ENGINEERING ASPECTS TO BE INCORPORATED INTO DESIGN OF NEW STORAGES AND MODIFICATION OF EXISTING STORAGES FOR CONTROLLED ATMOSPHERE

D. M. ELLIS
Co-operative Bulk Handling Limited
22 Delhi Street WEST PERTH WA 6005 AUSTRALIA

ABSTRACT

This paper sets out various modifications to a standard design structure which should be carried out if a programme of sealing is to be implemented in the near future. The costs of these modifications when carried out during construction are much less than the costs associated with altering and modifying an existing building. All of the modifications keep in mind good storage practice and are in no way detrimental during an interim period. The items listed hereunder are to serve as guidelines and cover structural, ventilation and interior treatment.

INTRODUCTION

The great majority of storages operated by Co-operative Bulk Handling Limited (CBH) are of the flat, or 'horizontal' type. Figure 1 shows the typical 'A' Type storage, having concrete walls, concrete floor and truss or portal frame roof structure and corrugated, galvanised iron roof sheeting. Figure 2 shows a typical buttress wall type storage, known as 'E' or 'G' Type. In this instance the floor is of compacted form with bitumen topping. Walls are inclined timber 'A' frames, sheeted in horizontal running, corrugated iron. The building structure for roof and floors is independent of the wall system. Both types of construction have been utilised throughout the C.B.H. system for a number of years and, in essence, are very similar to many storages constructed around the world for handling grain, either in bag or bulk.

DESIGN CHANGES TO ASSIST SEALING

It is easy to make minor changes in the design of these storages so that they can be more easily sealed after construction than the current storages. This paper details some changes made to CBH designs to assist sealing after construction.

Changes to Ventilator Design

Existing storages were ventilated throught the roof with a number of convection-type ventilators. When the storage is to be sealed, opening and

closing these ventilators would be a difficult and expensive undertaking. The design of ventilators was, therefore, modified to allow for the later addition of a sealing support plate (Fig. 3). At the time when sealing is undertaken, the plates would be attached to the underside of the ventilator and sealant material applied. They may be removed for ventilation at a later date if so required.

Changes to entry into storage from inloading Conveyor

The overhead belt conveyor from elevator or from distant pit area generally passes through the wall into a penthouse from which the grain flow is either split or distributed on to overhead conveyors. A readily sealable panel around the belt was considered difficult to achieve. Therefore the conveyor is now elevated above the roof line and spouting passes through the roof to the distributing belts. a simple manually operated slide plate is provided in the spouting and the outside edges of the spout sealed against a support platform. Access by personnel is through a lockable, sealable man-hatch (Figs. 4 and 5).

Elimination of Bird Netting

In previous designs of storages ventilation openings were fitted around the structure under the eaves. This area is sealed off with sealed storages. It has been the practice to fit moulded nylon netting there to prevent entry of birds. This has now been replaced with inclined galvanised sheeting which may be readily sprayed with sealant to give a gastight seal at the eaves.

Modified Sealing of Main Doors

The main doors of the storage are used for access of mobile grain handling equipment during outloading. As the storage is filled and the grain heap reaches the floors, they are closed and sealed from the inside. Previously, flaps of rubber belt had been provided as a rough seal at the door to prevent grain escape at the hinges. These are now eliminated to make the work of sealing the hinge line easier. The doors are also fitted with a 'last man out hatch' so that whichever is the last access door, sealing can be fully carried out from the inside. The operator crawls then through the sealable manhole hatch and bolts it into position (Fig 6).

Installation of Lighting

Previous storages were found to have sufficient lighting from the natural light coming through the eaves, doors, ventilators and translucent sheeting (skylights). With advent of the design changes, as described in this paper, it was found necessary to install artificial lighting along the conveyor

gallery. The lighting is D.I.P. (Dust Ignition Proof) and suspended from the main portal frames. Lights are used during operation and maintenance of the conveyors and as general lighting over the area during outloading by front end loaders. Alternatively, installations in remote areas without power can utilise light panels with sealed edges to be closed and sealed whenever sealing is carried out. (Light Specification:- D.I.P. HAZLUX No 3.400W High Pressure Sodium DS25C-225B).

