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Principal Author(s)

Frank Platt, David B. Burnett

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Submitting Organization

Texas A&M University Texas Engineering Research Station GPRI
College Station, Texas 77843-3116

Participating Organizations

McFaddin Ranches

Pecos Desert Test Center

Escondido Resources

Newpark Composite Mats

U of Wyoming – Lay Down Roads

Scott Environmental

RPSEA - U.S. Department of Energy Disclaimer

GPRI Disclaimer

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Disappearing Roads (Reducing the Environmental Footprint in Desert Ecosystems)

Executive Summary

The disappearing road (DR) project has been a multi-year project to design, test and evaluate multiple temporary and permanent road materials for use in harsh environmentally sensitive areas. This included a nationwide University competition sponsored by Halliburton to come up with potential designs as well as actual field trials of commercially available products.

DR is a critical component of the joint industry project Environmentally Friendly Drilling Program (EFD). http://www.efdsystems.org

The specific objectives of the DOE Environmental Drilling Systems Project are:

Identify new technology that can reduce or eliminate the impact of drilling operations on environmentally sensitive areas.
Design an EFD system using most promising technology
Include environmental stakeholders in the designs

After drilling operations are completed or suspended, roads are often remediated. This removal is intended to allow the recovery of the lands to a pre-use condition so as to minimize additional access. Experience has shown that such efforts pose difficulty, highlighting the complexity of potential long-term consequences of oil and gas operations. New systems have been tested to avoid this expense.

Tests have been performed in a desert environment in West Texas as well as a second test located in a moderate climate with significantly more rain to determine the optimum operational conditions for the materials. The project evolved to include roads made from recycled well cutting, plastic composite mats and mats made from waste materials. As in all projects the viability of any method is measured by the cost and benefit relationship. If the road material reduces cost either for construction or in the case of remediation and disposal of cuttings it could be considered a success.

Introduction

How Access Roads Change the Environment

Access roads constructed for E&P operations can have immediate and long-term effects on the surrounding terrain and the life it supports. These effects are not always negative, but the existence of an access road can invite unwarranted traffic into sensitive areas.

The simple roads typically associated with oil and gas operations can have both beneficial and detrimental effects on wildlife. Benefits include food, water and shelter provided by roadside ditches, while disadvantages include the removal of vegetation for construction purposes, dangers from traffic and run-off pollution containing minerals, heavy metals, organic compounds, sediments and agricultural chemicals.[1] In relatively arid lands, such as Otero Mesa, the forage and water accumulating by the roadside may have a positive impact on local wildlife populations.

[1] Road Ecology: Science and Solutions, R. Forman et al, Island Press EBooks http://islandpress.org/ip/books/book/islandpress/R/bo3558764.html

Pollutants can originate from construction or maintenance activities, vehicle traffic, seasonal road treatments, spills and leaks related to vehicle operation and chemical transport. Elevated concentrations of heavy metals can extend up to 330 ft. from the highway, and toxic levels may exist only a few feet from the highway (Ministry of Transport, Public Works and Water Management 1994). Erosion can be significant in some areas and the displacement of soil during road construction can contribute to significant or severe changes in run-off and flow patterns (Forman 2003).

Industry Needs

Reducing the environmental footprint imposed by drilling operations will help enlarge support for these operations, given the current attention being paid to energy shortages that can be resolved by encouraging domestic exploration and production. Low impact roads are an important feature of the overall effort to persuade environmentalists, O&G industry, and the general public that sensitive lands and waters will not be spoiled in the process.

A number of companies and research organizations are investigating and implementing ways to recycle drilling waste materials. Processed drill cuttings and other drilling by-products have been used successfully for road construction in a few areas, and as drilling waste processing technologies grow more sophisticated, the options should increase. Mechanical and chemical treatments to remove or neutralize potentially harmful components in these waste materials are increasingly effective.

The industry should develop, test and adopt technologies that contribute to the cost-effective construction of low impact roads. Side by side comparison testing of several proposed road types under carefully controlled conditions will help researchers and producers identify the most promising technologies. These tests should be performed at a location where the environment is not overly susceptible to damage, yet the outcomes will be clearly manifested. By testing several types of road simultaneously, we can determine the best applications for each type and eliminate impractical or uneconomic options.

Converting Drilling Waste into Road Bed Materials

In 2005, the Texas Railroad Commission issued the Guidelines for Processing Minor Permits Associated with Statewide Rule 8, or Guidelines Developed by Environmental Surface Waste Management in Coordination with Field Operations. [2]This document outlines the specifications for drilling waste materials intended for use in road construction, including limits on total petroleum hydrocarbons (TPH), total organic halides (TOX), and electrical conductivity (EC), as well as analytical standards for the Toxicity Characteristic Leaching Procedure (TCLP) Test for organics, metals and pH. These requirements would govern the development and testing of the proposed low impact roads.

Since then new waste treatment and disposal practices have been developed to convert drilling muds and associated cuttings to beneficial and environmentally friendly road base material to help minimize E&P operator liability. With the assistance of Scott Environmental Services, this project has tested recycled material under field conditions.

[2] http://www.tceq.state.tx.us/rules/indxpdf.html accessed Oct. 24, 2013.

Recycled Well Site Waste for Spine Road

This road type recycles waste materials remaining after wells have been drilled. Data from the UK show 50-80,000 wet tons of oily drill cuttings discharged annually[3]. The numbers for the U.S. are significantly larger due to the number of wells drilled but no official number is known.

Scott Environmental Services Inc. (SESI) (http://www.scottenv.com/aboutus.html) has developed proprietary processes designed to allow the reuse of fresh water, saltwater, and oil based drill cuttings and heavy mud in a variety of applications including road and drill pad construction. SESI also provides environmental advisory services to the oil & gas industry. This roadway portion was built from water-base mud and cuttings taken from a reserve pit in a field in onshore coastal south Texas.

Newpark Mats

The second type of road material is a completely removable section or grid system from Newpark Mats and Integrated Services. For this project they supplied 40 mats measuring 8 ft. by 14 ft. each weighing 1040 lbs. The mats use a pin/lock system to link the mats into the desired shape or direction of placement. An example of the mat is shown in figure 8. These mats can be laid out into many different formats from roadway to location pad.

Wyoming Mats

The Wyoming Mats were the result of the Halliburton sponsored competition between Universities to design a disappearing road material. The winning design came from the University of Wyoming.

