Coal ash was used by two methods: and J.A. Pennington

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addition of by-products of coal combustion is another option for the initial chemical composition of the coal. The ash contains silica when exposed to water. The strength of the final product depends on ash. The pozzolanic reaction causes the ash to set up like concrete electricity in power plants, and can be placed in a heavy use area to bond with soil or other fractions of ash due to the pozzolanic action of coal ash. The pozzolanic reaction causes the ash to set up like concrete when exposed to water. The strength of the final product depends on the initial chemical composition of the coal. The ash contains silica and alumina that react with calcium to respond much like cement or lime.

The objective of these demonstrations was to illustrate methods of utilizing coal combustion products in heavy use areas to reduce problems associated with mud.

Experimental Procedures

Options to Use Coal Ash. Coal ash was used by two methods: (1) mixed with the soil on site or (2) prepared as a bottom ash blend (BAB) of 70% bottom ash: 30% fly ash. The blend is easier to transport and apply compared to fly ash which is prone to blow in the wind due to its small particle size.

In-State Demonstrations. In the late 1990’s, Arkansas dairies in Yell and Washington counties were the sites of demonstrations using coal ash to reinforce the soil in heavy use areas. On two sites, fly ash was mixed into the soil. At site 1, the soil ash mixture was about 18 inches deep on an equipment road. This site had traditionally failed to support a tractor and feed mix wagon when the soil was moist. Also at site 1, fly ash was incorporated with the soil for a pad depth of about 4 to 6 inches for a travel lane, an area in front of a commodity barn, and an area to support silage bags. At site 1, fly ash also was pneumatically applied to the muddy area around a waterer. The fly ash was not mixed because the truck and equipment could not get close to the muddy area. The total depth of the mixture was probably 18 inches but could not be determined because the area was saturated with water. At site 2 where ash and soil where mixed, a cattle travel lane was treated to a depth of about 8 inches. In both of these sites, the mixing was accomplished with a bulldozer. For shallower mix-depths, a plow could mix the material adequately. In terms of thorough mixing, a PTO powered tiller would be ideal. After mixing the material, it was watered and compacted.

On site 3 in Washington County, a combination of various types of ash (fly ash, bottom ash, and mixtures) was used to make an 8-inch pad for a cattle travel lane on a pre-prepared soil surface. On site 4 in Van Buren County, a lane to the milking parlor was built with 12 inches of a 70:30 blend of bottom ash and fly ash. At site 4, pads were also built with extra BAB at a feeding area for hay and a storage site for hay, but were approximately 6 inches thick.

At site 5, a 70:30 blend of bottom ash and fly ash was also used to build a pad for a feeding area. The existing travel lane was narrowed, and an open lot that had previously served as a loafing area was covered with a 10-inch pad of a blend of bottom and fly ash. In addition, the loafing area was shaped to form a ridge so that 100 ft of feed bunks and two waterers could be installed along the ridge. The conversion of the loafing area to a loafing area with feed and water allowed the cattle to be kept out of the mud and prevented the cattle from creating muddy conditions elsewhere on the farm during wet weather. Before the pads were built, roof gutters were installed on a side of a hay barn that dumped clean rainwater onto the cattle travel area. The captured rainwater was piped under the travel lane to an adjunct pasture. Then the travel lane was scraped to remove accumulated manure and to get to firm soil. Dump trucks and a bulldozer were used to deliver, spread, and partially pack the ash blend. During the spreading of the ash, a water hose was used as needed to help control dust. As the soil was moist and rain was expected in the

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next couple of days, no effort was made to supply enough water to initiate the chemical reaction that causes the ash to set; however, prior to and after the rain a homemade water-filled cultipacker was used to smooth and pack the pad.

Results and Discussion

Cattle were able to walk on the packed pad surfaces immediately, even though they had not chemically reacted. After the pads absorbed water from the soil and rainfall, they reacted chemically and became a hard surface. The installation of the pads confirmed that readily available equipment like bulldozers, dump trucks, and tractors work well to apply the blend of bottom and fly ash. In addition it was determined that while ideally water should be added to the blended ash as it is being applied and packed, it will absorb the necessary water from the soil and rainfall to cure and form the desired hard surface. However, packing of the ash is critical.

Since treatment, the soil ash mixtures with at least 8 inches of pad at sites 1 and 2 have supported vehicle and cattle traffic, even under moist conditions. At site 1, fly ash was pneumatically applied to a muddy area around a waterer. The fly ash was not mixed because the truck and equipment could not get close to the muddy area, but the area has maintained a firm surface for 5 years. One pad at site 1 that was placed at the entrance to a commodity barn failed when the tractor broke through. This failure occurred when the 4-inch pad could not support a tractor when the soil under the pad became saturated. This failure emphasizes the importance of proper design and drainage, especially as pertains to depth of the pad. A geotextile fabric (that allows water movement but retards soil movement) under a pad of less than 8 inches might support the ash and allow the use of material less than 8 inches deep but this method was not attempted in these demonstrations.

