Guidance on the support of salvage faces in coal mines

Introduction

1 This document provides guidance on the support of longwall salvage faces in coal mines. It is aimed at coal mine managers, supervisors and mineworkers who have responsibility for support operations. This web-only version replaces the 1997 edition of this guidance.

2 This guidance is prepared, in consultation with HSE, by the Deep Mined Coal Industry Advisory Committee which was appointed by the Health and Safety Commission as part of its formal advisory structures. The guidance represents what is considered to be good practice by the members of the Committee. It has been agreed by the Commission. Following this guidance is not compulsory and you are free to take other action. But if you do follow this guidance you will normally be doing enough to comply with the law. Health and safety inspectors seek to secure compliance with the law and may refer to this guidance as illustrating good practice.

Application

3 This guidance applies to salvage faces in coal mines and includes the associated T-junctions and roadways immediately adjacent to the face line. It covers the use of free-standing support alone, or mixed systems which rely on a combination of free-standing support and rockbolts. A face should be considered as a salvage face from the time when salvage preparation work begins in accordance with the design document.

Definitions

4 The following definitions apply throughout this guidance:

- **Free-standing** supports are supports which are erected between the floor and roof, eg arches, girders, steel sets, chocks/cribs, props and bars.
- **Inspection officials** are persons appointed to carry out inspections under regulation 12 of the Management and Administration of Safety and Health at Mines Regulations 1993 (MASHAM).
- **Members of the management structure** are the mine manager and other persons appointed to the mine management structure under regulation 10 of MASHAM.
- **Powered supports** are supports which are advanced and set by mechanical energy, and use an external power supply to provide the initial setting resistance.
- **Rockbolt** is a rod inserted into the roof or side which is used in conjunction with fully encapsulating resin or some other appropriate substance to provide reinforcement of the roof and sides of a working place in a mine. Reference to

rockbolts in this document indicates that they are expected to offer significant support.
- Significant support is offered by rockbolts which are systematically installed as part of the support system. Rockbolts used as required to reinforce poor ground conditions are not in this category.

Geotechnical assessment

5 A geotechnical assessment is a fundamental prerequisite for the design of a support system. Managers may themselves undertake geotechnical assessments or appoint another person who is competent and suitably qualified to do so. It may be based on previous knowledge and experience where free-standing supports are to be used, or it may need to be a detailed and technical analysis where the use of rockbolts is being considered. The results of the assessment need to be recorded.

6 The assessment needs to take into account all factors likely to affect the system's performance during the life of the salvage operations and any future use of the face line. It also needs to consider the strata deformation processes to be controlled and the action of the support system in controlling the deformation.

7 The assessment should include reference to the following, as appropriate:

- **Geology:** including the strata section, rock properties, faults, cleat, parting planes, presence of water or any substance likely to flow, borehole information and gradients. All factors need to be correlated relative to the mining horizon.
- **Nature of caving:** including the consolidation of the goaf.
- **Stress:** the direction and magnitude of the stress field components for pre-mining, mining-induced conditions and interaction.
- **Pillar design and effects:** the assessment needs to identify potential risk areas.
- **Environmental effects:** including the effects of ambient temperature, mine water and associated impurities.
- Conditions in the T-junction areas and roadways immediately adjacent to the face, particularly where the salvage is to be undertaken into roadways principally supported by rockbolts.

Support system design

General design considerations

8 A support design document will need to be prepared, based on the geotechnical assessment. The document will need to consider the following:

- Tests on the powered supports to ensure that they are operating at their specification.
- The operations to be carried out during the preparation cuts which need to be completed to ensure that the face is in a suitable condition for salvage.
- The protection to be offered against the goaf. Where the powered supports are to be withdrawn, the design should specify the setting and maintenance of supports for the purpose of preventing the breaking of the roof in the goaf overriding the supports on the face line.
- Protection against the goaf flushing into the area where supports are being salvaged by the use of mesh or similar material installed over powered support beams and allowed to carry back into the goaf.
- The reinforcement of face ends and the adjacent roadway by free-standing supports or bolting techniques.

- The provision of adequate height for transport on or off the face, especially on advancing faces.
- The maintenance of two means of egress until salvage is complete.
- The limits of the design and the need for further assessment in certain circumstances. This may apply where powered supports have become trapped by the strata and need to be released before salvage.

