UKOPA

UK ONSHORE PIPELINE OPERATORS' ASSOCIATION - INDUSTRY GOOD PRACTICE GUIDE

IMPACT PROTECTION SLABS

Guidance Issued by UKOPA:

The guidance in this document represents what is considered by UKOPA to represent current UK pipeline industry good practices within the defined scope of the guide. The document does not specify prescriptive requirements, should be considered guidance and should not be considered obligatory against the judgement of the Pipeline Owner/Operator. Where new and better techniques are developed and proved, they should be adopted without waiting for modification to the guidance in this document. The term 'shall' has been used to identify any requirement of UK law in Great Britain at the time of publication.

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Disclaimer

Contents

1 INTRODUCTION

This specification provides guidance on the design and construction of impact protection slabs for use above high pressure oil and gas transmission pipelines.

2 SCOPE AND APPLICATION

2.1 Scope

The standard design for an impact protection slab, as detailed in this specification, is primarily intended to act as a physical barrier to reduce the likelihood of pipeline damage from third party activities. These typically cover excavation on construction projects or drainage works.

The standard slab design applies to soil overburden loads for a maximum pipeline cover of 2m.

The design in this specification does not apply to:

- Traffic loads
- Construction loading
- Sustained 'abnormal' loading

For these situations, a case specific design is required based on the anticipated loads, pipeline installation geometry and ground conditions.

The principal design method involves a steel reinforced concrete slab; however other construction materials may be suitable subject to additional checks.

'Abnormal' loading implies situations such as excessive ground settlement, industrial loads, storage of agricultural product or plant etc.

2.2 Application

The guidance in this document is considered by UKOPA to represent current UK pipeline industry good practice within the defined scope of the document. All requirements should be considered to be guidance and should not be considered to be obligatory against the judgement of the Pipeline Owner/Operator. Where new and better techniques are developed and proved, they should be adopted without waiting for modifications to the guidance in this document.

The design guidance in this specification is principally based on the following codes and standards. Unless otherwise specified, the latest editions of the documents apply including all amendments.

Relevant codes

BS EN 1992-1-1:2004	Structural use of concrete
BS EN 206-1:2000	Concrete. Specification for the procedures to be used in producing and transporting concrete
BS EN 13164:2008	Thermal insulation products for buildings. Factory made products of extruded polystyrene foam (XPS).
BS EN 1992-2:2005	Design of concrete structures. Concrete bridges. Design and detailing rules
BS 5400-4:1990	Steel concrete and composite bridges
BS 8110-1:1997	Structural use of concrete. Code of practice for design and construction

Industry Standards

IGE/TD/1	Steel pipelines and associate installations for high pressure gas transmission
T/SP/SSW/22	Safe working in the vicinity of national grid high pressure gas pipelines and associated installations – requirements for third parties
Linewatch (Revision 13.04)	Special requirements for safe working in close proximity to high pressure pipelines

3 Standard Design

3.1 Geometry

The basic geometry and layout of the protection slab and relation to the pipeline is summarised in **Figure 3.1**.

