached shall both be provided.

**6.2.2** When the load hoist mechanism has power-operated brakes for controlling loads without continuous mechanical linkage between the actuation and braking means, an automatic means shall be provided that will prevent the load from falling in the event of a loss of power.

**6.2.3** Hoist drums shall have rope capacity with recommended rope size and reeving to operate the boom and hook within the range of boom lengths, operating overhang, and vertical lift recommended by the manufacturer, with no less than two full wraps of rope remaining on the drum.

**6.2.4** Hoist drums shall provide a first wrap rope pitch diameter of not less than ten times the nominal diameter of the rope specified by the machine manufacturer.

**6.2.5** Boom and load hoist sheaves shall have a pitch diameter of not less than ten times the nominal diameter of rope used.

**6.2.6** When using the manufacturer's specified rope reeving and with rated lift capacity suspended,

- a) the boom hoist mechanism shall be capable of raising and lowering the boom, stopping motion, and, without control movement, holding the load stationary;
- b) the load hoist mechanism shall be capable of raising and lowering the load, stopping the load, and, without control movement, holding the load stationary.

### **6.3 Hooks and rope**

For information on maintenance and repair of hooks and rope, see [annex A](#).

## **7 Rated lift capacity**

Rated lift capacity shall be expressed for a specified machine configuration, at a specified load overhang, and for a stationary machine. It shall be the smallest of the following four lift capacities:

- a) rated tipping load lift capacity:
  - for pipelayers: 85 % of tipping load,
  - for wheeled machines: 65 % of tipping load,
  - for machines with outriggers: 85 % of tipping load;
- b) rated mechanical draw works lift capacity:
  - 100 % of the lift capacity of the mechanical draw works and brakes;
- c) rated hydraulic lift capacity:
  - 87 % of the lesser of the lift capacity of the hydraulically actuated draw works or the hydraulic cylinder(s)
- d) rated rope factor lift capacity:
  - 100 % of the rated lift capacity value if the rope factor based on the rated lift capacity is 4 or greater, or 2,5 to 4 when meeting the special provisions of [6.1.2](#).

## **8 Load rating chart**

A rated lift capacity chart or graph shall be provided with legible letters and figures such that at specified machine configuration and load overhang positions, the rated lift capacity can be clearly identified. It shall be permanently affixed in a position so that it is clearly visible to the operator while seated at the

controls of the machine. The data and information provided shall include, but not necessarily be limited to, the following:

- a) The manufacturer's rated lift capacity at stated overhang for permissible boom lengths and stated counterweight (see [figure 9](#)). The mass of any ballast used in tyres shall be specified separately from the counterweight mass.
- b) Ratings limited by factors other than tipping load shall be identified. Such factors may include lift mechanism, hydraulic system and performance.
- c) A working range of rated lift capacity derived from the use of a rated rope factor equal to or greater than 4.
- d) A maximum load capacity range shall be identified that has a rated rope factor of 2,5 to 4 that meets the special provisions of [6.1.2](#).
- e) Specified equipment such as rope size, minimum breaking strength, number of part lines, boom length, and details of counterweight shall be listed.