9 When the initial design has been completed, documentation needs to be prepared detailing:

- the use of the face line/junction;
- the free-standing supplementary support including goaf edge protection;
- the method of work, referring to the phased installation of support material and removal of coalface equipment;
- the maximum designed beam tip to face distance;
- the monitoring system.

10 The monitoring system should include visual observation of conditions on the salvage face and should recognise the level and frequency of work activity at that place.

11 The design document needs to be signed by the person making it and will form the basis of the manager's support rules.

Design where rockbolts offer significant support

12 Where rockbolts are to be used to give significant support, the manager should appoint a suitably qualified and competent person to undertake and record the results of a geotechnical assessment and, on the basis of the assessment, design a safe and suitable support system. A suitable qualification for such a person would be a chartered engineer, or equivalent, who has had three years' appropriate experience in work related to mine strata control. For the purposes of this guidance this person is referred to as the design engineer. The assessment needs to be signed by the person or persons carrying out the investigation.

Powered support used as a walking buttress

13 In addition, where rockbolts are to be used, the manager should appoint a suitably qualified and competent person at the mine to implement, audit and co-ordinate the support system, and must ensure that sufficient resources are available for the fulfilment of these duties. A suitable qualification would be a Higher National Certificate in a mining-related subject together with at least six months' relevant experience of strata control activities in a coal mine and the completion of a training course in rockbolting and cablebolting. For the purposes of this guidance this person is referred to as the rockbolting co-ordinator. Where appropriate, sufficient suitably trained and competent persons need to be appointed to assist in the performance of these duties.

14 The normal minimum support requirements for a longwall face using powered supports are set out in the Appendix. If, for salvage operations, it is calculated that the powered supports will not comply with the required yield resistance, or if measurements being made confirm this, then rockbolts should not be used unless in conjunction with free-standing supports. Free-standing supports should be set ahead of the powered supports and in places where powered supports have been withdrawn and persons work or regularly pass.

15 Where rockbolts are being considered for use to give significant support and the geotechnical assessment indicates that the strata is suitable for their use, the

design engineer should prepare the initial design of the support system which will consider all strata control aspects. As a minimum, the design needs to take account of the following:

- Face cross-section including the height and beam tip to face line dimension.
- Length of bolts to be used in the roof along the face line; normally the longest practicable length of bolt should be used and the minimum length should be 1.5 m;
- Goaf edge protection.
- Mesh or other material to control encroachment of the goaf and immediate roof in the rockbolted area.
- The type of rockbolt.
- The rockbolting pattern including spacing between bolts in the same row and spacing between rows of bolts.
- The density of rockbolts in the roof along the face line. (The recommended minimum bolt density in the zone of roof above the powered support canopy is 1 bolt/sq m. In the area between the beam tip of the powered support and the face it is 2 bolts/sq m.).
- The placing of rockbolts. It is recommended that bolts to be installed in the roof are installed as close to the face as possible and as soon as practicable after the exposure of the roof. Rockbolts should be installed vertically with the exception of the final row where alternate bolts may be angled over the coal face.
- The bond strength. Measured by short encapsulation pull tests carried out at a representative site in the same seam using the proposed rockbolting materials and components. The tests need to be carried out for all major roof horizon changes within the length of the proposed rockbolt and the effect of wet flushing or alternative dust control system on the bond strength determined. This test should not be carried out in the zone of roof above the powered support canopy. The bond strength should have a minimum value of 130 kN for a bond length of 0.3 m over 50% of the bolt length.
- Reinforcement of the face side at the finishing position of the face.

16 Where an existing design has already been proved, reference to it may be made for other salvage faces of similar dimensions in the same seam. This is providing that suitable and sufficient steps are taken to show that geological conditions, rock properties and stress fields at both sites are substantially similar.

Face line after salvage

17 Attention should be paid to the design of the roadway entry onto the face, particularly where support of the roadways is principally by rockbolts. Additional reinforcement and support should be clearly specified.

Monitoring

18 The Deep Mined Coal Industry Advisory Committee publication *Guidance on the use of rockbolts to support roadways in coal mines* (www.hse.gov.uk/pubns/mines01.pdf) advises that the mine manager needs to prepare a scheme for the routine monitoring of roadways and appoint a suitably qualified and competent person to implement, audit and co-ordinate the scheme. Where rockbolts are used on salvage faces, the manager should prepare a further scheme which takes account of this. The guidance also describes the monitoring devices and procedures and reference should be made to this when implementing a scheme of monitoring.