Addition of Girts to Allow for Installation of Fans

When the additional sealing preparations described here are made, it is found that the storages are part way to being fully sealed and as such, air movement within the storage is reduced. Loose fines and dust from the grain remains in suspension in the air, particularly during full sealing stage. It has been found that the installation and use of reversible fans in each of the gable ends of the storage disperses these fines. Fan direction is operated in accordance with prevailing wind direction. For a storage capacity of 27 200 tonnes (approximately 35 000 m^3), fan capacity of 170 m^3/min^{-1} to 180 m^3/min^{-1} each is satisfactory i.e. air 'in' equals 340 to 360 m^3/min^{-1} with equivalent air exhausted at the other end of the storage. Some strengthening of the area where the fans are installed is required to provide adequate structural support. After storage has been fully sealed, changes in fan capacity are not required. In addition to the fans, ventilation doors are provided in the apex of each gable end (Fig 7). In Co-operative Bulk Handling installations the ventilation door is fitted behind a retractable monorail utilised when servicing motors and other equipment.

Additional Purlins for Strength on Roof Sheeting

Normally purlins are installed on our recommended pitching consistent with roof loading and type of sheeting. It is found, however, that with the additional loads of sealing material plus the requirement for operators and sealing personnel to move about the roof it is necessary to decrease the purlin spacing slightly. To make the roof safer to walk on and to reduce the headspace volume in the storage the pitch has been reduced by 10% from the normal design specification. Safety eye-bolts are provided at ridge line for maintenance workers to attach safety lines when working on roof (Fig 8).

Elimination of Translucent Sheeting

Many of the old storages had translucent sheeting at approximately five metres staggered pitch with one section of roof sheeting being replaced with translucent sheeting. The light input was sufficient for work within the storage. However, the heat input was found to be high. Translucent sheeting

on existing storage has to be sprayed over with a clear material for sealing. With new storages, the sheeting is simply eliminated.

Provision of Colourbond Roofing

To lower the heat input to the air within the storage, white colourbond roofing material has been selected. Colourbond is a corrugated iron sheeting with a factory-applied coloured coating on one side. Tests have shown that substantially lower day temperatures (45°C compared to 60°C) are experienced in the headspace of storages so constructed. Gas losses due to the daily temperature changes are therefore considerably less. (For additional data on tests carried out by Co-operative Bulk Handling Limited for heat reflective materials, see Paper No. 20 (C. Barry) - this Symposium).

Gallery Conveyor Painting

With the loss of natural light in the storages from the elimination of skylights, attention was given to the colours for equipment and walkways within the storage. Originally, Co-operative Bulk Handling Limited conveyors were painted glade green with grey structure and galvanised walkways and black grids. This has now been modified to galvanised equipment including walkways and grid so as to form a better reflector for what light is available. Machinery such as trippers, conveyors, head etcetera have been painted white enamel. Pulley shells and rotating items have been retained at Industrial yellow and electrical equipment remains orange.

CONCLUSION

It can be seen that the design changes facilitating sealing are minor and simple to carry out. Incorporation of such changes in the design stage makes the work of sealing subsequently both cheaper and more reliable.