Construction of the rollout roads and mats require the use of synthetic 2x8 in. (full 2 in. by 8 in. not modified to current lumber standards) boards. The original tests used 2x8 in. boards fabricated by Heartland Biocomposites Inc., in Torrington, WY. The boards were recycled plastic with straw and sand filler. The boards displayed excellent "cross grain" strength, suitable for the heavy loads of the "mountain mover" trucks hauling the fracing sand. The flexural strength of the boards was less than oak, therefore a hinge was placed midspan to relieve the flexural stress caused by truck tires. The rigid mats were built 12 ft. by 14 ft. with boards laid in two directions. A tongue and groove interlock was built into the mats to allow the mats to interlock. The rollout mats were a single board thickness with two boards connected by a wire frame in the middle and on the ends. This allowed the panel to be laid in a non-linear fashion to fit the needs of the project. All boards were mechanically locked into location by clamps on the cables located on the ends and through the middle of the panel.[4]

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[3] Cornwell, J.R., Road Mixing Sand Produced From Steam drive Operations 25930 SPE/EPA Exploration and Production Environmental Conference, 7-10 March 1993, San Antonio, Texas

[4] Burnett, D. B., J. McDowell, J. B. Scott and C. Dolan (2011). Field Site Testing of Low Impact Oil Field Access Roads: Reducing the Environmental Footprint in Desert Ecosystems. SPE Americas E&P Health, Safety, Security, and Environmental Conference. Houston, Texas, USA, Society of Petroleum Engineers.

Field Project Organization, Planning, and Resources

Organization and Responsibilities

Schedule

The schedule of the program was to construct all three sections of road consecutively at the Pecos Test facility with the requirement that all traffic into the facility be routed across this road section. Periodically, large loads similar to that seen in the oil and gas industry would be routed over the sections to see the effect.

The effect of loads and traffic on the road would be periodically noted and reported to determine the effect on the environment. After removal the site was monitored to document the progression of land reclamation.

Description of the Trial Site

The Pecos test site is approximately 22 miles SE of Pecos TX on FM 1450. A map section showing the site and routes is shown in Figure 1.

The Pecos Desert Test center is located on the edge of the Chihuahua desert, chosen because it is representative of soils found in the desert southwest. The surface of the desert floor is classified as a Cryptobiotic soil crust, consisting of soil cyanobacteria, lichens and mosses[5]. These soils play an important ecological role in the arid Southwest where the crusts increase the stability of otherwise easily eroded soils, increase water infiltration in regions that receive little precipitation, and increase fertility in soils often limited in essential nutrients. Cryptobiotic soil crusts are highly susceptible to soil-surface disturbance such as trampling by hooves or feet, or driving of off-road vehicles, especially in soils with low aggregate stability such as areas of sand dunes and sheets in the Southwest, in particular over much of the Colorado Plateau. When crusts in sandy areas are broken in dry periods, previously stable areas can become moving sand dunes in a matter of only a few years.[6]

Average rainfall for this area is from 10-11 inches with an average high temperature of 82 F. The summer temperatures can reach above 100 F and the winter temperatures can be below 32 F.[7]

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[5] Burnett, D. B., J. McDowell, J. B. Scott and C. Dolan (2011). Field Site Testing of Low Impact Oil Field Access Roads: Reducing the Environmental Footprint in Desert Ecosystems. SPE Americas E&P Health, Safety, Security, and Environmental Conference. Houston, Texas, USA, Society of Petroleum Engineers.

[6] Rosentreter, R., Bowker, M., Belnap ,J., Lange, O. L., Biological Soil Crusts. Structure, Function, and Management, USGS Canyonlands Research Station, Moab, UT 84532

[7] Pecos, TX. http://en.wikipedia.org/wiki/Pecos,_Texas accessed October 23, 2013

Figure 1. Map to Pecos Test facility from Pecos TX to site.

Construction of the Spine Road with Recycled Material

This roadway portion was built by Scott Environmental Services, Inc. (SESI) with a starting material taken from a reserve pit and mixed with a plasticity reducing agent (PRA), using a large excavator bucket. The amount of PRA used had been previously determined by laboratory test to be (i) sufficient to make the mixture, unlike the starting material, easily transportable by truck without loss from sloshing; and (ii) not sufficient to cause the mixture to harden into a monolithic structure.

The material was trucked to the site and used as road base for construction of the model lease road. A cross section of the road design is shown in Figure 3. The design is planned for a multi-season "spine road" that would serve as access to the field and serve as a high use local or rural road. A test section of *in situ* soil approximately 170 feet long x 14 feet wide (Figure 4 AND 5) was readied as the test site. Work began by watering, scarifying, and compacting the *in situ* soil using a water truck, grader, compactor, and roller, to form the road subgrade. Then a single lift of PRM and some water was placed on top of the prepared subgrade in sufficient quantity to have 10 inches of thickness after compaction, and the lift of material was smoothed, shaped, and compacted using the water truck, loader, grader, compactor and roller. Next, a pre-determined amount of Portland cement was spread over the prepared PRM by the cement truck, and then the cement and the PRM were mixed with the reclaimer and grader to a depth of 12 inches, then compacted.

Water was then sprayed from the water truck over the mixture in an amount to achieve optimum moisture content, as determined by previous laboratory testing, and the wet mixture was again mixed using the reclaimer. After that, all of the emplaced materials were compacted, then bladed and shaped to get a uniform mixture again, with additional water added as needed.

Construction, as described above, was successfully accomplished in one day, although strength gain in the material continued for several days. Figure 6 shows the strength gain of the material in place. A photograph of the completed road is shown in Figure 7. The PRM was sampled at several instances during the placement, and a composite sample was formed from these samples and sent for evaluation to a geotechnical testing laboratory, where it was mixed with the percentage of cement used and with an amount of water determined to yield a maximum density mold, then aged for seven days while being maintained moist. After completion of aging, the compressive strength and dielectric properties were obtained by standard tests.

Construction and Installation of Newpark Composite Mats

The composite mats were placed in a mowed area of the new roadway abutting the previously constructed SESI road. A total of 40 mats were delivered to the site, unloaded by a forklift and placed in a sequenced order in the roadway. Figure 8 shows the mats being installed.. A guide line was used to keep the mats in a straight line as they were placed, and then connected with the locking devices Figure 9. Once the mats were installed, the guide line was removed and the road was ready for use. Total time to install the mats (not counting unloading from an 18-wheeler) was less than 3 hours for a 250 foot road on unprepared soil.