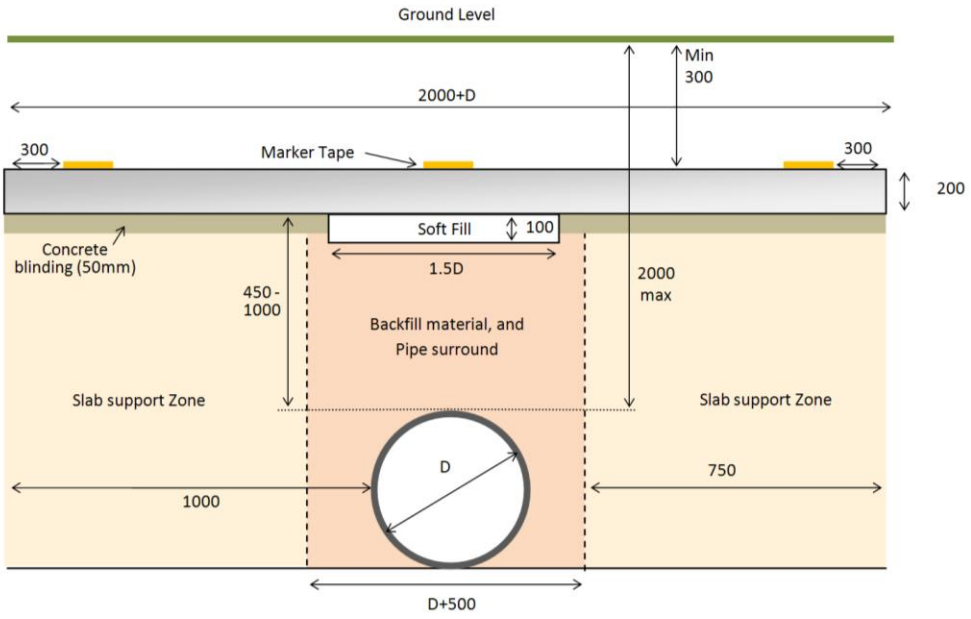


Figure 3.1 - Geometry of the slab
(All measurements are in millimetres, not to scale)

A detailed design is set out in Drawing 001 in Section 8 of this specification.

The slab width is designed to provide a minimum lateral encroachment distance of 1.0m. This is considered adequate for standard excavation plant. See Appendix 1 for a diagram of possible excavator and pipeline interaction.

3.2 Requirements for Standard Design

For the standard slab design to be applicable the site must adhere to the following requirements. If they fail to qualify for any of the conditions, then a site specific design must be carried out by a competent civil or structural engineer.

- The slab installation is for un-trafficked areas.
- The maximum depth of cover on the pipeline is 2 m.
- The slab should be a minimum of 300 mm from the surface.

- The soil strength in the slab support zones must meet or exceed the BS5930 classification of firm, or exhibit a minimum California Bearing Ratio (CBR) of 4%.
- The width of soft-fill centered on the pipe crown is 1.5 times the diameter of the pipe, but is a minimum of 450 mm.

In addition the slab shall satisfy the following criteria:

- The slab depth in agricultural areas shall be a minimum depth of 0.5 m below ground surface to avoid normal plant activity interference; and,
- The maximum distance from the pipe crown to the underside of the slab is 1 m and the minimum distance is 450 mm.

4 Materials

4.1 Standard Materials

The following materials shall be used;

Concrete	C35
Reinforcement	Grade 460A, B785 fabric mesh The 10 mm diameter bar is orientated perpendicular to the pipeline axis
Softfill	LD grade expanded polystyrene board, suitable for the control of clay heave
Subgrade	Type 1 or 2 fill (Specification of Highway Works (SHW) series 800 definition) to be used when the existing load bearing subgrade is below the required standard.

4.2 Alternative Materials

Alternatives to the standard reinforced concrete slab used in this specification may be possible. These include:

- High-Density injected Polyethylene (HDPE); and,
- Steel plate.

These materials exhibit good resistance to punching shear such as from excavator buckets. The primary design issue is low flexural stiffness which could develop higher crown loads on the pipeline. Proposals to use an alternative material must be supported by appropriate assessments of pipeline integrity.

5 Site Preparation

5.1 Pipeline Location

Prior to commencing any works around an existing pipeline, the alignment of the pipeline shall be clearly marked out on the surface. The depth of the pipeline from the surface shall be measured at a minimum of 5m spacing on small installations less than 30m in length and a 10m spacing for larger installations. Electronic measurements of the pipeline depth shall be confirmed by excavation at one or more locations. Further guidance on procedures for establishing the pipeline location and exposing the pipeline can be found in the Linewatch document.

5.2 Coating Check

The pipeline owner should consider a survey of coating condition prior to installation of the impact protection slab because ease of access will be reduced following installation. Repairs of any damage should be completed before the slab installation commences.