19 A suitable monitoring scheme should include as a minimum the use of dual height tell-tales installed to at least twice the bolt length or 4.8 m, whichever is the greater and with the lower anchor positioned 0.3 m below the top of the bolt. These should be installed:

- at 20 m intervals along the salvage face once the cutting cycles have been completed;
- at face line junctions with the gate roads;
- 10 m outbye of the junctions where the roadways are supported by rockbolts;
- in areas of known or suspected instability;
- in areas of likely interaction from other workings.

20 In addition, where gate roadways are supported on rockbolts, a multi-height extensometer should be installed as close to the centre of the T-junction as is practicable.

21 Each monitoring station should be given a unique identification code which can be used to identify readings. A plan needs to be prepared showing details of the siting of monitoring stations having regard to geological and mining features, and including details of the instrumentation at each station.

22 Monitoring instruments need to be read by suitably trained, competent and authorised personnel using the appropriate equipment.

23 The monitoring scheme should set out the manager's requirements for:

- the procedures for the auditing of routine monitoring devices;
- the equipment to be used;
- the duties of individuals;
- plans, schedules and reports;
- the maximum levels of movement allowable on the monitoring devices before action is required;
- the action to be taken and the person responsible for taking the action.

24 The monitoring results and interpretation need to be retained for future reference.

25 The results of the monitoring need to be interpreted by the co-ordinator. The manager should be informed of any actions or changes recommended as a result of the interpretation, and these actions or changes should be implemented.

26 When the initial design has been completed, the design document described in paragraph 9 needs to be prepared. Additional documentation will be required detailing:

- the layout and dimensions of the rockbolting pattern;
- the specification of rockbolting consumables to be used;
- the specification of the rockbolting installation equipment and related matters such as the minimum air or hydraulic pressure to be provided;
- the maximum designed face to bolt distance.

27 The design document needs to be signed by the person making it and will form the basis of the manager's support rules.

Appendix Minimum support requirements for powered supports on longwall faces

The face working comprises four zones of operation (see Figures 1-5 for details of the parts of the face covered by each zone):

- The face line zone.
- The buttress zone.
- The pack zone.
- The roadhead zone.

The designed yield resistance for the powered support system in the above zones should not be less than the values given below:

Yield resistance

Zone	*Tonnes/m^2*
Face	15 H or 15 tonnes/m^2 whichever is the greater
Buttress	15 H or 15 tonnes/m^2 whichever is the greater
Pack	10 H or 15 tonnes/m^2 whichever is the greater
Roadhead	10 H or 15 tonnes/m^2 whichever is the greater
Where H is the designed extracted height expressed in metres	