Construction and Installation of Wyoming Composite Mats and Rollout Road Element

This section of road was installed after the Newpark mats. The methodology was similar but different in two specific areas. First the panels do not have a fixed connection and second the rollout panels are flexible to allow for a change in direction of the road. With these two factors another point was found, the Wyoming mats can only be run in one direction. The panels were built to be fitted together in one direction for road construction. They were not built for pad construction which may limit their use in the field.

To install the panels a junction or union was required between the Newpark and Wyoming mats. This was done by excavating or clearing the dirt from the edge of the last Newpark mat shown in Figure 10. After shaping the union between the panels the mats were brought down the track by forklift to the entry to the road section shown in Figure 11.

The Wyoming mats were brought to the end of the Newpark section and placed by forklift shown in figure 12. Note the gap and transition between panels figure 13. The second panel installed was levered into position by tipping the mat as we joined the two panels in figure 14.

Note the extension of board below the panel in Figure 15 which becomes more apparent in Figure 15 and 16 as a tongue and groove union between the panels. Figure 17 gives some indication of the complexity of the mat design. The panel is made of two courses 90 degrees apart bolted twice at each crossing point. At conclusion of installation of the fixed panels a semi-complete road section can be seen in Figure 18 and 19.

At this point the installation of the Wyoming Rollout panels was begun. The panels are shown in storage before installation in figure 20. Note the cables and locking clamps on the edge of the panel. These sections had been folded over and rolled up for shipment to save space on the truck. Before installation the panels required the unfolding and rolling out of the section shown in Figure 21. After preparation of the panels they could be moved by forklift shown in Figure 22. Note the buckle along the cabled connection between the two sections. This was unstable during movement and did cause some problems during installation.

Installing the road required both the forklift and a roustabout truck to stretch out the panel. This is shown in Figure 23. Without a fixed structure similar to the panels each unit requires special care during installation to obtain the best results. After stretch and layout the forklift drove on the panel to return to storage for another section. Note the break in an interior board of the rollout panel in figure 24. A second fracture of the panel occurred at the end of the section as noted in figure 25. In this case the track of the forklift can be seen over the failure as well as a washout or unlevel section at the point of the break.

Although these breaks were serious a repair was possible as shown in Figure 26 and 27. The broken sections could be replaced by removal of the broken section and replacement from the end of the panel. This would shorten the panel but would make it usable. In this case the removal of the broken sections helped in the installation of the panels. The rollout panels are only one half as thick as the fixed panels they must be connected to in the roadway. In this case we used the broken sections to build a transition between the two materials shown in Figure 28. After placement backfill was placed to smooth out the transition between the roadbeds.

In the next figures, Figure 29 and 30 the final rollout panel on this section is stretched and shaped to fit the road bed it connects. In this case the last board on the left was removed to fit the road transition.

The final section of road to be built was at the street union on the outlet side of the test road. With the trouble installing the rollout section we approached this installation differently. In this section we used the extreme range of the field forklift to pick up the road mat for placement similar to laying out a blanket or towel on the ground. An example of this is shown in Figure 31 and 32. This was superior way to install the section and took only minutes for setup and installation. The addition of a steel bar or pipe on the forklift would have made it even faster to that found in this method.

This method would be the optimum for this installation both in time required and results. Note in Figure 33 and 34 the panel upon laydown was flat and straight. Following fixed panels can be seen in Figure 34. Note the non-linearity of the rollout panel to match the union between it and the asphalt pavement.

Field Project: Operations

Trial Operations, Results and Data –Pecos Site

This test was conducted for a year with limited traffic on the pavement. Due to safety concerns with the closed overpass and a reduction of research at this site the project was terminated at this location. All temporary road sections were picked up and removed to a storage site at the office area nearby. Note the growth of tumbleweeds on edge and at breaks between panels on the Newpark mats shown in Figure 36. Since no preparation of roadbed was conducted on these sections plant growth was not stopped or inhibited during the tests.

A major issue noted on visits to the site. Buckling was occurring on the outer edges of the Newpark mats. This was due to the connection method used to install the panels. This can be seen in Figure 37 and 38. The buckling although not a complete failure of the road would make it uncomfortable for drivers over long section of mat installed as a road. A second method of installation would be to fix the outer edges of the mats with keylocks to force the sections to remain at the same elevation and not buckle.

The rollout sections of the Wyoming mats while appearing to be a novel approach to changing directions; correcting mistakes are unacceptable for roadbeds unless a base road material is installed to add strength to the material. This installation would negate the environmental impact of a temporary road with the long time required for plant life to re-grow.

One year after removal, the slow return of the area plant life can be seen in Figures 39-42. Plant life has returned to the road outlet and weeds have begun to return to the roadbed. Since removal the operator of the facility has cleared the area periodically for their use but the return is evident in what was seen.

Environmental Impact of Recycled Materials on Soil

One of the standard requirements of a road base of recycled oil field waste is that there are no hazardous materials leaching from the stabilized rock bed. To affirm that the material was stable, a set of samples was taken at the outset of the year-long test, then again after approximately 13 months. Table 1 contains the early and late time data. Very little difference in the concentration of metals was observed – slight differences were judged to be within experimental error.

One year after abandonment of the site the road remains as constructed in Figure 43. Note that this could be considered a permanent road versus a temporary road that would return to the environment. In the case of a road that may remain in service for decades this could be a good alternative to present methods.

Trial Operations, Results, and Data – Eagle Ford Site

Description of the Eagleford Shale Trial

The Eagleford Field trial was located on a ranch approximately 23 miles SE of Cotulla, TX and shown if Figure 2. Cotulla is approximately 90 miles south of San Antonio on I35. This is the central area of the Eagleford Shale and near the location to be tested.

The ranch is part of the Tamaulipas mesquite Eco region. The Coahuila desert region is to the North west of this area. The Sierra Madre Oriental range to the west separates the Tamaulipan mezquital from the drier Chihuahuan Desert. The Tamaulipan matorral is a transitional ecoregion between the mezquital and the Sierra Madre Oriental pine-oak forests to the west and the Veracruz moist forests to the south. The Western Gulf coastal grasslands, known as the Tamaulipan pastizal south of the border, fringe the Gulf of Mexico. The Edwards Plateau savannas lie to the north, and the East Central Texas forests and Texas blackland prairies to the northeast[8].