5.3 Excavation

Excavation for the slab installation shall only be carried out under supervision of the owning authority or delegated authority. On completion, the excavated area shall be marked out to define the area of expanded polystyrene centered on the pipe and the load bearing strips either side of the polystyrene.

5.4 Strength of Slab Subgrade

The strength of the subgrade in the slab support zones on either side of the pipeline must be sufficient to support the slab without bearing capacity failure or excessive settlement. Cohesive soil that is classified as soft to BS 5930 is not permitted. This shall be determined by an engineer competent in the field assessment of soil strength. Where there is uncertainty, the suitability of the material shall be demonstrated by the California Bearing Ratio (CBR) test. A minimum of 3 tests shall be undertaken for small installations less than 30m length, and one additional measurement for every 10m length over 30m.

Where access for in-situ tests is difficult, laboratory values for CBR may be considered by using the density and moisture content of the in-situ soil. Correlations of CBR value from soil properties may be acceptable providing the source and validity of the method is substantiated.

5.5 Replacement of Slab Subgrade

Where the soil is deemed unsuitable or has been demonstrated to be unacceptable by a CBR value of less than 4%, the material shall be removed and replaced with an imported granular fill. This shall extend to the depth of the unsuitable material or to a maximum depth equal to the base of the pipe. Type 1 or 2 fill to SHW Series 800 is recommended. The imported fill shall be compacted to the requirements of SHW Series 600.

6 Installation

6.1 Cast In-Situ Slabs

6.1.1 Concrete blinding

A 50mm layer of lean concrete blinding shall be laid onto the subgrade to ensure a good base for the placement of the slab. Refer to Drawing 001 in Section 8.1.

6.1.2 Reinforcement

The concrete cover to the reinforcing mesh shall be 50mm from the base and edges. The orientation of the major reinforcement elements of the mesh shall be perpendicular to the axis of the pipe.

6.1.3 Joints

The optimum distance between the joints can be determined by the operator but shall be formed at maximum centres of 35m. For each set of three joints, two will be contraction joints and one will be an expansion joint. Refer to Drawings 002 in Section 8.2 for detailed designs.

6.1.4 Lifting

To move the slab after installation, a minimum of 4 points of contact shall be used with a spacing of no more that 1.8m and a distance to the edge of no more than 0.9m.

6.2 Precast Slabs

6.2.1 Lifting

The lifting points for the slabs shall be formed from heavy duty tubular inserts placed a sufficient distance from the edge to prevent shear failure. This shall be a minimum of 200mm. A 4 point lift arrangement is required. The maximum slab segment length (in the direction of the pipeline axis) shall be 2.5m. The metal inserts shall be protected adequately from corrosion for the life of the slab.

6.2.2 Placement

The slab sections shall be clearly marked to indicate the top to avoid problems of incorrect placement.

6.2.3 Joints

Refer to Drawing 003 in Section 8.3 for detailed design.

6.3 Pipeline Marker Tape

Three continuous strips of pipeline marker tape shall be laid above the slab centreline and 300mm from each slab edge along the full length of the slab to warn of the presence of the pipeline during any excavation activity.

