ROUND BAR MANGANAL® STEEL "JAIL BAR" BAT GATE

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Abstract

Over the last 18 years, the Utah Abandoned Mine Reclamation Program has utilized metal shaft and portal closures when physical constraints or the presence of sensitive bat species required an alternative closure method to backfilling. A variety of metal closures have been installed with the round bar Manganal® "jail bar" bat gate being optimal in meeting the duel goals of preventing human entry while allowing bats continued use of the mines. All types of metal closures are susceptible to vandalism and, as such, the design or creation of a secure closure is a dynamic process. Easily adaptable, the Manganal® gate design has proven its resistance to hacksaws, come-a-longs, and jacks. The gate design incorporates such features as ease of field fabrication and installation (thus minimizing the construction time under the brow), the labor involved, and disturbance to the area. Construction costs for Manganal® gates are comparable with mild steel closures due to reduced construction time and a smaller volume of materials required. In Utah, mine site access is often difficult and locations remote favoring small volumes of construction materials with comparatively light- weight. Maintenance repairs can usually be performed by a single individual.

Introduction

Over the last 18 years, the Utah Abandoned Mine Reclamation Program (UAMRP) has utilized a variety of metal shaft and portal closures when physical constraints such as equipment access, lack of or cost of fill materials, or the presence of sensitive bat species required an alternative closure method to backfilling or the construction of concrete block walls.

These metal closures have been met with a variety of success and, as a result, have evolved over the life of the Abandoned Mine Reclamation Program. When left undisturbed, most any closure works well with very little degradation occurring. But with the human factor and its associated vandalism, no closure is totally damage proof and, as a result, all of the closure designs utilizing metal have experienced vandalism of some kind.

Metal Closures

Since 1983, the AML program has used seven types of metal closures. Many were implemeted prior to any sensitivity to bat habitat issues and were developed based on other concerns such as continued air or water flow through the mine workings. The first such closure was an A-frame style bird cage closure constructed out of one-inch square tubing and 3/8-inch square bar stock (Figure 1). Although this design allowed bats continued use of the mine habitat that was not its design intent; airflow and movement of water from snow melt into the mines was its main goal. However susceptibility to collapse under moving snow loads and ease of vandalism eliminated the continued use of this type of closure (Figure 2).

The second design, again not specifically adapted for bats but usable by them, was the use of 3/8-inch round bar metal turned to form a cyclone fence design that laid flat at grade over an open shaft and was bolted into bedrock on the sides. This design was used when backfill material was not available or the shaft depth was too great making the economics of backfilling impractical. With this design bats could pass through the 5 by 5-inch openings, but off-site fabrication and difficulties with installation made this method too costly.

The third method used was to fabricate a 1-inch diameter rebar mesh on 5-inch centers cemented into a concrete grade beam around the perimeter of vertical openings (Figures 3 and 4). This method is currently still used for vertical openings and in some geological settings, such as sandstone, the rebar can be drilled and "pinned" directly into the bedrock below grade of the opening and epoxyed in place (Figure 5). Spot-welding at each cross member aids in stability and vandal resistance. To date, only one of these rebar type grates has suffered vandalism.

A forth method utilizing aircraft cable net has been used by the Utah AMRP on mines in the State within Nation Park Service boundaries. These cable nets consist of a single strand of aircraft cable woven and clamped at cross points creating 8 by 8 inch openings (Figures 6 and 7). One problem with the nets is they are easily breached by vandals if they are placed in areas that have easy access. Cable nets have also failed due to corrosion when in contact with acid soils.

Steel mesh doors have also been used in a limited number of mine openings. These closures leave a gap at the top of the gate that could be used as a flyway thus allowing some limited use by bats (Figure 8).

Bat Closures

In the early 1990's, when many abandoned mine programs developed an awareness of the critical relationship between bats and abandoned mines, Utah installed many of the angle iron bat gates. Many of these gates have been breached by vandals. They used hacksaws in order to gain entry into the mine workings. One area where the angle iron gate has been very successful is in Capitol Reef National Park. In 1993, eight angle gates were installed in adits that make up the Oyler mine complex (Figures 9 and 10). These gates remain in place today, vandalism free. It is likely this is a direct result of increase enforcement presence and frequent patrols typical in National Park Service administered lands.