Location of Site

The test site was located on the Story Ranch property near Cotulla, TX. This site is currently undergoing constant change due to drilling, and operation of multiple wells in the Eagleford Shale. Traffic and operations are saturated at this site and on the state and County roads of LaSalle county. Access and operation of all vehicles on this site is controlled by the operator of the property and must be approved before operations begin.

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[8] Wikipedia or internet source

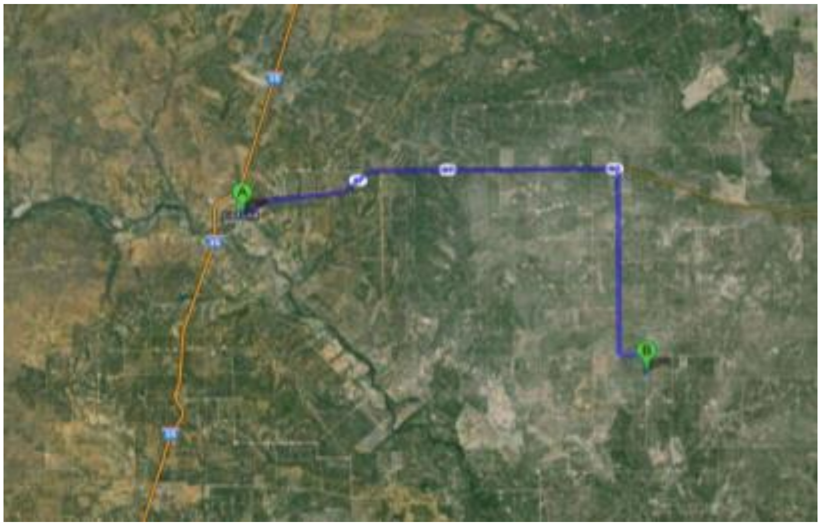

Figure 2. Satellite map of roads from Cotulla, TX to the Eagleford Shale Test Site.

Installation and Construction Procedures for Eagleford Shale Test Site

The road mat materials both Newpark and Wyoming were disassembled and moved from the road bed in Pecos and moved to a site near Cotulla, TX for a second trial. In this case it would be on a true oil field lease and used to facilitate operations for the operator of the property. Since the start of the project, the manufacturer of the Wyoming mats has filed for bankruptcy and is no longer in business. Material support and information on this product is no longer available and for that reason the Wyoming mats were dropped from this trial. For the continuation of the project we looked specifically at the Newpark mats while looking for new products that could be used for the same purpose.

The mats were installed in a similar fashion to that used in the Pecos trial. For this trial we were looking for an installation that would have adequate traffic and loading to determine if this was a workable solution. For this trial we selected a section of road to be installed in front of a production battery. Before construction can be seen in Figure 44. In this case we laid two panels side by side versus a continuous laydown of the panels used in Pecos. This laydown procedure can be seen in Figure 45. This gave better strength characteristics as well as prevented the buckling seen in the first trial. Figures 45 to 49 present the problems and issues seen while installing the mats at this site. As shown before for installation and setup of the mats a roust about crew and forklift operator were all that was necessary for this project.

In this project we had a continuous change in operations which was an important item to consider for this project. In this case the mats in front of the tank battery were located too close to the tanks for installation of spill containment. Before construction began on containment the mats needed to be moved approximately 9 feet. To do this three backhoe excavators were rigged to the mats and they were dragged the required distance from the tank. This move can be seen in Figure 50-52.

A second installation was performed for use by this research group to conduct field trials of water treatment technology. For these trials Newpark mats were laid to construct a pad for the installation of the spill containment and equipment required for the field trial. This installation can be seen in Figures 51 to 59. Note in this case the mats were laid two wide to obtain the maximum width and for a total length of 6 panels. The panels were also connected with more keylocks making this a more secure setup for people walking across the site.

Eagleford Shale Test Results

As described the mats laid lengthwise and connected side by side had a lot less incidence of buckling and heaving after laydown in comparison to the Pecos test site. The increase in the number of keys//locks prevented problems seen earlier.

A problem did appear in this trial not seen earlier. With the ability of the trucks using the mats to enter or leave the road section by driving off the side of the mats cracks began to occur on the sections which overlapped the lower panel. Without support of this overhanging section the mats begin to fail and crack. This failure can be seen in Figure 60 and 61. A trim or finish piece is necessary to complete this cross-section and prevent failure. The drawback to this solution is cost. The number of trim or finish pieces to complete the road is equal to one half the number of panels used and can be a factor that is cost prohibitive. In our installation we modified the layout by using sections of the rollout panels Figure 48 as inserts under the overhang shown in Figure 49.

Conclusions: Performance and Cost Effectiveness

Exploration and production companies are aware that minimizing their environmental footprint is crucial to reducing environmental liabilities, controlling operational costs, and encouraging public acceptance for the sustainable development of the U.S. natural resources. There are restrictions, and in some cases complete prohibitions that prevent drilling in many sensitive areas in the continental United States. U.S. stakeholders are united in the desire to improve the energy independence of the country, and to understand the environmental tradeoffs necessary to secure energy for America. The use of removable mats offers an alternative to the less expensive but less environmentally accepted caliche gravel.

Economics of Disappearing Roads

In the South Texas region usually described as the Eagleford, the usual format and design for location pads and roads are for them to be made of caliche from local suppliers. The usual pad size is 330 by 400 ft. with a 150 by 150 ft. section left out for the rig sub structure and tanks. The caliche can have varying prices from 7-27 dollars a yd. The pads can have different thickness depending on the operator but for this study we are looking at a 12 inch thick pad.

The economics of material cost as well as installation could be the major problem to using mats or other materials for artificial roads and well site pads. All operators try to limit the cost of construction and other items that are not a direct cost or implement to well construction. This item does not specifically have an effect on the well or operations of the well. In that case unless otherwise directed the owner of the well will take the least cost alternative.

We have used wellsite pads as the primary example in this economic model for a specific reason. The wellsite pads can be considered temporary, lasting from 1-4 months on average. A lease road for an operating well must remain in operation for the life of the property. In some cases it can be measured in decades not months. In that case a temporary road is not an option.