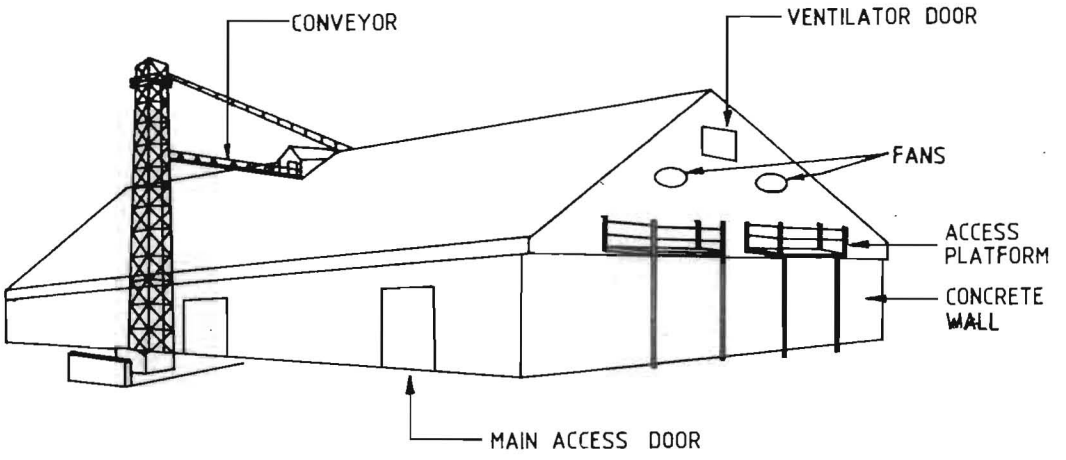

FIG. 1. A TYPICAL 'A' TYPE HORIZONTAL STORAGE AS USED BY C.B.H. IN WESTERN AUSTRALIA. DESIGN CHANGES ASSISTING SEALING ARE INDICATED.

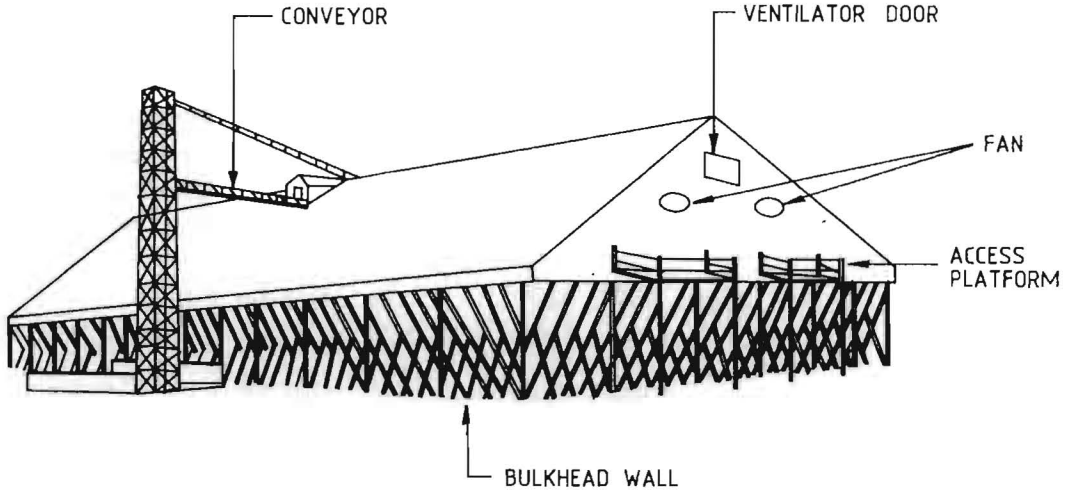

FIG. 2. A TYPICAL 'G' TYPE STORAGE AS USED BY C.B.H. IN WESTERN AUSTRALIA. DESIGN CHANGES ASSISTING SEALING ARE INDICATED.

