Evaluation of Positive Grip Span Locks

Concepts Evaluation Report

(DRAFT)

Prepared for

Florida Department of Transportation

by

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engineering that moves you

1/17/2011

Contents

1. LOCK BAR MACHINERY BACKGROUND

Bascule bridge span lock machinery is designed to hold down the bascule leaf/leaves in the closed (lowered) position under live load. There are two types of bascule bridges, Single Leaf and Double Leaf, each requiring locking devices at the ends of the bascule leaves. The locking devices are designed for different load cases depending on the span configuration (single vs. double leaf).

Single Leaf Bascule

Single leaf bascule bridges are designed such that the toe of the bascule span is seated on the rest pier with shear transfer directly to the pier through the bascule girder bearing. The span lock machinery is designed (sized) to hold the span down in the event that the operating machinery limit switches fail, causing the span to open and drive the span into the lock until the motor limit switch is engaged and stalls the motor.

Double Leaf Bascule

A double leaf bascule bridge is designed to transfer shear due to vehicular live load through the lock bar machinery. The bar is modeled as a "pin" connection transferring shear only. The details to allow for proper shear transfer are critical. If the lock bar machinery is not properly aligned during installation, the contact surfaces between the lock bar and bar guides will not perform as designed, causing the bascule leaves to bounce under live load deflection. Improper shear transfer can lead to secondary stresses not accounted for during the design process, as well as causing additional wear on the operating machinery and lock bar machinery.

Poor lock machinery performance will lead to increased maintenance requirements during the life of the bridge. To assist with mitigating long term effects of lock bar misalignment, installation procedures require that the Contractor adhere to tight design tolerances during installation. The fit-up tolerances are designed to minimize secondary effects on the structure due to improper alignment of the bar and guide assemblies. The increased alignment procedures are required to allow the lock bar machinery and bridge superstructure to act as a "system", minimizing secondary issues as previously described. While these details are required to allow the system to function as the design intends, the additional effort to perform the high level of detail and accuracy in installation contributes to higher construction costs.

2. PROJECT OBJECTIVE

The development of a new span lock system will focus on two components which will ultimately lead to an efficient and cost effective design for the lock components as well as the overall bridge structure. The new design considers:

1. Alignment Constraints during Construction
2. Structural Effectiveness (lock contribution to overall structural system)

Alignment Constraints

The cost of a new span lock system considers both fabrication and construction costs. As previously mentioned above, installation procedures for span lock systems include precise tolerances which greatly impact the construction cost. Field alignment and installation can be very time consuming, requiring several iterations of shimming as well as field drilling by the Contractor in order to adhere to the required specifications. Relaxation of these tolerances can lead to structural and mechanical issues throughout the life of the structure.

Structural Effectiveness

Center span lock machinery for double leaf bascule spans provide transfer of shear loads due to vehicular live load. The transfer of shear loads ideally eliminates differential deflections of the opposite leaf while the span is subjected to vehicular traffic, in addition to keeping leaves from opening. If the shear loads are not properly transferred as intended during design of the bascule leaves superstructure components (i.e. Bascule girders, floorbeams, brackets), secondary stresses will occur due to increased span deflections. In addition, stresses can rise specifically in fatigue-prone members during span deflections.

Addressing the Issues

New span lock systems have been developed to address these two concerns by decreasing the alignment constraints during construction, while providing a system that will effectively transfer shear under vehicular live load. Cost savings will be seen during the bidding process as well as in the long term effects of the structural system. Additional Contractors may be willing to bid on the installation of a system with less stringent alignment criteria, increasing the competition and ultimately lowering bids. In addition, the installation process will be expedited, with increased savings found in labor.

The new lock system will also provide for increased surface contact of the locking system during span deflections under vehicular live load. Bascule span tip deflection is a large contributor to the current lock bar wear. Over time, these lock bar components wear and ultimately lead to the previously mentioned secondary stress issues in the bascule span structural components. Allowance for bascule span tip rotation is a major contributor to the bascule span system and will be discussed as part of the lock bar system development.