The analysis is the same for road or pad installation. We used a pad for our example as a fixed area to work with versus a mileage length for the road. Second as stated, the pads tend to be temporary while the roads will tend to be permanent if the project is successful.

Maintenance of Pads and Roads

The maintenance of the roads in the area of operations is dependent on the operator. Some run constant maintenance to keep them dust free and well maintained while others may abandon the road after construction. That leaves this as an open question that must be answered on a project by project basis.

For our example we are talking about pads on drilling/completion sites for new wells. These will have a tremendous amount of traffic and depending on weather can be damaged by rainfall and continuous traffic. In this case the use of a synthetic material like the Newpark or Wyoming mats can have a significant effect on operational costs. The operator will not be required to grade and maintain the pads after every weather event. After construction there is no maintenance unless a **major** event occurs which is outside of normal operations.

Recycled Wellsite Waste for Road Construction

In this case the material must be used for road construction. The cost of recycling of the waste is the most variable item in this method. The cost can be low depending on the drilling mud used and the materials found in the cutting, or can escalate depending on the composition of the cuttings and the mud used in drilling operations. Lifecycle costs for utilizing fluid cuttings will include the cost of transportation to permitted solid waste disposal sites. It has been found that the cost is equivalent to or less than disposal of the cutting in approved sites which does make this a potential use for this method. There are ownership requirements of the materials and under current regulations, the operator is required to maintain a record of the location and extent of their use in his operations and be responsible for them indefinitely. Such requirements are equivalent whether the materials are in a recycled road or a regulated landfill.

Rough estimates for comparable life cycle costs (including comparable caliche road mantainance estimates[9] indicate a cost premium of appproimately 25% greater than currently available techniques. Such a premium would seem to be justified in areas where access is critical and access to disposal is limited.

An additional issue is durability under high traffic and heavy loads. One of the major issues in South Texas is county road deterioration under oil field traffic[10]. Further field trials are recommended in South Texas to test the long term performance and cost effectiveness of the recycled drill cuttings roads.

Newpark Mats

As an example for this project we will look at a well site pad for the drilling and completion of an Eagleford well. The size of the pad will be 330 ft. by 400 ft. with and area of 150 ft. by 150 ft. taken out for the operation of the rig.

[9] Burnett, D. B. private communication Land Steward Consultants, San Antonio TX.; Oct. 2013
[10] http://tefsmag.com/uploadmagazine/5/files/assets/basic-html/page28.html accessed 11.01.2013

To begin the analysis the emphasis needs to be on the current cost of materials. For a caliche pad the requirement is for a minimum of 5000 yds. of material. This can vary from 35,000 to 135,000 dollars for the caliche using the 7-27 dollar range in price for the material. The cost of installation is dependent on local conditions but should be comparable to the cost of the disappearing road materials.

As a comparison look at the Newpark mats. Currently the cost per mat is 2,400 dollars each or a rental of 6 dollars a day. This works out to a cost to buy of 2.35 million or 5,900 dollars a day rental for the same pad area.

The difference between the two pads is significant. If we use the higher priced caliche material as the average for the area the difference in material cost is 2.215 million dollars. We are basing this analysis on a similar cost of installation. To make the mats a viable alternative in this area the added cost for caliche installation would have to be at least 443 dollars a yd. greater than the cost of mat installation for the same area.

Wyoming Mats

The economic comparison for the Wyoming mats is similar. This company is no longer in business but a comparable price per mat would be 1400 dollars per mat and in this case we do not have a value for rental. The cost to buy would be approximately 1.37 million dollars which is also more than the cost of the caliche pad. Comparing this in the same example for Newpark, the excess cost of caliche installation would have to be over 247 dollars a yd. for this method to be acceptable on a pure economic basis.

Economic Conclusion

The cost for any of these materials is significantly more than that for a basic caliche pad on the well site. The environmental caveat for these products is for an area that will not allow construction of a permanent pad from caliche. In this case a system similar to those studied here would be required for the project to be viable. Economics are still a controlling factor that must be factored into the project analysis to determine if the project will be successful.

New Technologies

Since this project began several new products for roads and pads have been developed. These products are smaller and more compact than both the Newpark mats and Wyoming mats, and tend to be in the 2 ft. by 2 ft. size per section. For the two products reviewed for this project the cost was 2.5 dollars a sq. ft. and 4 dollars a sq. ft. In these cases the cost of the product is much closer to that of the caliche pad. The two products cost 275,000 and 438,000 dollars which is significantly closer to the caliche cost of a standard pad. Going back to our example, the additional cost of caliche installation would have to be in the range of 28-61 dollars a yd. excess cost for the installation of the caliche. This reduction is significant and indicates that there will be products or technologies available that may be acceptable to the operator.

The advantage to these two new technologies are that they are reusable, and after the second use constitute a savings in the cost of materials. For the Newpark mats the required number of cycles to reduce the cost to zero would be approximately 17 well pads.

Conclusions

The use of composite mats is a very workable solution for use in wellsite pads. The pads are a much more viable solution for operating in wet environments. The pad does not trench or deteriorate during periods of rain, and are a much cleaner environment. The pads as used in the field trial work by this group are a superior way to handle potential liquid loss on the site and to contain spills.

For road use the mats are still viable but there is one specific restriction which is life of the road. If the road is to be temporary as in a wildcat or exploratory venture then the mats may be a very viable solution to a problem. The primary constraint is cost of materials and life of the road. If this is a temporary road (2-4 months) this may be acceptable. After conclusion of operations the road is removed and the habitat is allowed to return to normal. If this road will be used for a number of years then a more permanent road may be required. This is especially true if the road is long. The cost for a single lane road can be in excess of 1.6 million dollars a mile. Many roads into wellsites can extend way beyond this value and would put the project in jeopardy on economic grounds.

Recommendations from Field Trials

From this project we have determined the viability and use of composite mats and recycled materials for use in oil and gas operations. The critical point is in the recommended practice of this technology. From the study the following recommendations can be made.

Wellsite Pads and Production Facilities

These composite mat materials are excellent for the wellsite during drilling and completion. They are temporary usually less than 4 months and can be recycled to the next well site. Laydown and installation is easy, and for long term use at the site should be a significantly smaller area than that used during drilling and completion of the well. The mats keep the location clean, allow for the operator to use good containment practices, and can be removed quickly at the end of operations.