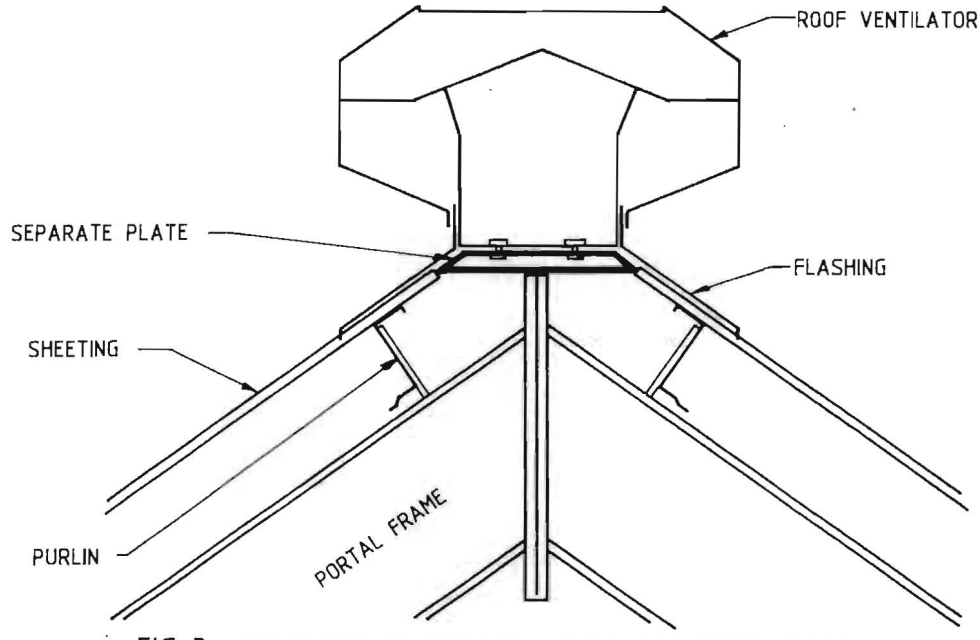

FIG. 3. MODIFICATION OF VENTILATOR DESIGN TO ASSIST SEALING

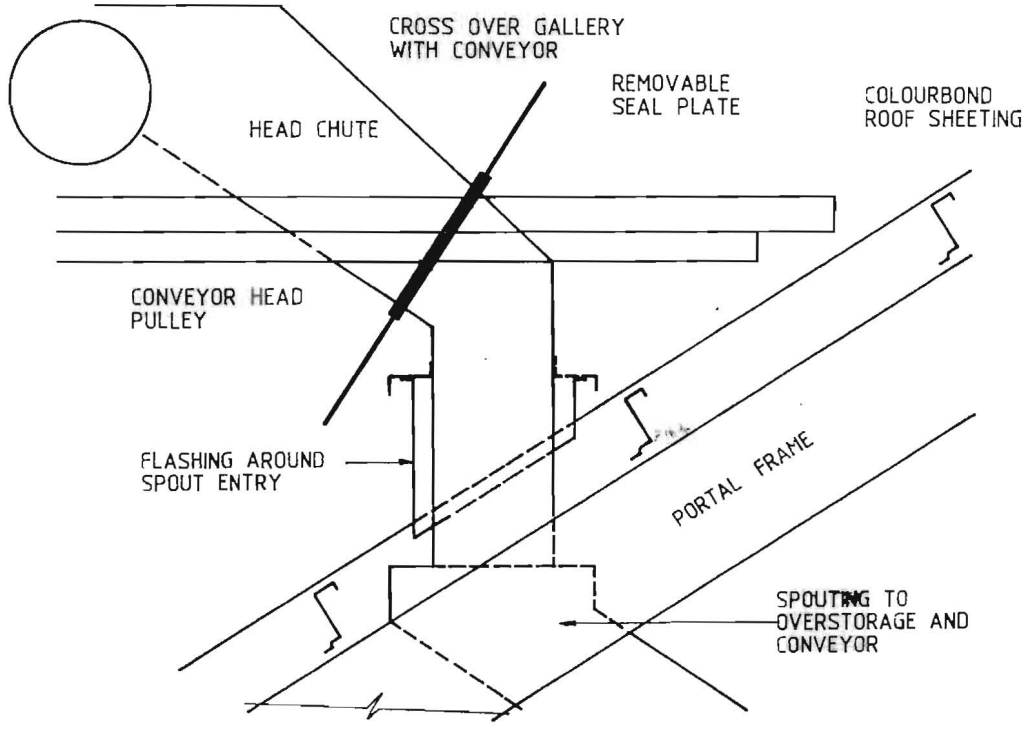