On site 3, a combination of various types of ash used to make pads on the pre-prepared soil surface has supported traffic well, but the pad was at least 8-inches deep. A blend of bottom ash and fly ash, BAB, was used to build a pad for a cattle travel lane 12 inches deep on site 4 and 10 inches deep on site 5. This BAB proved to be very easy to work with. It also resulted in a very durable surface that has held up well to cattle traffic. One area of the pad did not hold up well and was an apparent sinkhole. This area had been a problem previously and was adjacent to the holding pen. It was suspected that it harbored a wet-weather spring. Finally, a 12’ X 20’ concrete pad was poured over the area, which started as a perhaps 2’ x 6’ spot. The feeding floor of 10-inch depth at site 5 has held up well. Overall, the bottom ash and fly ash of 10 to 12 inches in depth has satisfactorily supported cattle and equipment.

At site 4, BAB that remained after building the travel lane to the holding pen was applied to a feeding area and area to store hay. These pads were approximately 6 inches deep and decreased the mud in the areas but would not have satisfactorily supported cattle or equipment travel as they broke up too easily and allowed weeds to grow. When weeds grow in the ash, water penetrates the mix and breaking usually follows.

Key concepts in utilizing coal ash products are outlined in Table 1. The ash blends have a pH of 10 or 11 which indicates that they should not be used in conditions where the unreacted ash can flow to ponds and creeks. Once the fly ash blend is set, there are no documented concerns regarding runoff and leachate water from the ash.

When these demonstrations were initiated in 1998, fly ash from Oklahoma and Arkansas was being hauled to Louisiana to utilize it. However, as additional uses have been developed for the fly ash, costs have risen and must be considered before deciding on its use. A primary factor in the costs of utilizing fly ash is the distance from the plant where it is produced since hauling of the ash to the farm may cost more than the ash.

Implications

Experiences from across the nation and the Arkansas demonstrations show the potential of coal ash to moderate the impacts of excessively muddy conditions in cattle operations. With proper design and use of coal ash, cattle heavy use areas can usually be reduced in size, and a better job of keeping cattle out of the mud can be accomplished. Coal ash products can be used to strengthen the soil of the heavy use area, either by mixing with the soil or by forming a pad of bottom ash blend to support cattle and equipment traffic. For most producers, a bottom ash blend may be more appropriate as it requires less equipment. Costs should be considered when utilizing ash.
Table 1. Key Concepts in Utilizing Coal Ash Products.

- The two basic approaches to using fly ashes are to build a pad on the ground surface or to mix with the soil as an amendment. Due to the difficulty with soil mixing and requirements for large land-moving equipment, that approach is not generally recommended.
- The problem with using pure fly ash is that it has the consistency of talcum powder that requires special pneumatic trailers to haul, and that makes it extremely dusty to work with.
- Ideally, the end user is better off to have the supplier mix bottom ash and fly ash on about a 70:30 volumetric basis. This mix makes a material with a soil-like consistency that is easy to transport and handle at the application site.
- If the supplier won't supply a premixed material, fly ash and soil can be mixed on site. It is possible to use a clean soil material instead of bottom ash; however the mix ratio should probably be changed to 50:50 on a volumetric basis.
- To build the pad, surface manure and mud need to be removed to get to a firm material. Generally, since the pad will bond together, a geo-textile filter fabric should not be required. However, on very weak soils and expected heavy loads such as mix wagons, filter fabric or an 18- to 24-inch pad may be required.
- Concerns about surface drainage need to be addressed and corrected before ash is applied. When finished, there should be positive drainage off the pad.
- During installation of the ash, adding water and compaction are critical. If adequate hydration and compaction do not take place, strength and life of the final pad can be significantly reduced.
- It is possible but very difficult to add too much water. The final moisture content should be about 25%. It should be moist to the touch, but you should not be able to squeeze out water. If too much water is added, either add more ash (preferred) or let the material dry a day or two before compacting. It is better to use slightly too much water than not enough.
- Compaction can be provided by tracked or rubber-tired equipment. Usually the rubber-tired equipment will pack better but may leave ruts unless care is taken. Water-filled cultipackers can be effective for packing and smoothing the surface. To help insure adequate compaction, the material should be packed in 6- to 8-inch layers.
- It is best to add moisture and compaction as the pad is built.
- If fence posts are to be placed in the treated area, it is strongly recommended that they be placed before the material cures.
- The material takes about a month to reach maximum strength; however, under dry weather conditions, cow and equipment traffic should be acceptable immediately after construction. For wet weather conditions, a 12 -to 24-hour cure or longer should be allowed.