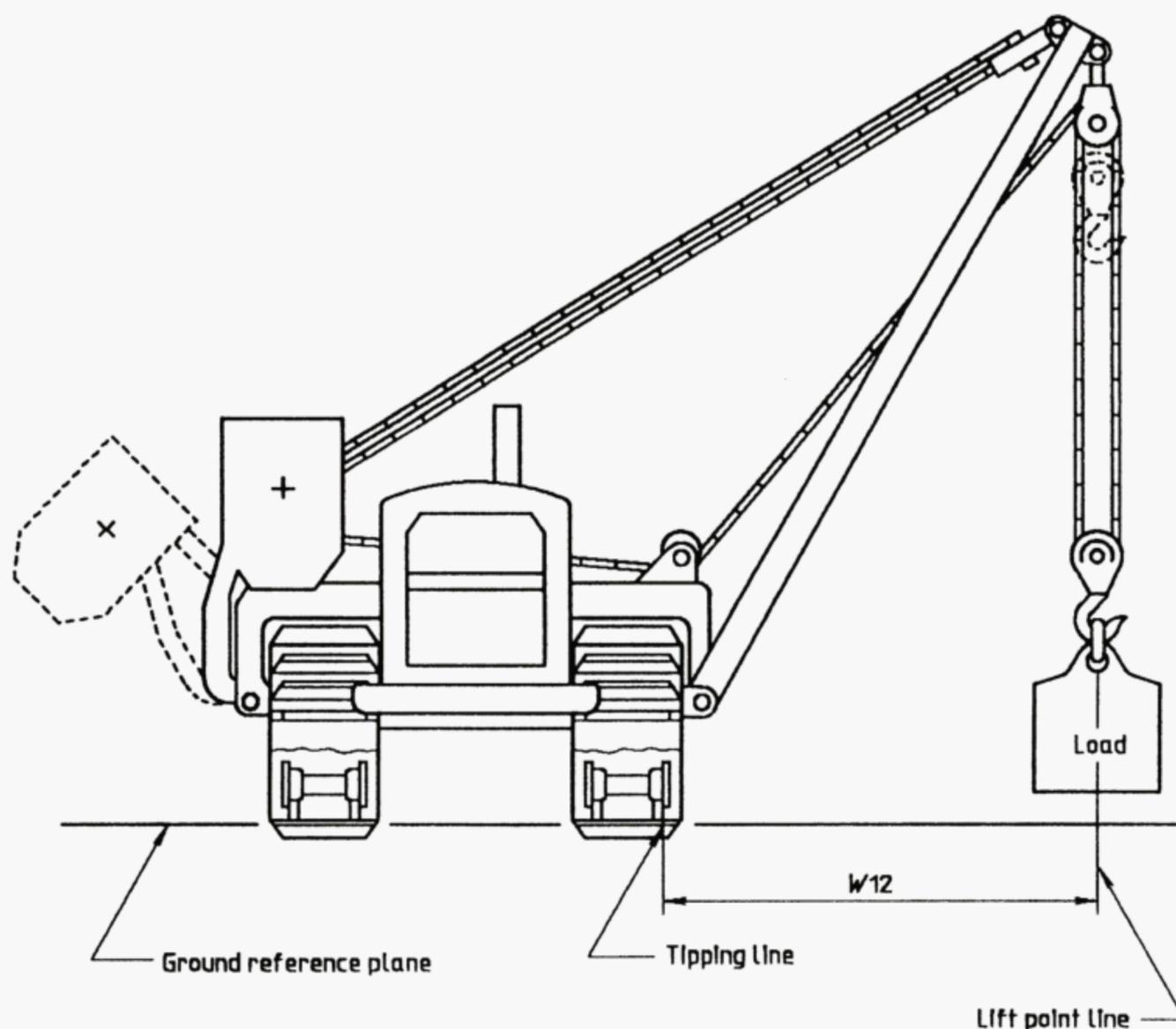


Figure 1 — Pipelayer