FIG. 4 REDESIGNED GRAIN ENTRY SPOUT

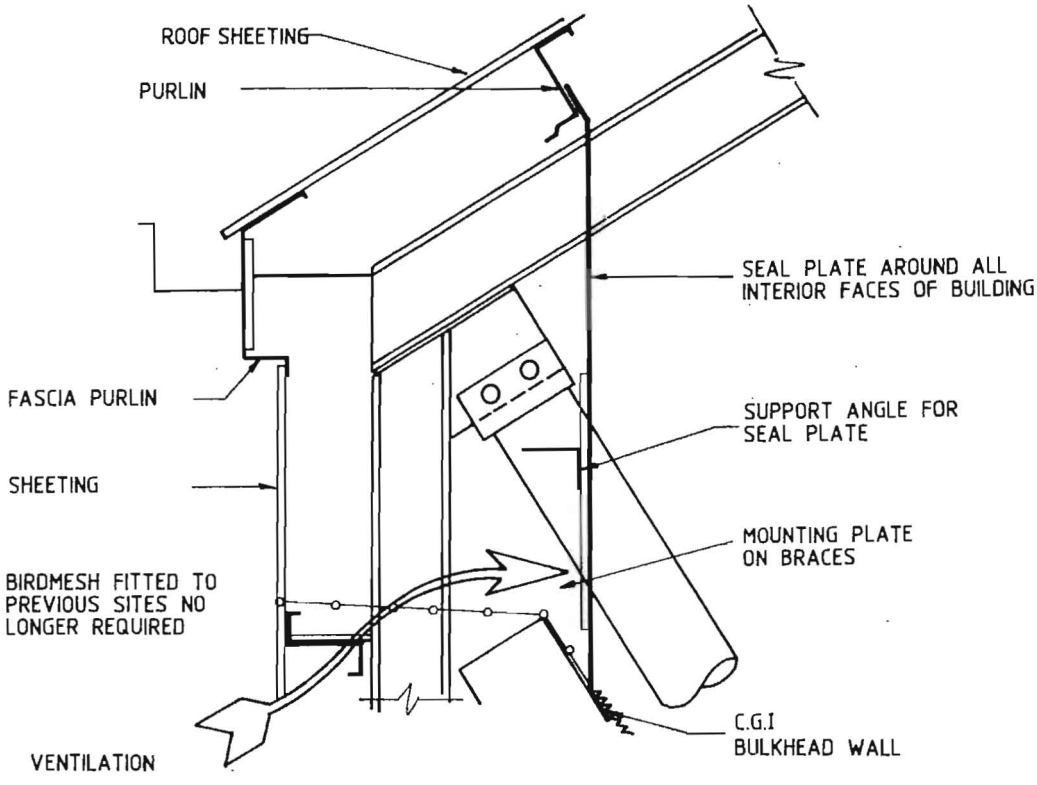

FIG. 5. DETAIL OF TOP OF WALL

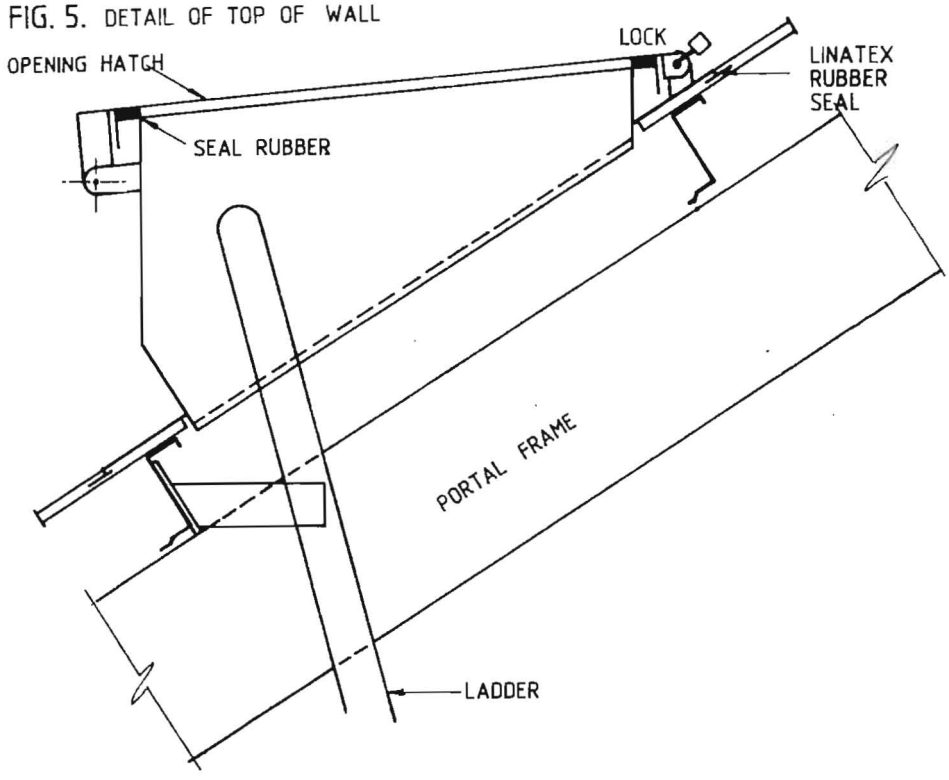