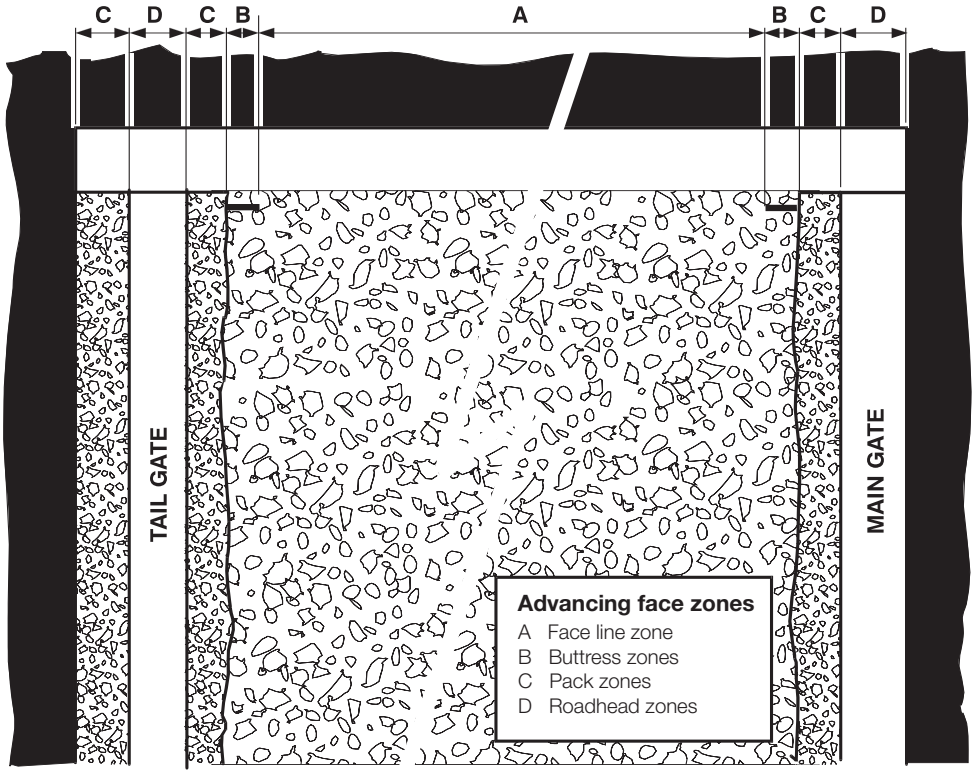

Figure 1 Advancing face

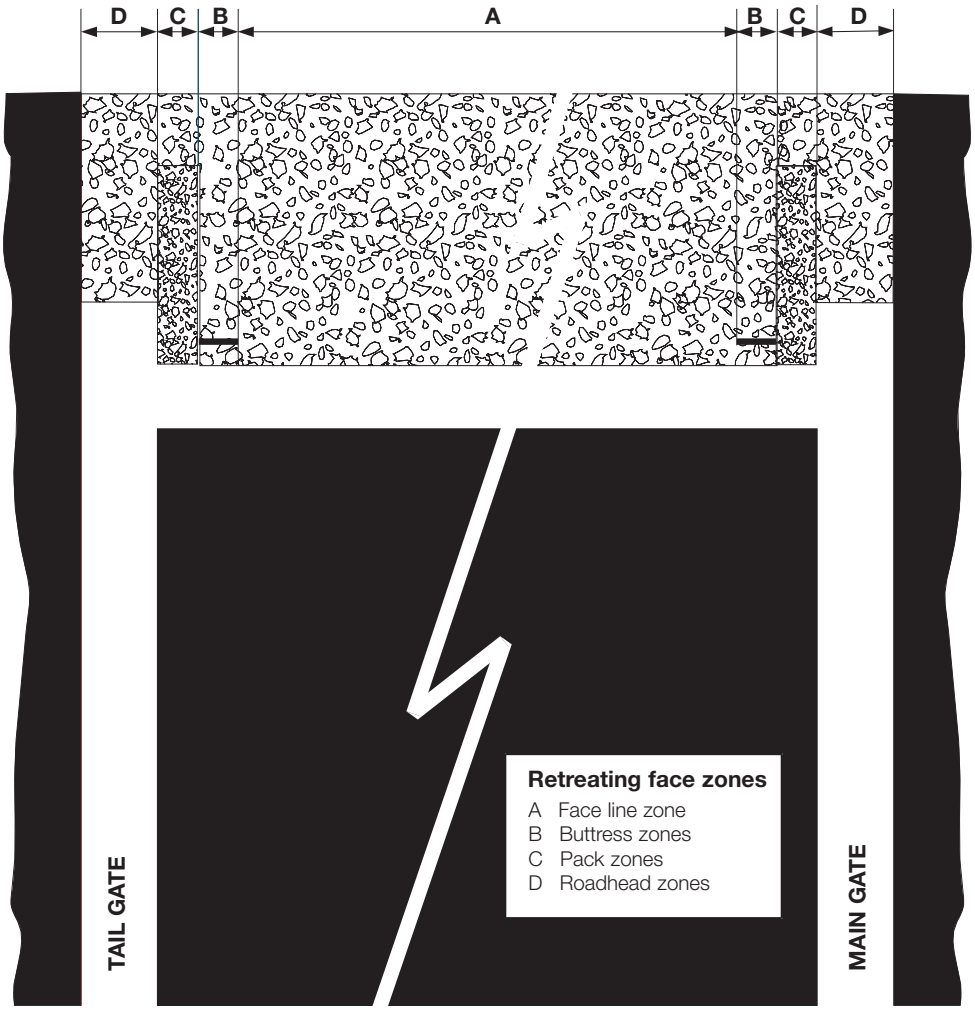

Figure 2 Retreat face

Note: *Zones B and C are not always present*

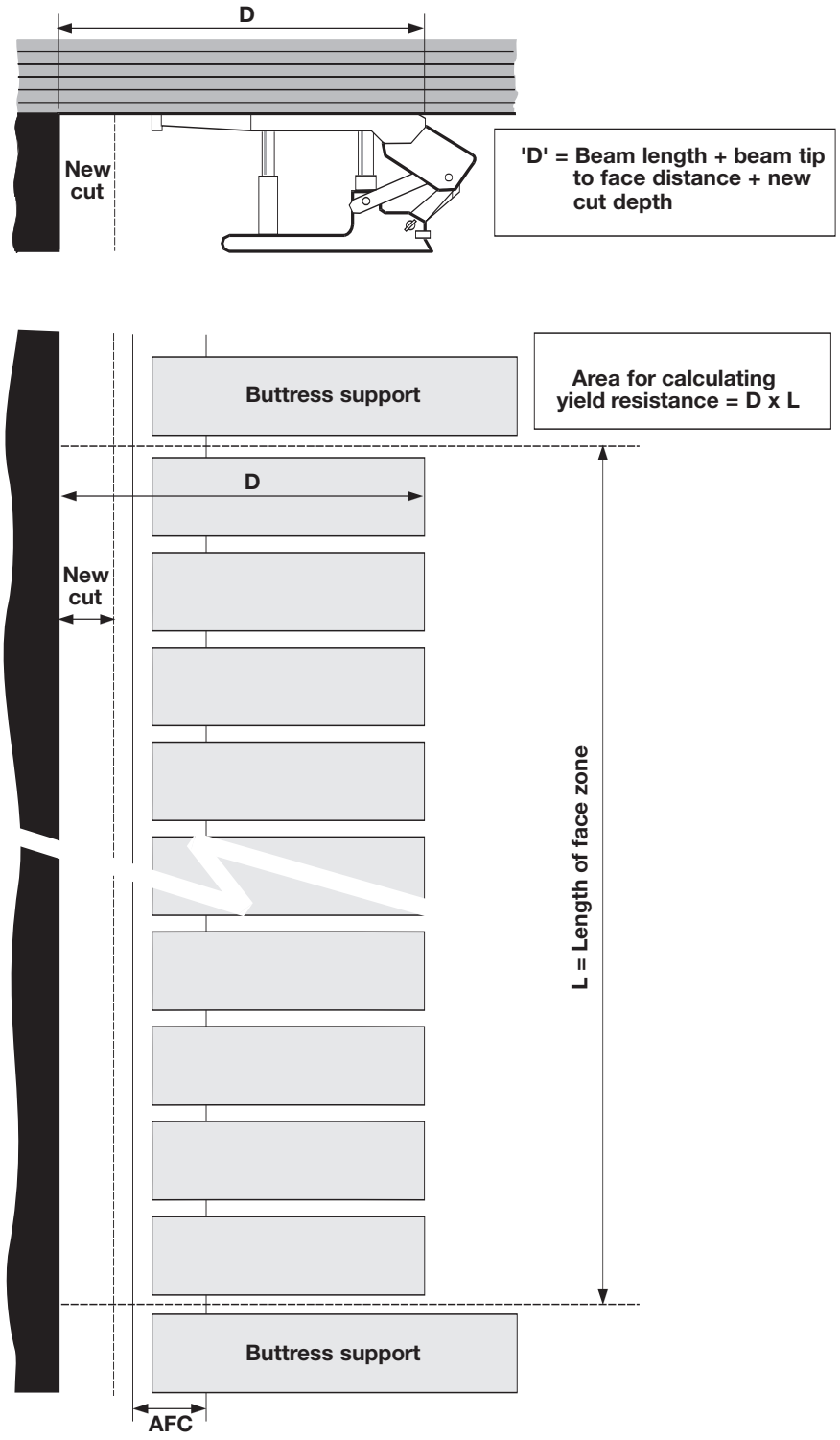

Figure 3 Face line zone yield resistance

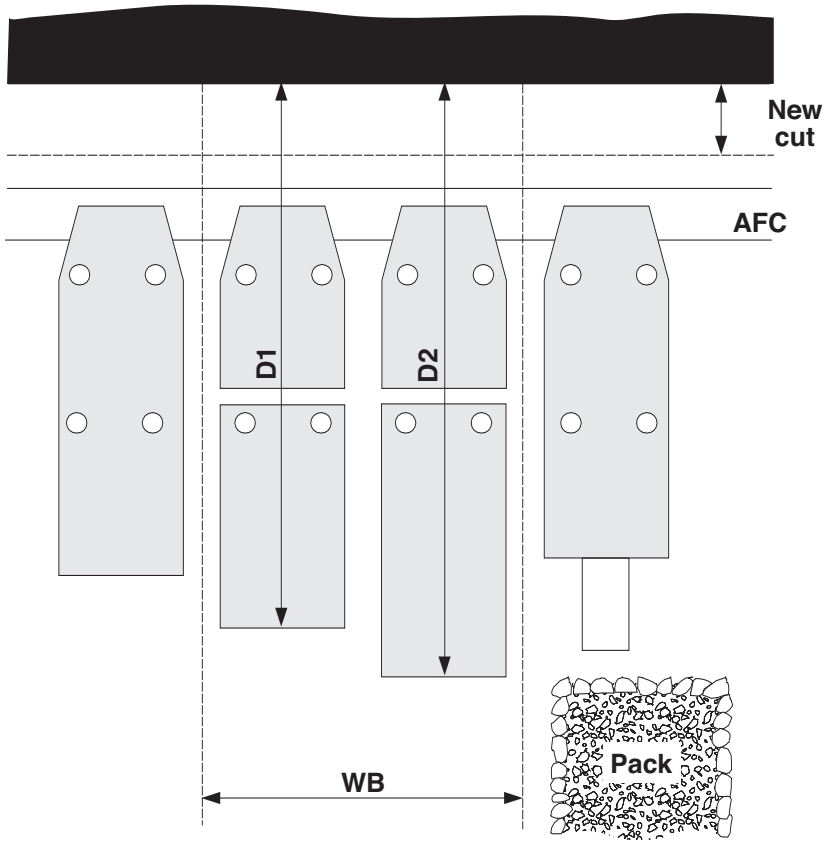

Figure 4 Buttress zone yield resistance

$$\text{Area for calculating yield resistance} = \frac{WB \times (D1 + D2)}{2}$$