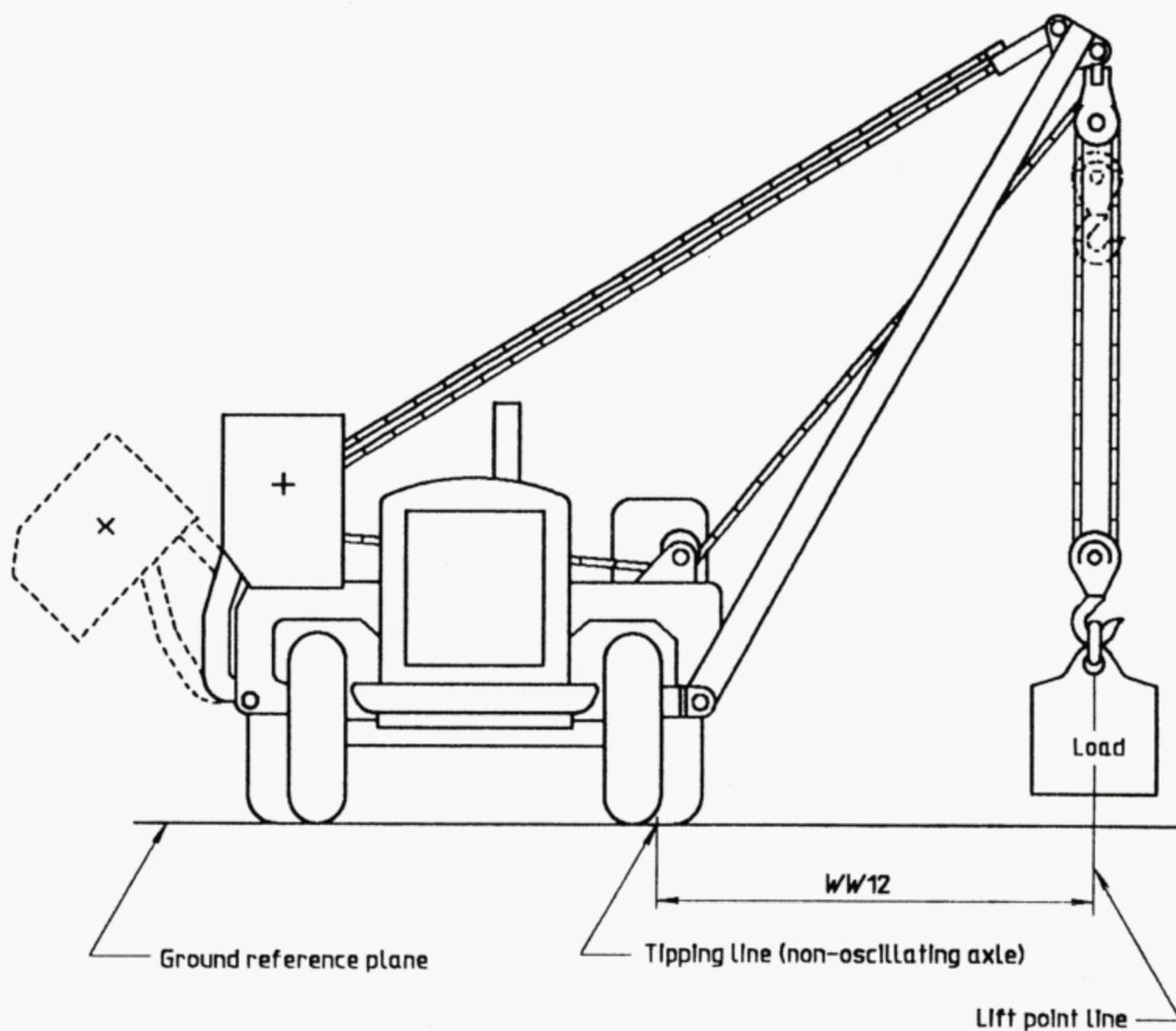


Figure 2 — Wheeled machine