Lease Roads

The composite mat materials are a viable alternative to the basic caliche road, but can be prohibitively expensive to build on the site. For this purpose they should only be used when specifically required to limit environmental exposure on the site. A very good solution to solids control would be the use of wellsite waste for road construction. The only restriction would be the economics based on the cost of recycling versus disposal. If the recycling cost exceeds disposal then the basic caliche road should be employed.

These mats can and should be used now for small sections of lease roads which have a problem with drainage during heavy rainfall, or during the transfer of water by pipeline next to the roadway. In these area mats can be used to keep the road open without the requirement to haul significant volumes of caliche to fill in the areas.

Cost Reduction

If the cost to manufacture and distribute the mats can be significantly reduced, the potential use of them would increase due to the increase in workable area and reduced maintenance costs. As stated the primary use of the mats now can only be economical if the cost approaches the cost of caliche.

Acknowledgements

Texas A&M has several partners who both sponsored and provided equipment and services to the development of the disappearing roads. These partners assisted in trials, helped sponsor the DR competition and contributed engineering expertise to its success, notably TEES (Texas Engineering Experiment Station), TEEX (Texas A&M Engineering Extension Service), and the EFD (Environmentally Friendly Drilling) program at the Houston Advanced Research Center (HARC).

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Thanks are to our prime sponsor RPSEA.

This project is dedicated to Mr. David Moore and Cheryl Wheelis of the McFaddin Rio Vista Ranches.

Tables and Figures

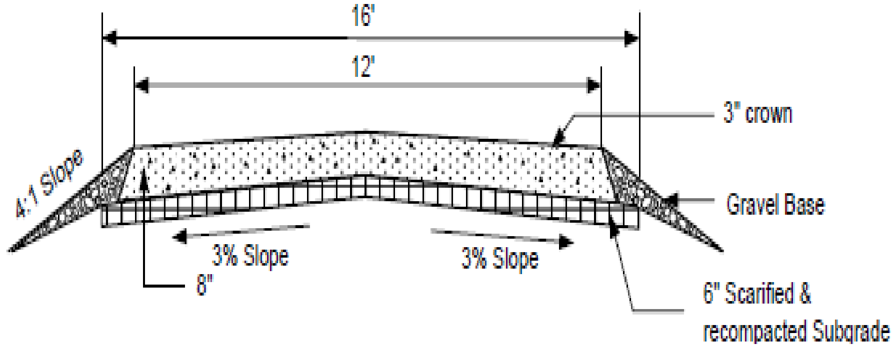

Figure 3. Cross-section diagram of the spine road section used at the Pecos Test Site.

Figure 4. Photograph of dirt road to be used for spine section of test. Note overpass has not been removed from entry road.

Figure 5. Bulk truck carrying mix for spine road. Dust from blowdown of material after unloading on site.

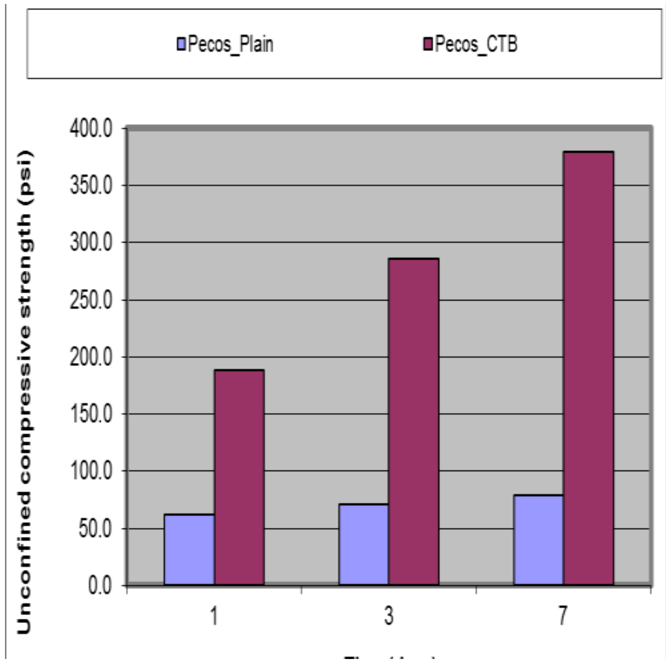

Figure 6 This plot represents a chart of the unconfined compressive strength of the Pecos road material as measured using the standard Tex-120-E Test Method "Soil-Cement Testing" protocol.

Figure 7. Completed Spine Road Section

Figure 8 Newpark mat installation at Pecos Test Site.

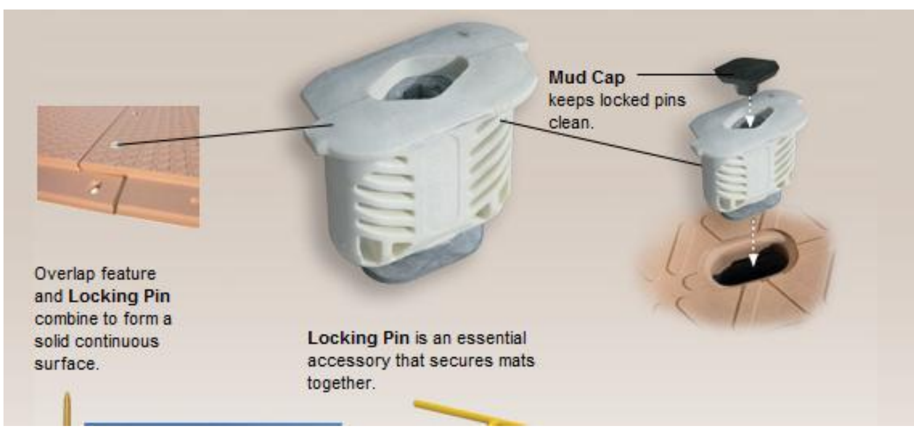

Figure 9 Locking pins and keylocks for Newpark Mats

Figure 10. Cleanout of dirt and weeds at transition between Newpark and Wyoming mats.

Figure 11. Movement of fixed Wyoming panels to road-site at bypass for overpass out of service.

Figure 12. Wedging of Wyoming Panel to match Newpark Mat.   Newpark mat set with an overlab on this side of panel to match the Wyoming panel setup.