FIG. 6. DETAIL OF FLASHING AROUND CONVEYOR ACCESS HATCH.

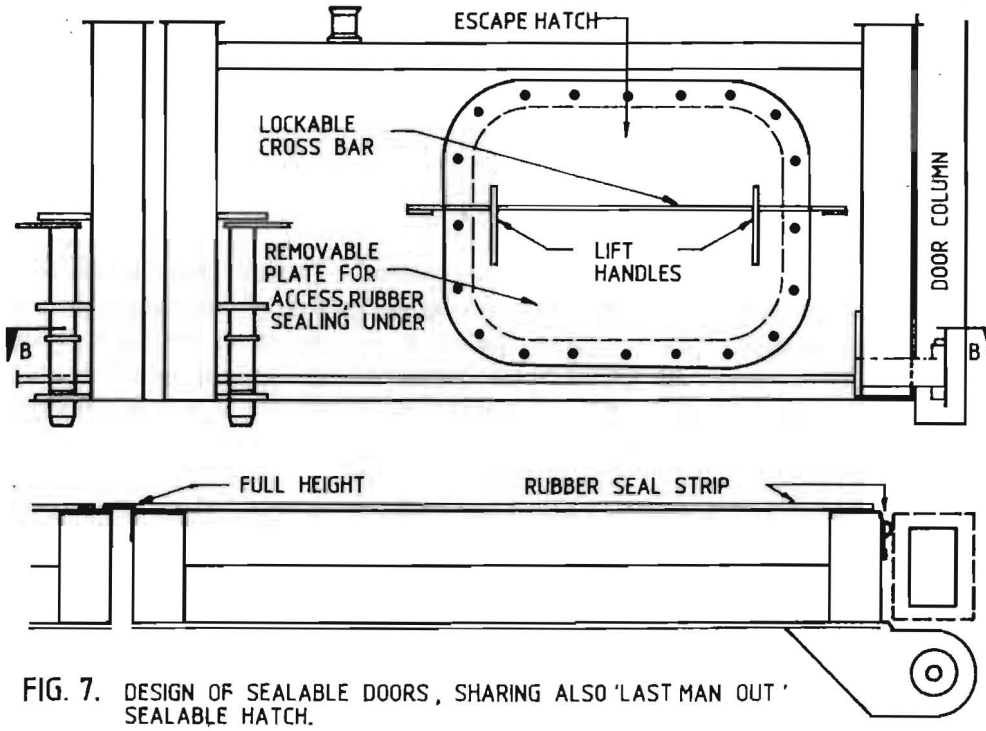

FIG. 7. DESIGN OF SEALABLE DOORS, SHARING ALSO 'LAST MAN OUT' SEALABLE HATCH.