steered straight

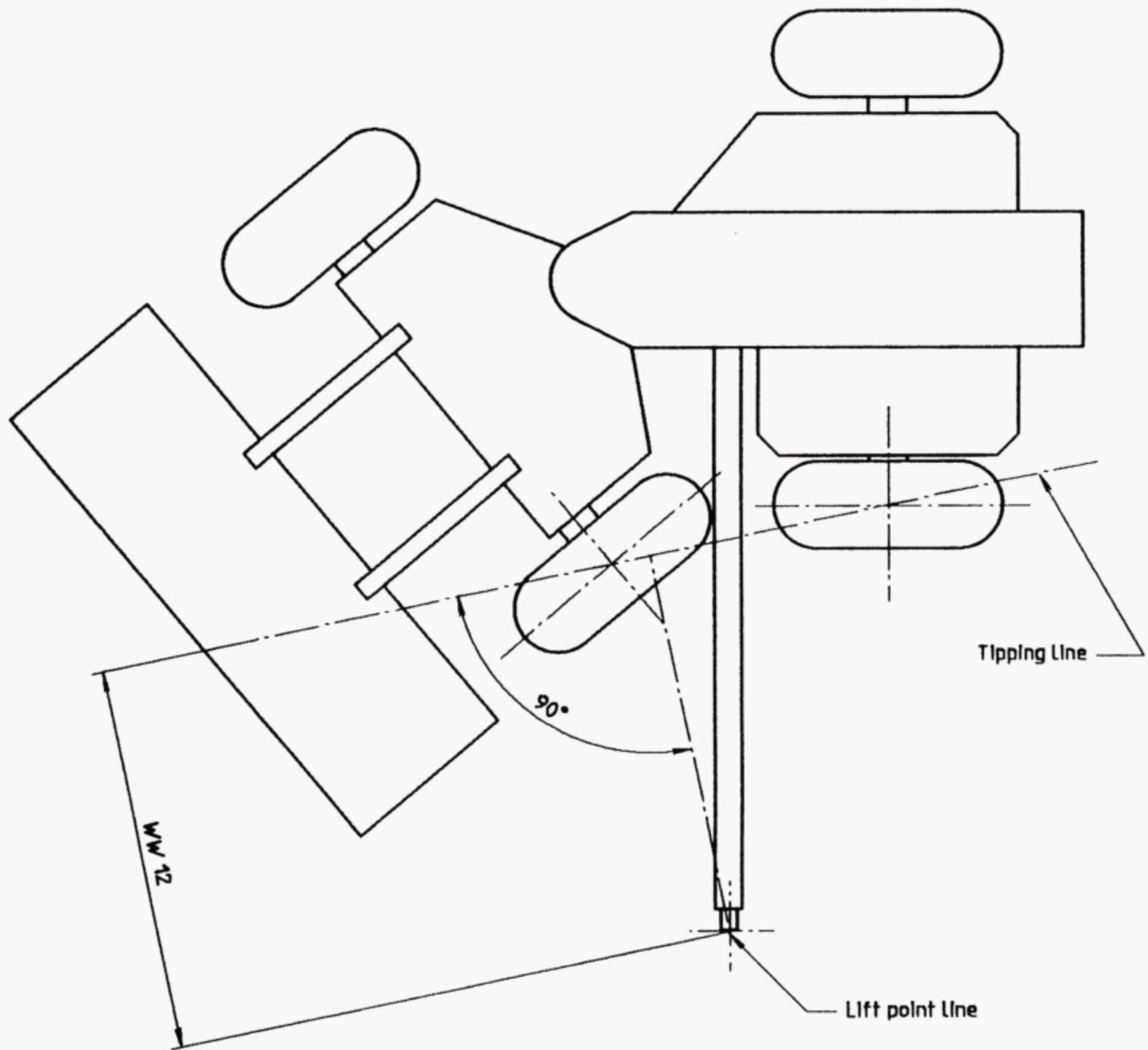