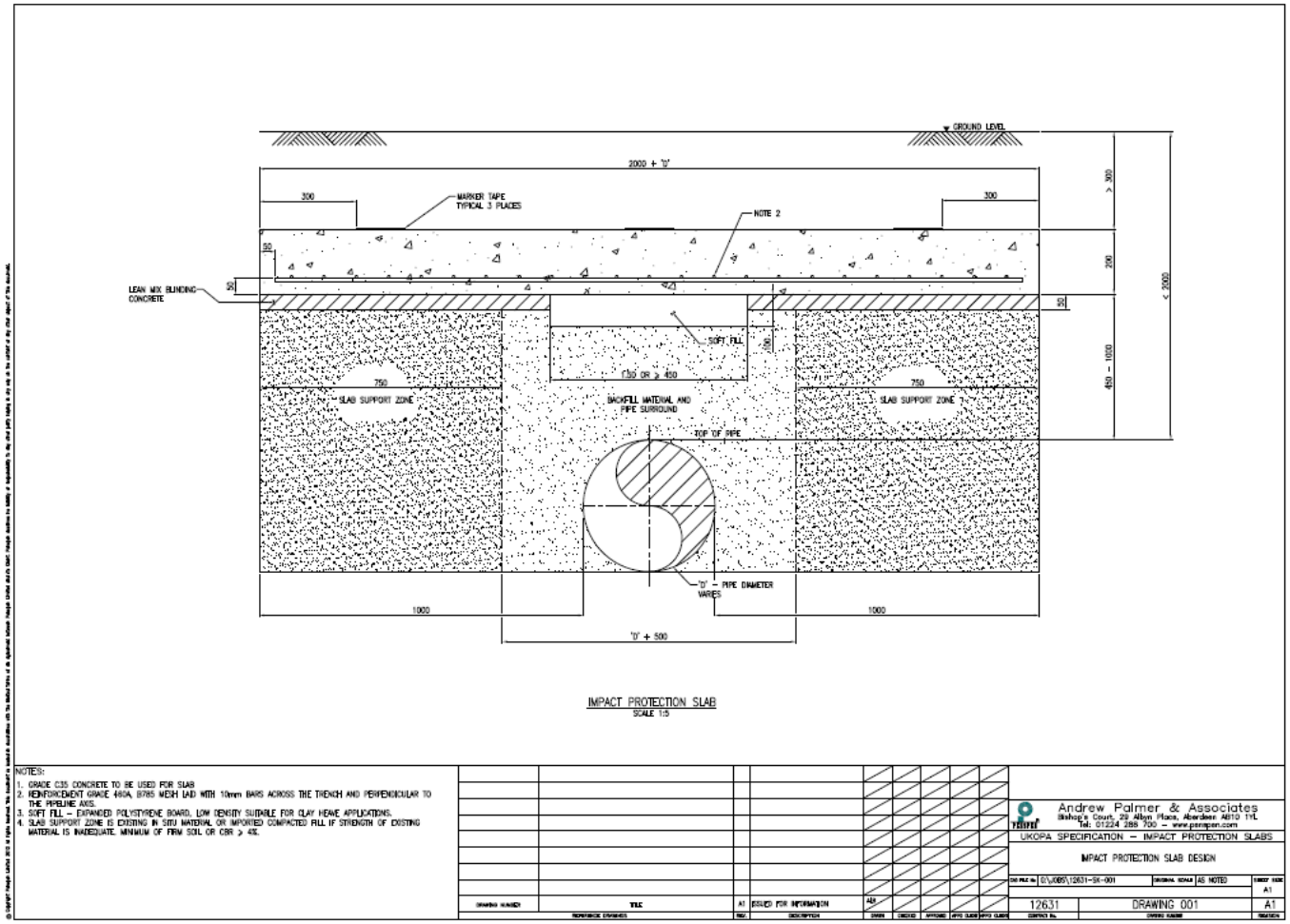
7 Workmanship

In no circumstances shall any reinforcement be allowed to protrude from the slab or contact the pipeline. All other workmanship issues should be carried out in accordance with the relevant standards as described below.

BS EN 1992-1-1	Concrete production and transportation
BS EN 206-1:2000	Machine mixed and batched
BS EN 1992-1-1	Placing of concrete
BS EN 1992-1-1	Cold and hot weather concreting
BS EN 1992-1-1	Compaction of concrete
BS EN 1992-1-1	Curing of concrete
BS EN 1992-1-1	Formwork
BS EN 1992-1-1	Reinforcing fixing
BS EN 206-1: 2000	Concrete Testing