The UAMRP continued to use the angle iron gate in other areas of the State undergoing mine land reclamation with less success. Vandals attacked gates installed in mines in the Wasatch Range, the highly visited mountains just east of Salt Lake City. Hacksaws were the preferred method used to gain entry at gated mines. Even though angle iron bars had the two inch stiffeners as per the design specifications, vandals would manage to saw through a cross bar at the connecting point to the upright, then by constant torqing of the free end of the bar vandals would break the weld holding the bar to the upright thus freeing the entire bar from both uprights.

In order to test the angle iron design and potentially thwart future vandalism, UAMRP installed a gate in a heavily visited mine that had easy access. When the gate was vandalized using hacksaws, hard facing was welded along each edge of the bars and uprights. This thrust and parry between the vandals and the maintenance team continued until UAMRP realized, that in Utah, this was not a design that would deter vandals. Additionally, the cost of returning multiple times to a single site to perform maintenance was cost prohibitive and impractical. For isolated hardrock mines in the State of Utah, a new design was needed to accomplish the multiple goals of public safety and habitat protection.

Manganal® "jail bar" gate

In Utah, the round bar Manganal® bat gate has become the optimal design in meeting the duel goals of preventing human entry into dangerous abandoned mines while allowing bats continued use of the habitat those same mines provide. The design is based on the 1-inch diameter Manganal® "jail bar" type steel (Figures 11 and 12). The Manganal® steel is an alloy comprised of 12-14 percent manganese and iron. This alloy work hardens giving it the necessary strength and resistance to hacksaws and chisels that seem to be the prominent vandal tool in Utah. During fabrication, the steel is relatively easy to work with using standard grinding tools or oxy/acetylene cutting torches (Figure 13). This design allows for both bat use and small mammal use (Utah now has to accommodate Ringtail cats in its closure designs). The small bar diameter and use of flat strap Manganal® for the uprights rather than the more bulky 4 inch angle iron and 4 x 4 inch tubing minimizes interruption of air flow and, as in the angle iron gate, there is no interruption of water flow at the mine opening.

A total of 13 projects (Table 1) have been completed to date by the UAMRP for a total of just under $500,000. This gives an average closure cost of $2,700 each. Current costs are about $75.00/square foot installed. As with most new designs, fabrication of the first Manganal® gate was very costly, more than double the costs of subsequent gates. This is due to the continued refinement of field installation techniques, such as the sequencing the field fabrication and welding requirements on-site and within the portal opening. Although the actual cost of Manganal® steel is greater than mild steel, total constructions costs for Manganal® gates are comparable with mild steel closures due to reduced construction time and a smaller volume of materials required.

NUMBER OF SITES	PROJECT YEAR	PROJECT NAME	TOTAL COST OF CLOSURES	AVERAGE COST OF CLOSURES
1	1994	WASATCH	$8,080.00	$8,080.00
14	1994-95	SUMMIT AMERICAN FORK	$58,520.00	$4,180.00
50	1996-97	SILVER REEF	$143,006.00	$2,979.00
6	1997	SNAKE CREEK	$19,180.00	$3,197.00
21	1997	BULLION CANYON	$55,690.00	$2,652.00
2	1998	RIDGETOP	$4,500.00	$2,250.00
16	1998	WEST DIP	$32,235.00	$2,015.00
5	1998	WHITE RIM	$14,945.00	$2,989.00
6	1998	WHITEHORSE	$11,775.00	$1,963.00
14	1999	FIVE MILE PASS	$28,765.00	$2,055.00
11	1999-2000	SILVER KING	$30,985.00	$2,817.00
20	2000	JACOB CITY	$42,040.00	$2,102.00
11	2000	EAST REEF	$26,780.00	$2,435.00
177	1994-2000	TOTAL PROJECTS	$476,501.00	$2,700.00

Table 1. Gate Project Construction Costs

The bat gates are constructed of 25 mm (1") diameter solid manganese steel bar with two or more 12 mm x 10 cm (2" x 4") manganese steel strap vertical supports (Figure 13). All components are made of 12-14% manganese steel. The manganese steel gates have been known by the trade name Manganal®. The vertical supports have 25 mm (1") diameter holes cut on 16 cm (6-1/2") centers with the horizontal bars either electric welded or brazed to the vertical supports. The vertical supports are anchored to the roof of the adit by 25 mm (1") diameter 12-14% manganese bars placed a minimum of 20 cm (8") and anchored with resin. The bases of the vertical supports are anchored to the floor of the adit by concrete grout (Figures 14 and 15).