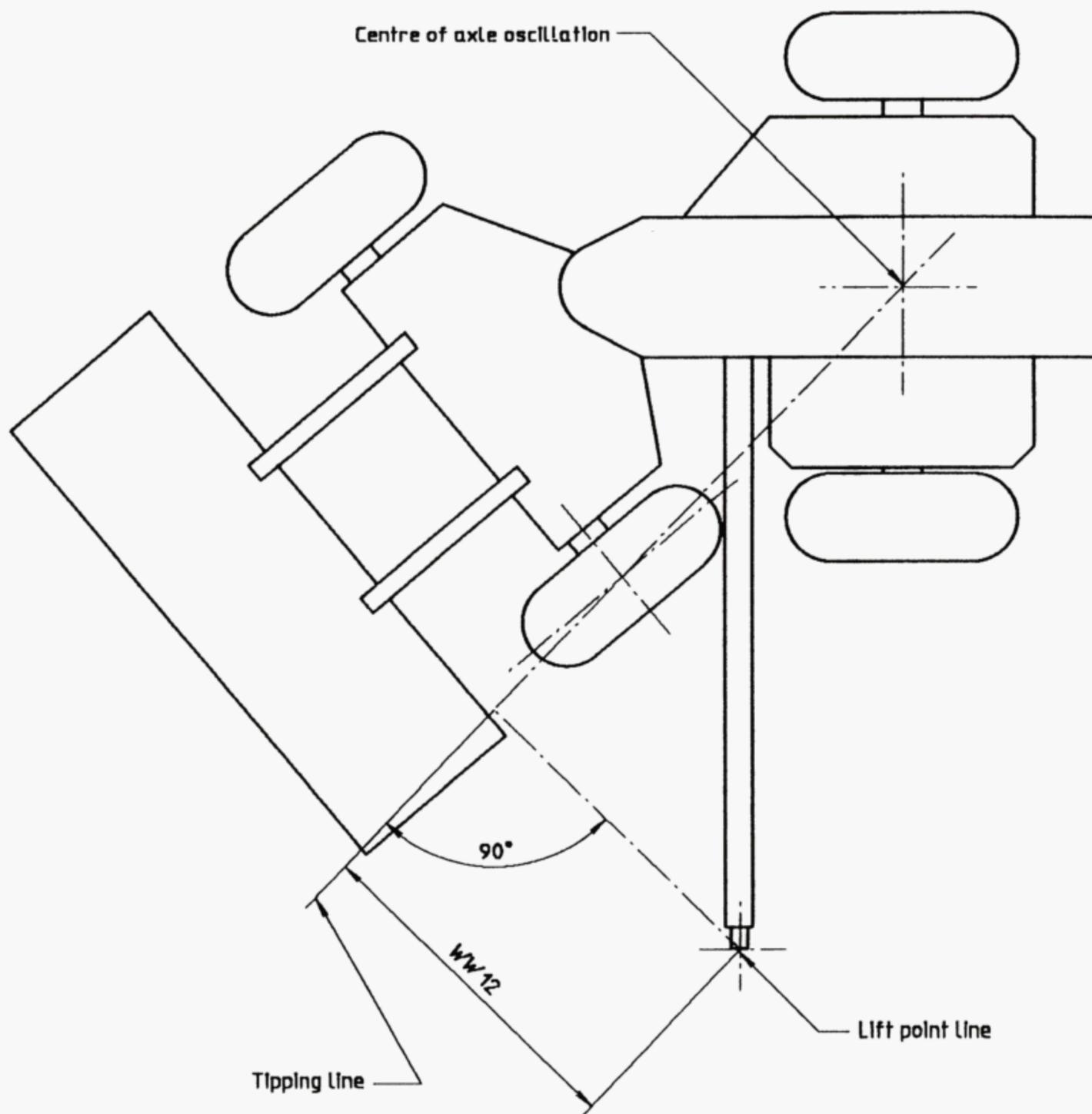
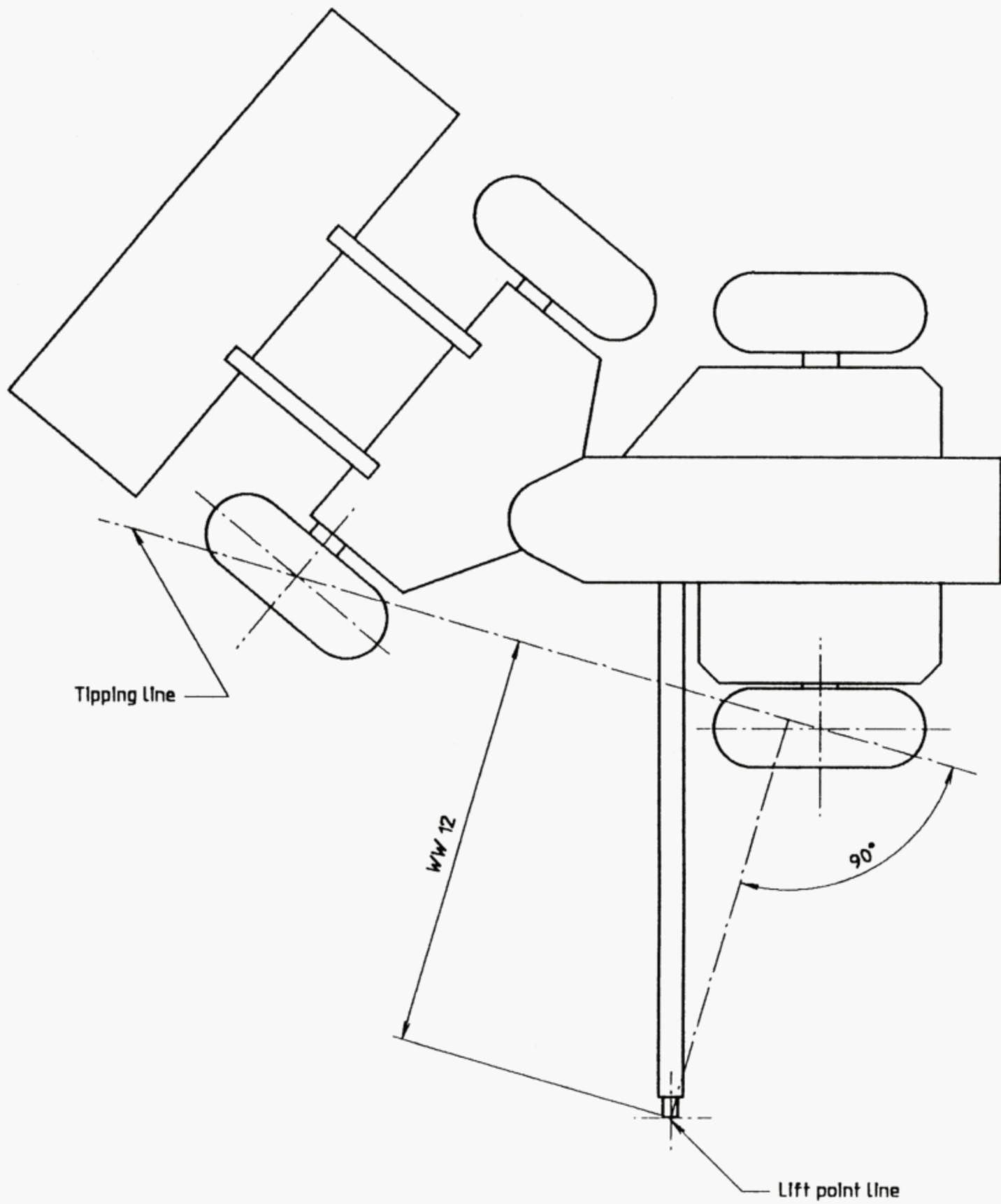