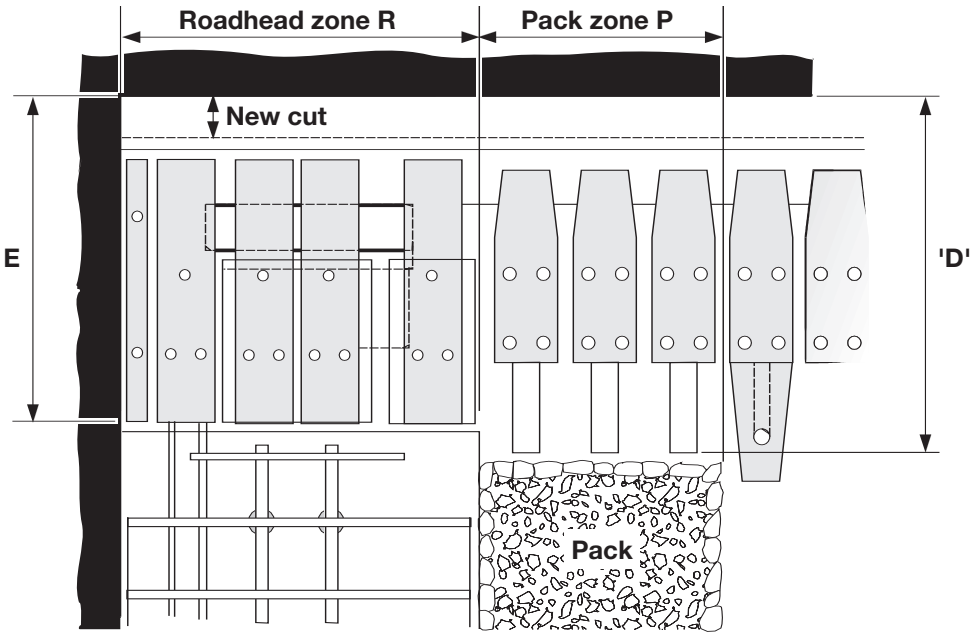

Figure 5 Roadhead and pack zone yield resistance

Area for calculating pack zone yield resistance = D x P
Area for calculating roadhead zone yield resistance = E x R

Further information

HSE priced and free publications are available by mail order from HSE Books, PO Box 1999, Sudbury, Suffolk CO10 2WA Tel: 01787 881165 Fax: 01787 313995 Website: www.hsebooks.co.uk (HSE priced publications are also available from bookshops and free leaflets can be downloaded from HSE's website: www.hse.gov.uk.)

For information about health and safety ring HSE's Infoline Tel: 0845 345 0055 Fax: 0845 408 9566 Textphone: 0845 408 9577 e-mail: hse.infoline@natbrit.com or write to HSE Information Services, Caerphilly Business Park, Caerphilly CF83 3GG.

This document is available web only at: www.hse.gov.uk/pubns/mines03.pdf