Figure 13.Transition between Newpark and Wyoming panels in final layout of Pecos road section. Thickness of both type of panels similar and did not require major movement of soil to match panels.

Figure 14. Dipping of front edge of Wyoming Flat panels to match new panel to previous installed panel before final layout of unit.

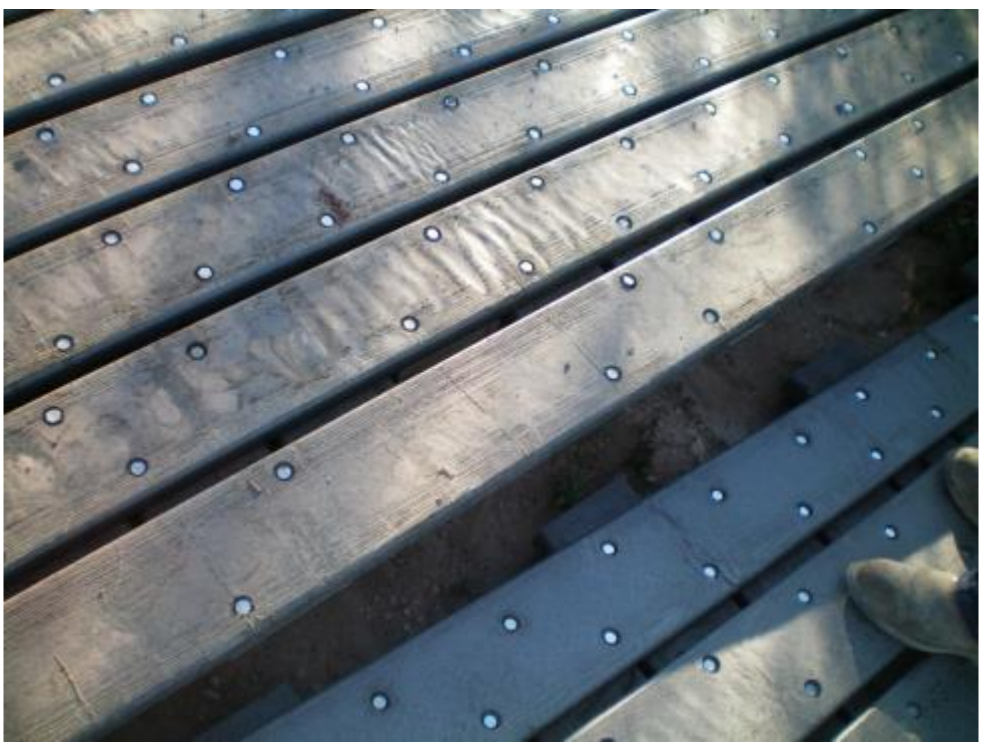

Figure 15. Adjustments required to match two panels to finalize installation of panels.

Figure 16. Top view of tongue and groove connections between two Wyoming Flat panels.

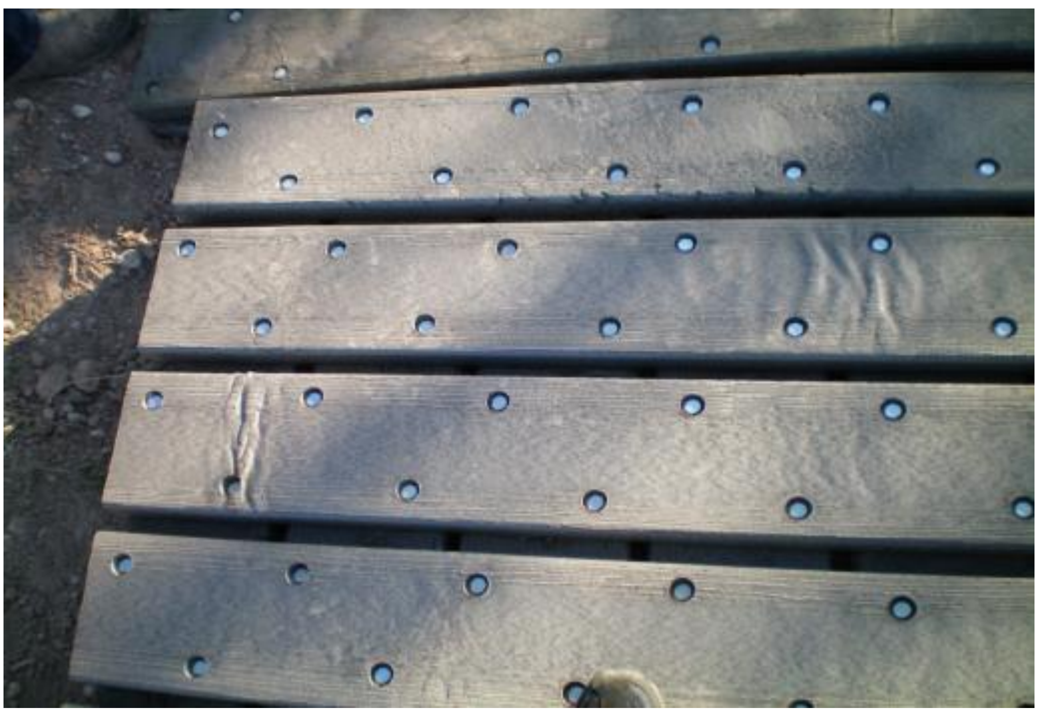

Figure 17. Wyoming Flat mats with cross hatch design. Note bolts used to connect upper and lower sections which are 90 degrees apart in direction.

Figure 18. Back view of road sections note straight line of road. Special care is required to prevent a lateral slippage during installation that can cause problems later depending on length of road.

Figure19. End of installation of Wyoming flat mats, crew ready to begin rollout installation.

Figure 20. Stored Wyoming Roll-out mats after unloading from truck.

Figure 21. Wyoming Rollout panels must be rolled out and unfolded after shipment. All panels were packed this way to save space during shipment.

Figure 22. Movement of Wyoming Roll out panels can be difficult due the inability of the mats to lie flat on the forklift with the connection between panels.

Figure 23. Laydown and drag out of first Wyoming rollout panel. Requires both the forklift and roustabout truck for placement.

Figure 24. Note Break in interior board of Wyoming Rollout panel.