Figure 3 — Articulated wheeled tractor steered left; non-oscillating axle



**Figure 4 — Articulated wheeled tractor steered left; oscillating axle**



**Figure 5 — Articulated wheeled machine steered right; non-oscillating axle**

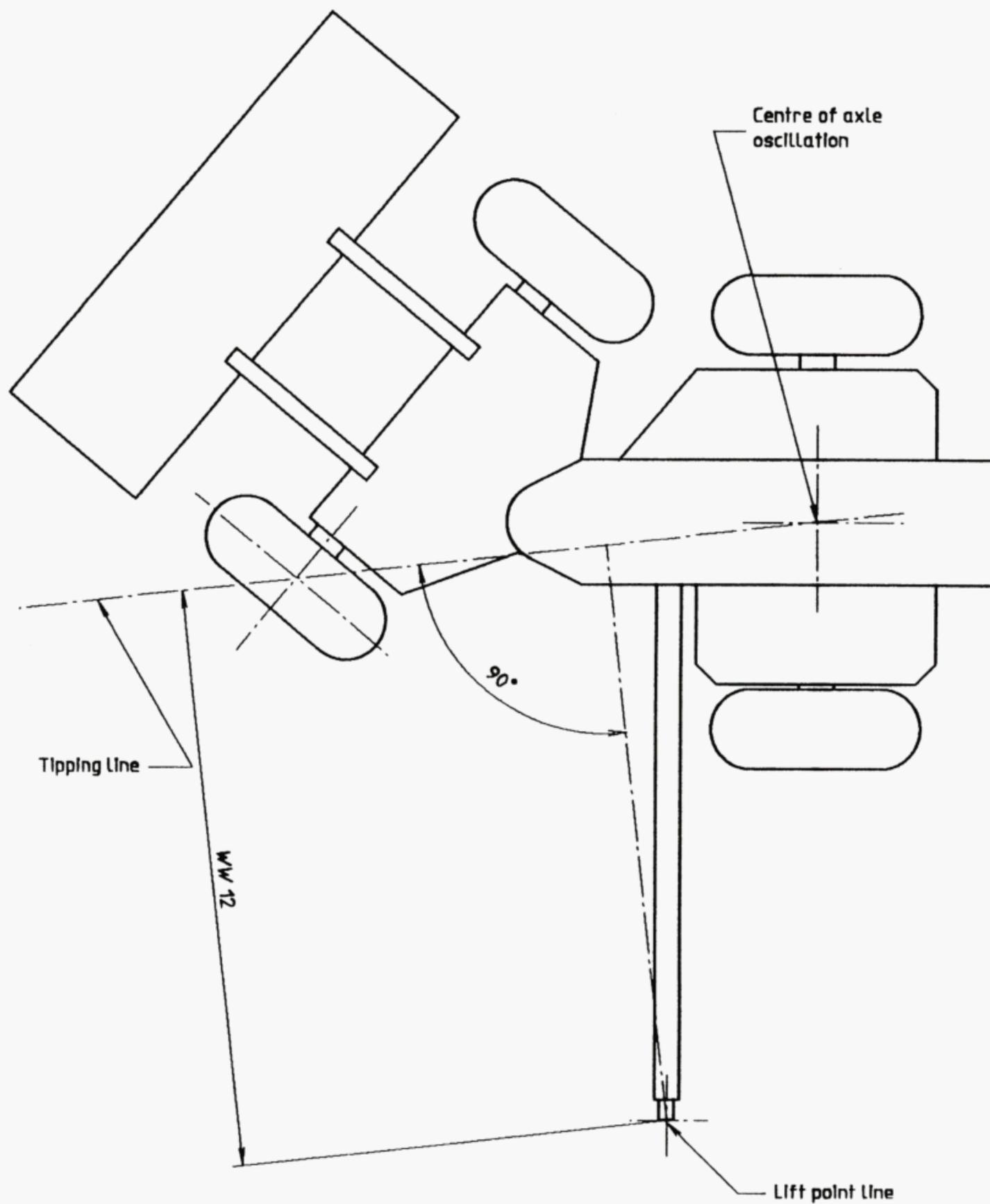
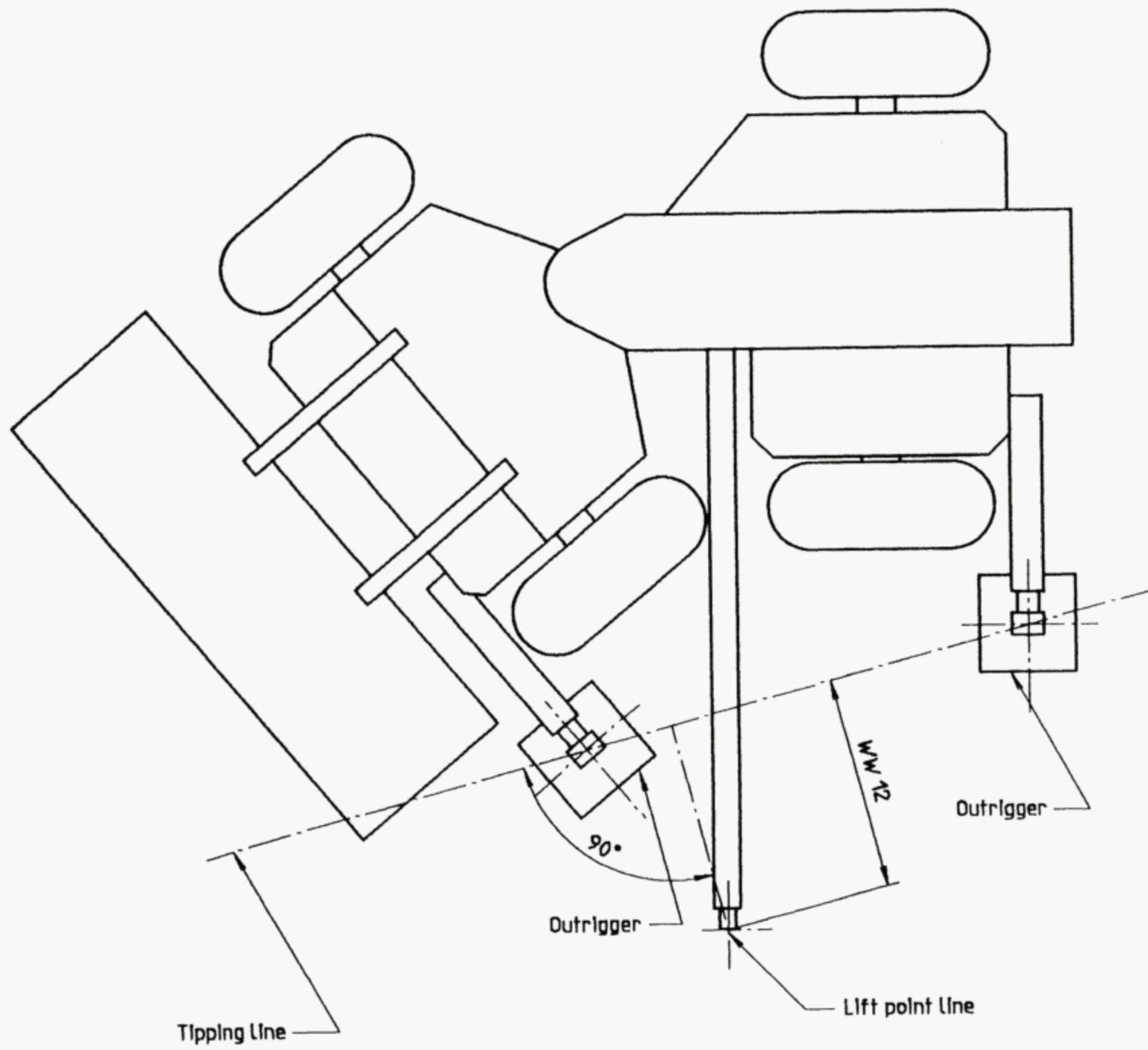