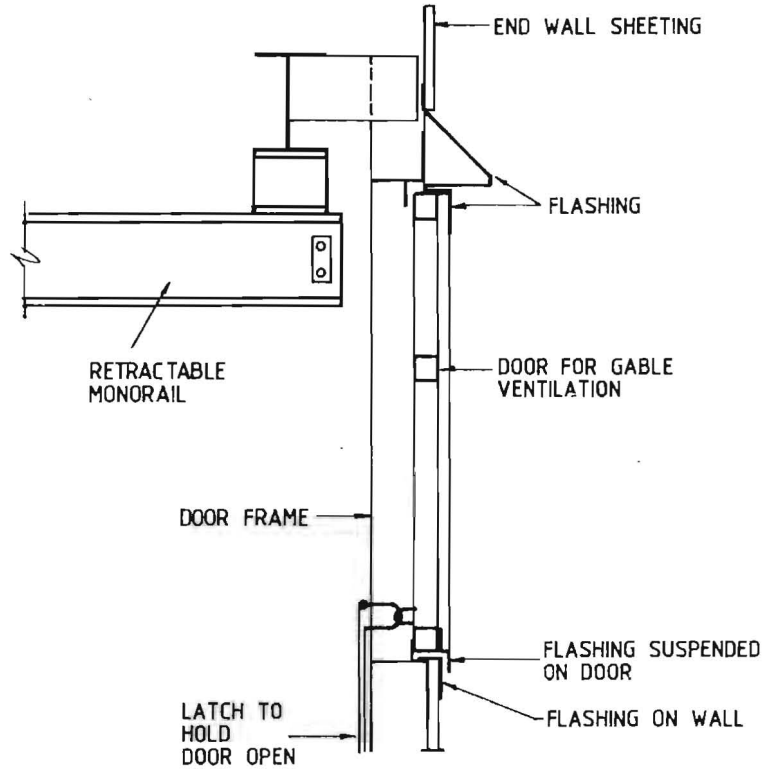

FIG. 8 DETAIL OF DESIGN OF VENTILATION DOOR FOR EACH GABLE END.

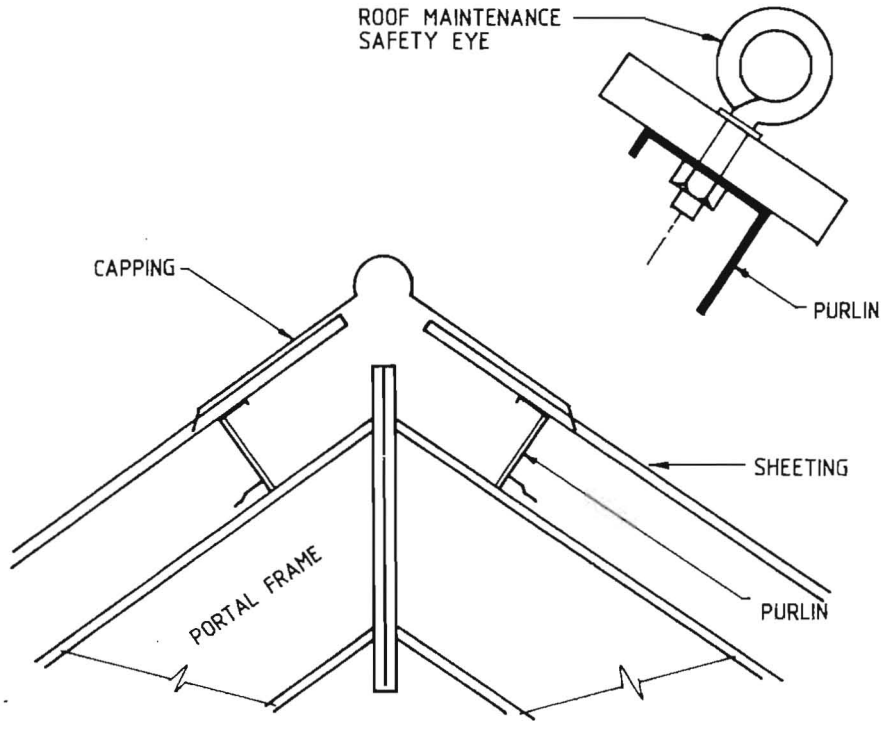

FIG. 9 . DETAIL OF SEALED RIDGE LINE SHARING FITTING OF SAFETY EYE FOR MAINTENANCE AND SEALING WORK.