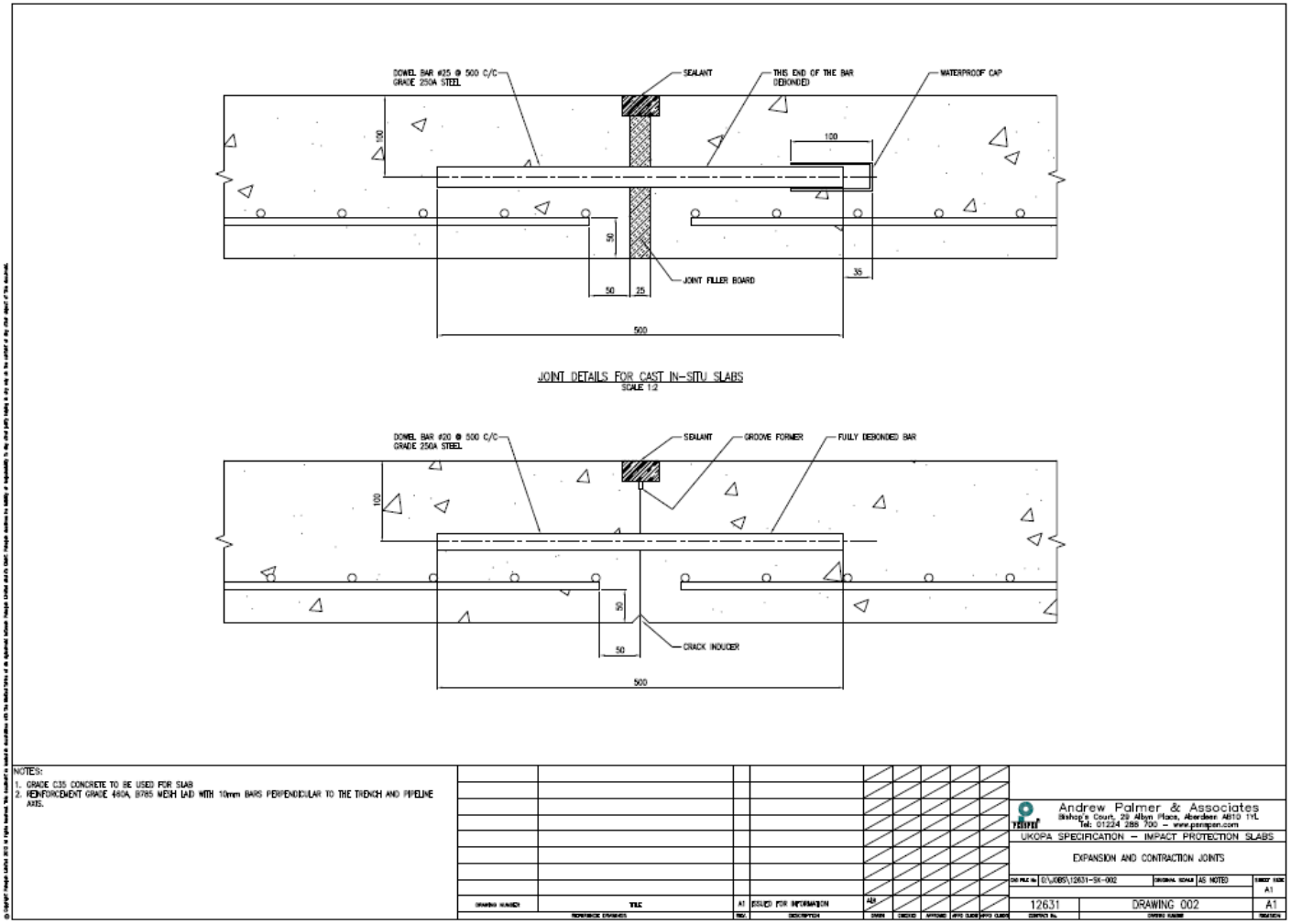
8 Drawings

8.1 Drawing 001 – Impact Protection Slab Design

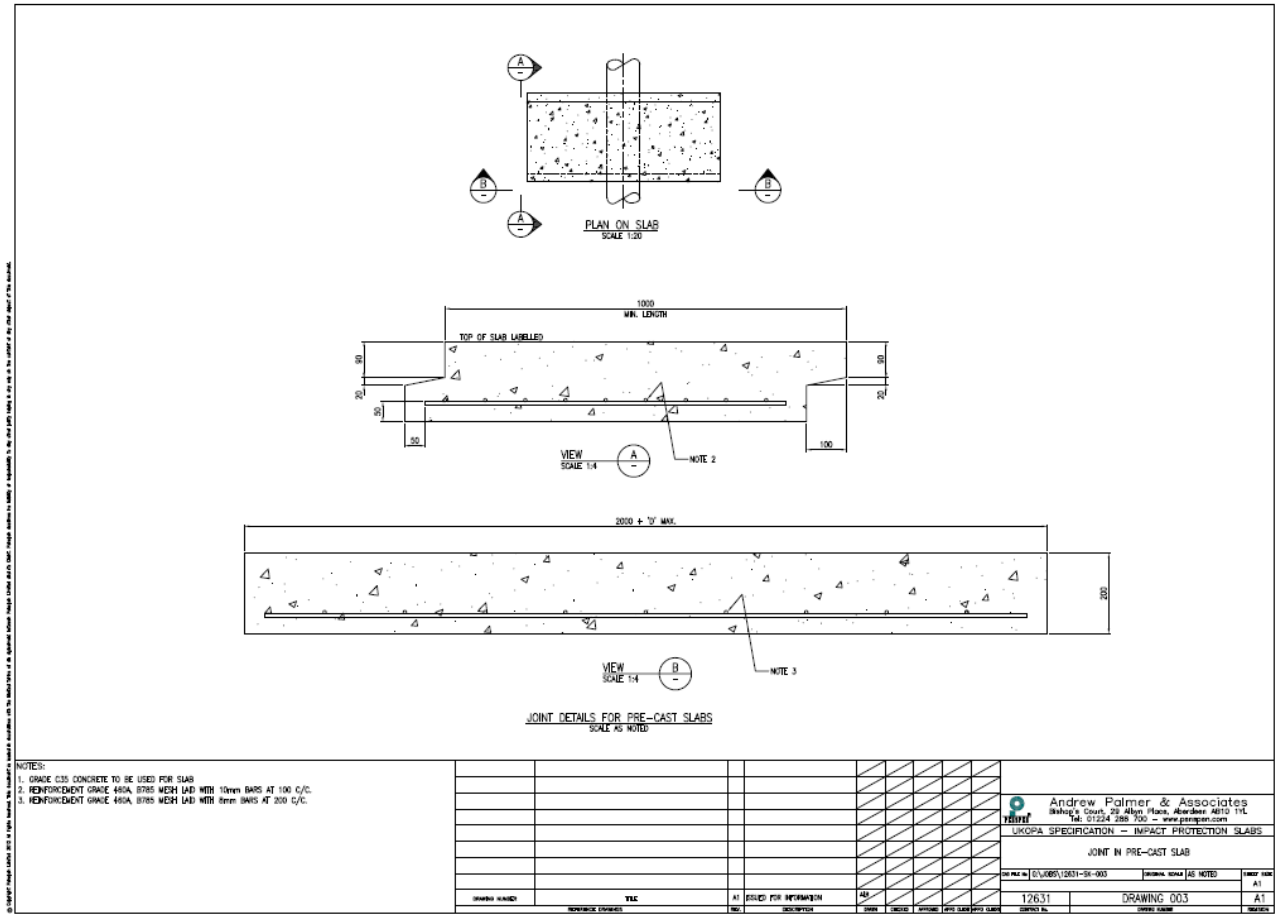


The minimum target cover over the slabs is 300 mm, although a reduced cover of 250 mm may be permitted in special circumstances such as installation below pavement structures typically in urban environments. Traffic loading should be assessed on a case specific design.