Figure 25. Note broken board section at end of panel. Cause of break can be seen by tire print on panel and the washout below the break in the board. The design of these mats gives strength in only one direction. To obtain maximum strength panels need bi-directional construction to prevent failure.

Figure 26. Removal of broken interior board of Wyoming rollout mat.

Figure 27. Removal and replacement of broken section of mat during installation. Required removal of locking clamps on each end of board to be removed.

Figure 28. Placement of broken sections at union between fixed mat and rollout mat during installation. Note that vertical transition is attained using broken board sections as lift points on the mat.

Figure 29. Backfill of transition point between fixed panel and rollout mat using broken sections as grade transition between units.

Figure 30. Use of the Roustabout truck and chains to shift direction of panel after laydown to match direction of crossroad.

Figure 31. New Approach to installation of rollout panels. This required the chaining of the panels to the forklift to allow a vertical pickup with the panel hanging below the forks of the unit.

Figure 32. Extended View of rollout panel after pickup using new approach for installation. Panel is pivoted in middle but addition of steel stringer or section with chains would remove it and allow a straight hang of the panel before laydown.

Figure 33. Wyoming Roll out panel as installed from roadway note flat installation before twist of panel to match street intersection.

Figure 34. View of Rollout panels after placement. Note twist or nonlinear direction of panel as installed.

Figure 35. Final layout on Wyoming and rollout panels on exit from field road to paved street. Note nonlinearity of roadway with use of the rollout panels.

Figure 36. View back on Newpark panels installed earlier in project. Note the growth of tumble weeds along edge of road and at unions between panels.

Figure 37. Note washboard buckling due to lack of connection between mats. Only two pins/locks were used per connection. The panel allows for a total of 5 per connection.

Figure 38. Outside edge of Newpark mats indicate buckling potentially caused by lack of keylock to connect panels.

Metal concentration, ppb

Date Samples Taken: July 15, 2009

Sample ID	Ba	Ag	Se	As	Pb	Hg	Cr	Cd
Pecos Soil Sample #1	316.1	96.88	34.44	4.283	2.343	-0.344	-47.12	-29.29
Pecos Soil Sample #2	61.63	129.6	31.39	6.085	8.968	-0.285	-58.2	-31.01
Pecos Soil Sample #3	106.1	40	31.61	1.014	7.974	-0.47	-62.93	-31.84
Pecos Soil Sample #4	125.9	61.19	24.22	5.098	11.29	0.178	-65.57	-28.45
Pecos Soil Sample #5	107	11.67	32.18	4.434	5.764	-0.325	-66.87	-40.94
Pecos Soil Sample #6	45.1	31.44	32.98	6.538	8.672	-0.042	-69.63	-32.08
Sample average	*126.97*	*61.8*	*31.14*	*4.58*	*7.5*	*-0.21*	*-61.72*	*-32.27*

Date Samples Taken: October 7, 2010

Sample ID	Ba	Ag	Se	As	Pb	Hg	Cr	Cd
Pecos Soil Sample #1	310.1	88.88	30.23	4.673	2.711	NDA	NDA	NDA
Pecos Soil Sample #2	60	133	23.99	5.085	8.678	NDA	NDA	NDA
Pecos Soil Sample #3	106.5	44.4	41.22	2.104	8.33	NDA	NDA	NDA
Pecos Soil Sample #4	120.9	53.99	55.68	6.66	9.98	NDA	NDA	NDA
Pecos Soil Sample #5	103.3	13.11	31.11	4.333	5.778	NDA	NDA	NDA
Pecos Soil Sample #6	50.7	55.6	31.88	5.8	8.09	0.01	NDA	NDA
Sample average	*125.25*	*64.83*	*35.69*	*4.78*	*7.1*	*0.01*		

Table 1 Soil Samples from Pecos Site

Figure 39. View of temporary road from track towards interior of facility. Note return of weeks and plant life to roadbed. Roadbed has been graded in last 4 months in preparations for a permanent road.

Figure 40. Weed growth at Track side of road. Same species was found at same location when we installed road mats.

Figure 41. Reverse view of road from spline road section to Track. Note tilled soft dirt versus hard packed caliche. Material will allow for growth of plant life on old road.

Figure 42. Are to side of roadbed that has been cleared for future work.

Figure 43. Spine road using well cutting after two years. Note no growth of plant life and limited weather wear on road section.

Figure 44. Test Site in Eagleford Shale area, note muddy location with soft clay content of caliche.

Figure 45. Initial setup and layout of road panels before containment built for tank battery.

Figure 46. Use of forklift to spot and place mats along proposed road section.

Figure 47. Completion of first row of roadbed. Note road not wide enough for large vehicle and overhang on left side of panel could be a problem.

Figure 48. Due to the overlap of the Newpark mats some type of support needed for the overlap section of the mats. Each mat is made of two panels with an approximate offset of 8 inches in two directions of the panels. Without a specific trim piece for this section alternative methods are required to support the edge of the mats.

Figure 49. Note the installation of the board sections under the overhang section of the panels in this section.

Figure 50. When ready to install the containment the road section needed to be moved for the installation. In this case two backhoes were used to drag the section approximately 8 feet to allow for containment.

Figure 51. This indicates the amount of embedment of the mat into the caliche base on the location. The mat tends to imbed to some extent depending on the strength and integrity of the base material.

Figure 52. Final installation of road mats after construction of containment. Note the traffic patterns on the mats showing the drive up on to the road as well as the departure from road after loading.

Figure 53. A second use of the Newpark mats was for a pad for field trials. The pad must be secure for equipment as well as preventing punctures of containment during tests. Note panels are not locked together due to a shortage of lock/pins.

Figure 54. Final layout of pad behind production facility.

Figure 55. Panels after shipment of locks/pins arrive. Note that each corner has three pins as well as one in the middle of each panel to prevent buckling seen at the Pecos site.

Figure 56. Final layout of pad before equipment move in and setup. Pad on unconsolidated soil not a prepared pad.

Figure 57. Layout of containment on pad to prevent leakage. All equipment of field trial will be on a pad made from some type of artificial material.

Figure 58. A secondary pad was made using the Wyoming mats for the generator. The size of the mat matched the size of the containment for the unit to be used.

Figure 59. Final install of field trial equipment on pad using Newpark mats. Note we used a total of 10 mats for the pad.

Figure 60. On several mats stress cracks occur at the union point between the upper and lower section of each mat.