The design and installation of a lock box to the vertical support allowed one of the bars to be removed allowing entry into the adit. This removable bar design was modified to allow for the removal of two bars in response to a request by search and rescue personnel to get rescue equipment into the workings if there was ever a need. The manganese steel may be rough cut off-site and cut to fit on-site utilizing a cutting torch. The 14 cm (5-1/2") spacing between bars allows bats to enter and exit freely while effectively restricting public access. Again, modifications of this design were deemed warranted in response to a change in the national building code standards for constructed gates in public areas and when concern over small children crawling between the lower bars of the closure was raised. This modification consists of reducing the spacing of the bars to 10 cm (4") on bars located below 1.2 m (48") from the floor of the adit. The spacing of 14 cm (5-1/2") is maintained above the 1.2 m (48") threshold. This allows for at least one and often many flyway spaces of 14 cm (5-1/2") in the average adit.

During fabrication, only two material components are needed, lengths of round bar and lengths of steel strap (Figure 16). Labor and time are reduced as only individual horizontal round bars and strap steel require cutting to finished length. Welding is only required to anchor the round bars to the strap steel and fabricate the lock box. For proper fit, the gate must be partially assembled on-site before installation within the opening (Figure 17). With subsequent installation projects, the contractors became fluent in the procedures required, thus further reducing the time spent under the brow of the mine, the most hazardous area during the construction process. Currently, time and labor required to install an average sized gate is two laborers and about one half day. Conversely, the mild steel angle iron gates require multiple components: 4 inch angle, 2 inch stiffeners, and 4 x 4 inch uprights. Numerous welds are needed to put the angle iron gate together.

Vandals have made numerous, direct attempts at damaging Manganal® gates. These attempts have included trying to shoot off the lock box, spreading the bars with a variety of jacks, and hacksawing through the bars. None of these direct attempts at gaining entry to the mines through the gates have been successful. However, two indirect attempts have been successful in gaining access to the mine workings. In one case vandals dug into the sill (floor) of the mine and underneath the concrete footing holding the gate. In a second case, one rib (side) of the mine was literally mined-out allowing access around the gate and into the workings. In both of these cases the damage was easily solved. In the first case, the hole was filled with additional concrete and steel and the second case by merely welding additional pieces of Manganal® into the gap created by the “mining” activity. Maintenance of the Manganal® bat gates can be performed utilizing a minimum of labor due to a reduced amount of materials and equipment needed. Equipment usually consists of a cutting torch and a small electric welder.

In Utah, mine site access is often difficult and locations can be remote. In some instances, such as in National Park Service lands access may be restricted to foot traffic only, mines scheduled for closure may be miles from existing staging areas. Manganal® gates are excellent for these types of applications. The relatively small volumes of construction materials, (lengths of round bar and flat strap pieces), and their comparatively light weight makes getting into isolated areas easy. Portable generators, welders, and gas cutting torches can also be easily mobilized into isolated areas. This was clearly demonstrated in the White Rim project in Canyonlands National Park. Mine sites were as far as two miles off existing access roads. Park rules prevented any motorized or wheeled traffic off existing roads. All materials and equipment had to be carried in by foot (Figure 18) to construct 5 bat gates that comprised a total of 176 square feet of Manganal® steel.

Conclusion

The key benefits of the Manganal® design are: 1) the ease of installation; 2) a reduction of materials and less welding thus minimizing construction time under the brow; 3) its resistance to vandalism by hack-saws, come-a-longs, and jacks; 4) reduced labor in the transport of materials; and 5) reduced disturbance to the area around the closure.

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