8.2 Drawing 002 – Expansion & Contraction Joints



8.3 Drawing 003 – Joint in Pre-Cast Slab



Appendix 1 (Informative)

Typical Encroachment Zone of a Range of Excavators

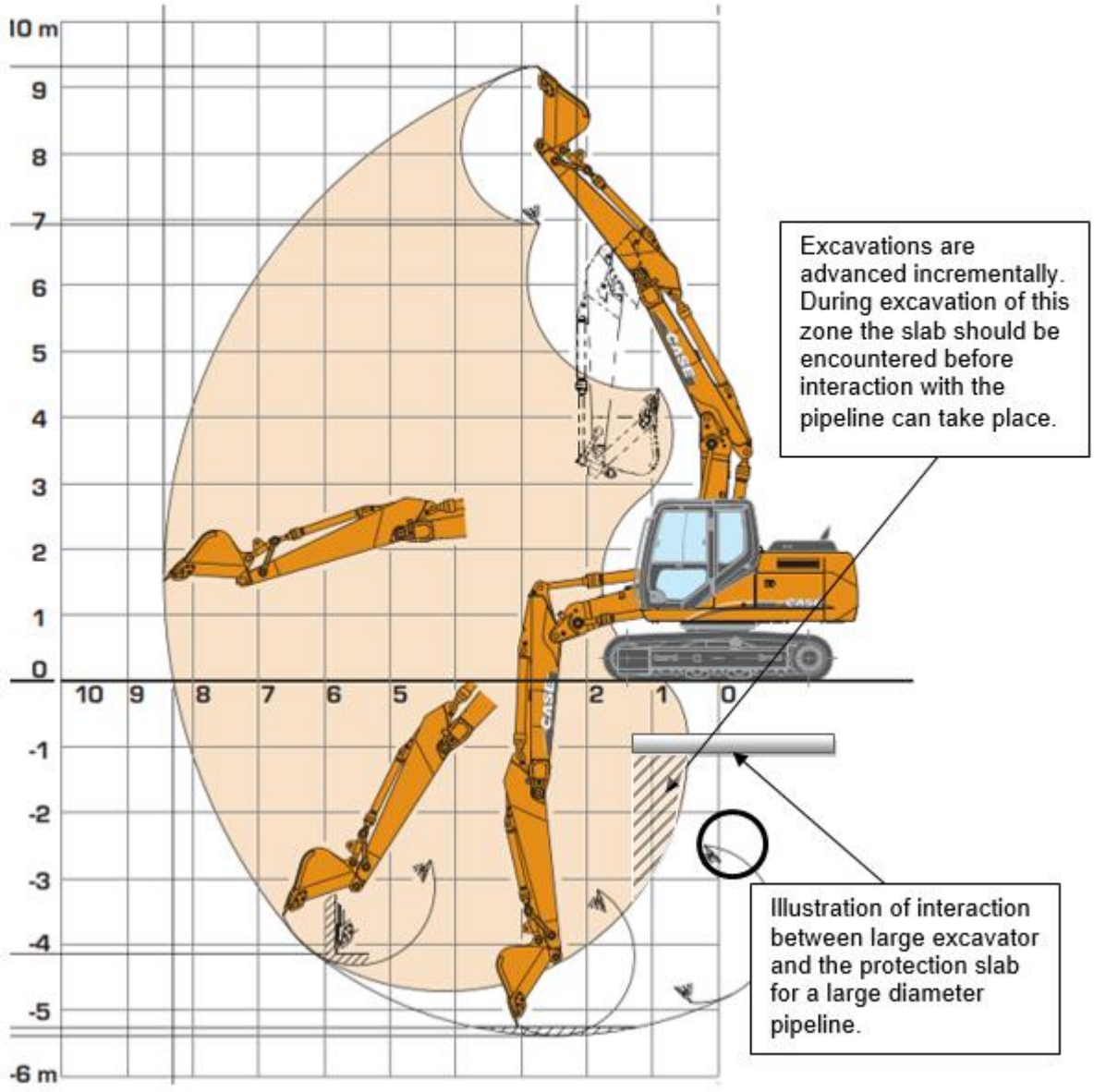


Figure A1.1 - 12T Case CX130B (Diagram by permission of Case Construction LTD)