3. SPAN LOCK SYSTEM DECISION MAKING PROCESS

The design Team has developed ten (10) span lock systems while addressing the previously mentioned concerns. The lock systems are as follows:

1. Improved Taper
2. Pincer Type
3. Jaw Type
4. Friction Locks (Multiple Finger Type)
5. Clamping Lock
6. Fin Brake
7. Cylindrical Nose-Receiver Lock
8. Cam Lock
9. EHM Concept – Internally Expanded Bar
10. Moment Lock

Each system was evaluated against the same criteria to allow for equal scoring. The criteria for each lock system, along with the weighted percent for each criteria is as follows:

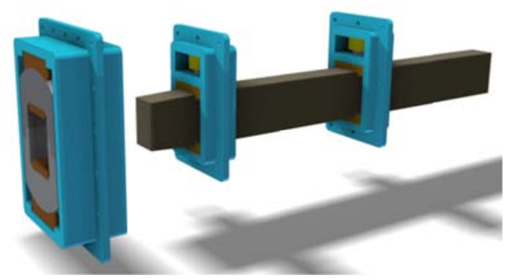
1. Effectiveness – 20%
2. Maintenance – 20%
3. Emergency Disengagement Procedures – 15%
4. Constructability – 15%
5. Durability – 30%
6. Adjusted Cost – The adjusted cost is determined based on a percentage increase compared to a standard lock bar assembly.
7. Scoring – The scoring is based on a weighted average per criteria divided by the Adjusted Cost percentage.

A detailed description of each criteria can be found with the Evaluation Matrix in the Appendix of the report. The final Evaluation Matrix will be utilized to assist with the decision making process for choosing a new lock system for further development. FDOT will provide comments along with Hardesty & Hanover making final adjustments in lock assembly scoring prior to moving forward with preliminary plan preparation.

4. SPAN LOCK SYSTEM DESCRIPTIONS

4.1. IMPROVED TAPER CONCEPT

Description



The major characteristic of this concept utilizes the tapered 'nose' portion of a standard lock bar arrangement, which has been used on several notable structures, to our knowledge, located in the North West portion of the US. The tapered nose is used to account for wear at the front socket, and automatically adjust by driving the bar further into the receiving socket assembly. The major concerns with the traditional arrangement have been the effects of thermal expansion of the mating leaves, and the tendency of the tapered nose section to wedge within the receiver. The thermal expansion of the span in the longitudinal direction as well as the effective nose rotation increases the pulling force required by the actuator. The second notable flaw of the traditional system is the arrangement does not account for wear to the front guide of the bar, which experiences the highest load from vehicles during the shear transfer.

Improvements

To account for the toe alignment of the leaves, and the thermal expansion effects described above, the receiver socket has been detailed with a spherical (ball) socket arrangement. This will allow for greater allowance for installation tolerances, and also allow for leaf toe rotation, which is expected in the relatively flexible structures that are seen across the district. The second improvement is front and receiver sockets are detailed with hydraulic jacks to account for wear throughout the system.

This improvement will also allow for greater installation allowances of the typical tolerances specified by the designer.

Disadvantages

The spherical system must be limited in rotation or else the ball component (gimbal) can theoretically rotate out of the limits of the tapered nose, and the bar will fail to drive. The solution is assumed to include limiting tabs or a key/keyway slot cut into the inner gimbal and outer race components. The added surface also introduces an additional surface that will undergo wear under the vehicle loading. The complicated surface (spherical) will likely deform in localized areas and provide for an involved assembly. It is anticipated that hardened bronze and steel components will be used for this components, since rotation is relatively minor, and the need to resist the impact loads are high. We would anticipate that the receiver assembly would be detailed as a cartridge type system that could be easily replaced as one unit. Lastly, the addition of hydraulic jacks at the front and read socket introduce additional components and complexity that will increase the anticipated maintenance efforts by the Department.

Major Limitations

We anticipate no major limitations with developing this concept into a working prototype.

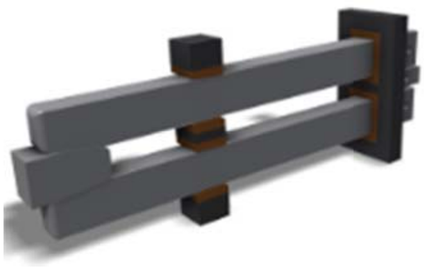
Evaluation of Scoring

This concept scored HIGH to HIGH-AVERAGE in most of the categories organized in the matrix. The introduction of the spherical component as well as the clamping jacks increased the complexity of the system, and as a result this concept score AVERAGE in the categories of COMPLEXITY and MAINTENANCE ACCESS.