Figure 6 — Articulated wheeled machine steered right; oscillating axle



**Figure 7 — Articulated machine using outriggers; steered left**

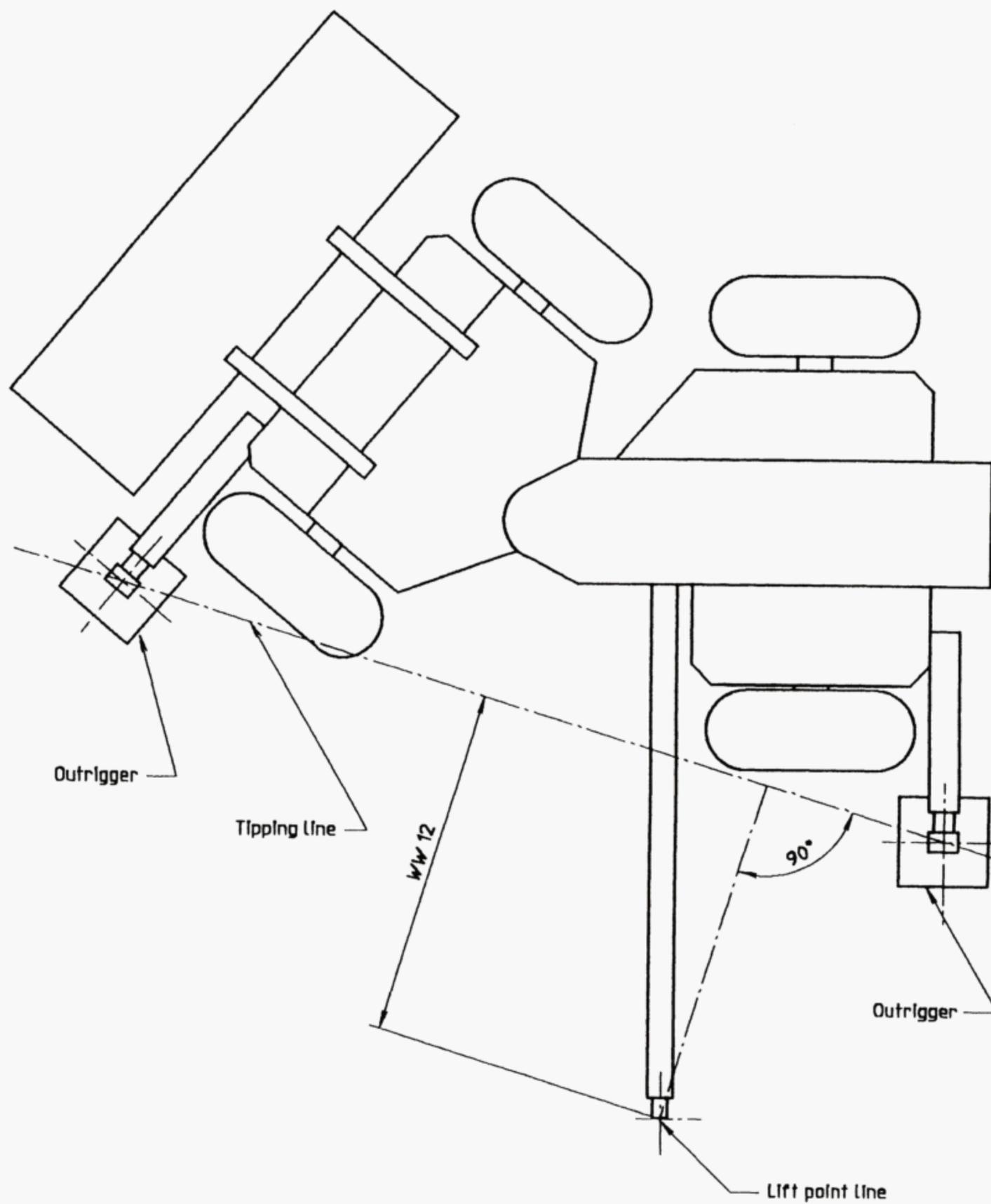


Figure 8 — Articulated machine using outriggers; steered right

## 9 Test summary

### 9.1 Pipelayer or tractor with side boom or loader with side boom<sup>2)</sup>

Model: .....

Serial No.: .....

Mass: ..... kg

Boom length: ..... m

Boom mass: ..... kg

#### 9.1.1 Pipelayer<sup>3)</sup>

Track gauge,  $W_2$ : ..... m

Track shoe width,  $W_4$ : ..... mm

Crawler base,  $L_2$ : ..... m

Track bearing area: ..... mm<sup>2</sup>

Mass: right: ..... kg, left: ..... kg

#### 9.1.2 Tractor or loader<sup>4)</sup>

Tread,  $W_3$ : front: ..... m, rear: ..... m

Tyre size: front: ..... , rear: .....

Tyre pressures: front: ..... kPa, rear: ..... kPa

Tyre ballast: right: ..... kg, left: ..... kg

Machine mass: right: ..... kg, left: ..... kg

Wheelbase,  $L_3$ : ..... m

### 9.2 Calculations<sup>5)</sup>

.....  
 .....  
 .....

### 9.3 Validation measurements

.....  
 .....  
 .....

### 9.4 Rated lift capacity

calculated in accordance with clause 7: ..... N  
 (See also figure 9, to be filled in as appropriate.)

2) Delete as applicable.

3) Delete as applicable.

4) Delete as applicable.

5) See [5.7](#).

## 9.5 Rope

### 9.5.1 Nominal diameters

Hoist rope: ..... mm

Boom rope: ..... mm

### 9.5.2 Breaking strengths

Hoist rope: ..... N/mm<sup>2</sup>

Boom rope: ..... N/mm<sup>2</sup>

### 9.5.3 Rope factor

as defined in 3.11: .....

### 9.6 Working range with rope factor equal to or greater than 4:

Rated lift capacity: ..... N

Overhang: ..... m

### 9.7 Maximum load capacity with a rope factor 2,5 to 4:

Rated lift capacity: ..... N

Overhang: ..... m

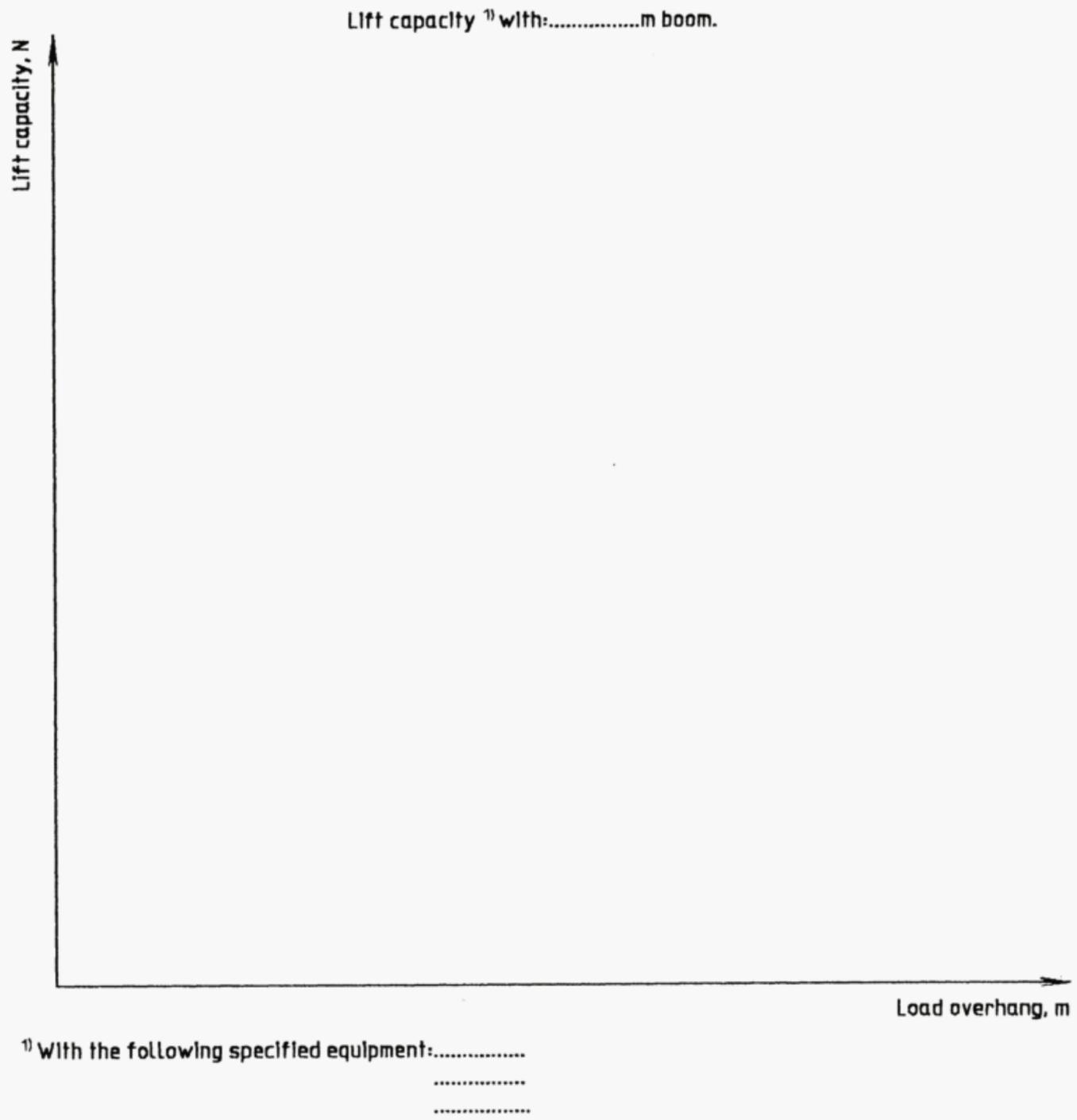


Figure 9 — Lift capacity

## **Annex A**

### **(informative)**

## **Hook and rope — Maintenance and repair**

### **A.1 Operator's manual contents**

The following or similar information should be included in the repair and operator's manual.

### **A.2 Justification for replacement**

Hooks and rope are expendable components requiring replacement when examination shows their strength to have diminished to the point where further use would be unwise. Periodic inspections are necessary so that these components may be replaced before failure occurs.

### **A.3 Hooks**

Hooks with cracks, or having more than 15 % in excess of normal throat opening or more than 10° twist from the plane of the unbent hook should be replaced.

### **A.4 Rope**

**A.4.1** No precise rules can be given for determination of the exact time for replacement of rope since many variable factors are involved. Continued use depends largely upon good judgment by a competent person in evaluating the remaining strength in a used rope after allowance for deterioration disclosed by inspection as stated in ISO 4309:1990, *Cranes — Wire ropes — Code of practice for examination and discard*.

**A.4.2** Conditions such as the following should be sufficient reason for rope replacement or increasing the frequency of inspection:

- a) in running ropes, six randomly distributed broken wires in one lay or three broken wires in one strand in one lay;
- b) wear of one third the original diameter of outside individual wires;
- c) kinking, crushing, cutting, unstranding or any other damage resulting in distortion of the rope structure;
- d) evidence of heat or electric arcing damage;
- e) external or internal corrosion;
- f) corroded, cracked, bent, worn or improperly applied end connections;
- g) reductions from nominal new rope diameter exceeding 7 %.

**A.4.3** Replacement rope shall be a size, grade and construction recommended by the machine or rope manufacturer for side boom service. Socketing, clips and fittings shall be applied as recommended by the rope, fitting or machine manufacturer.

**A.4.4** Rope life will be extended if maintained in a well lubricated condition to reduce internal wear and prevent corrosion. Lubricant applied as part of a maintenance programme should be compatible with the original lubricant.

## NOTES

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GPO Box 476 Sydney NSW 2001  
Phone (02) 9237 6000  
[mail@standards.org.au](mailto:mail@standards.org.au)  
[www.standards.org.au](http://www.standards.org.au)