4.2. PINCER TYPE CONCEPT

Description

The Pincer concept is a derivative of the original concept developed in the early part of the last century, which used a system of pins and links to extend and clamp onto an protruding ‘tongue’ portion mounted on the mating leaf. The major flaw of the original system was the unavoidable wear at the link pins and bushings, and the cumulative gaps in the system, resulting in an excessive relative play under vehicular traffic loads.



Improvements

This Pincer Type arrangement was improved for this study by eliminating the major flaws in the original system, namely the pins and bushings. The system shown in the renderings have utilized sliding surfaces and offset receivers to actually deflect the two bar system (slightly) during engagement around the mating tongue of the adjacent toe.

Disadvantages

The first notable disadvantage of this system is the spatial considerations of a two bar vertical system. The height required for this system would only fit into certain areas on an existing bridge, and is anticipated to be location within a box section of a large truss style double leaf bascule bridge.

The second notable disadvantage of this system is the driving load required to effectively deflect the two bar system to engage a clamping force on the protruding tongue. This driving load must also be considered under withdrawing the pincer clamp, as the lubricant is typically pressed out of the sliding surfaces under vehicular loading under long periods of engagements.

Major Limitations

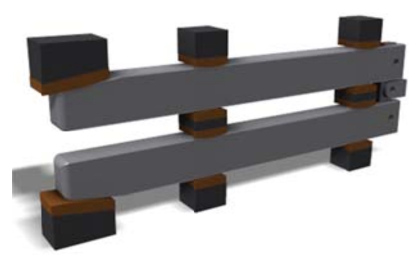
We anticipate no major limitations with developing this concept into a working prototype with the exception of limited space available depending on the systems use (i.e. on a rehabilitation of existing structure vs. new structure)

Evaluation of Scoring

This concept scored HIGH to HIGH-AVERAGE in most of the categories organized in the matrix. The introduction of the dual bar system resulted in AVE and LOW-AVE scores as the concept relates to the structural modifications required to implement this type of system, and the resultant maintenance access and complexity required for the introduction of additional components.

4.3. JAW TYPE CONCEPT

Description



The Jaw concept is a derivative of the original concept developed in the early part of the last century, which used a pair of cast links to form an eccentric column to transfer the live load from leaf to leaf. The major flaw of the original system was the unavoidable wear at the base of the link columns (load blocks), and the inherent access issues with replacing these components. This original system is commonly referred to as a 'scissor' lock as the mechanism opens like a scissor to induce a clamping force on the mating leaf.

Improvements

This Jaw Type arrangement was improved for this study by changing the links from columns into a beam system. This was done in order to (1) limit the amount of depth required compared to the original system, and (2) improve the access to the components that receive wear, i.e. the load blocks. The system shown in the renderings have utilized sliding surfaces and offset receivers to actually deflect the two bar system (slightly) during engagement and separate into engagement with an upper and lower load block on the mating leaf.

Disadvantages

The first notable disadvantage (as with the Pincer Arrangement) of this system is the spatial considerations of a two bar vertical system. In addition, the mating load blocks attached to the mating leaf will require additional vertical space for mounting. The height required for this system would only fit into certain areas on an existing bridge, and is anticipated to be location within a box section of a large truss style double leaf bascule bridge.

The second notable disadvantage of this system is the driving load required to effectively defect the two bar system to engage a clamping force on the protruding tongue. This driving load must also be considered under withdrawing the jaw system, as the lubricant is typically pressed out of the sliding surfaces under vehicular loading under long periods of engagements.

Major Limitations

We anticipate no major limitations with developing this concept, but note that it is very similar to the Pincer concept, but will require more vertical space for location of more components, and will require more horizontal space for the additional load block receivers. It is recommended that this concept does not offer any advantages over the Pincer Type that would compensate for these additional requirements.

Evaluation of Scoring

This concept scored HIGH to HIGH-AVERAGE in most of the categories organized in the matrix. The introduction of the dual bar system resulted in AVE and LOW-AVE scores as the concept relates to the structural modifications required to implement this type of system, and the resultant maintenance access and complexity required for the introduction of additional components.

4.4. FRICTION LOCKS (MULTIPLE FINGER TYPES)

Description

This concept is an entirely new concept that is not a derivative of an earlier system installed on any bridges to our knowledge. The system utilizes a multi-bar engagement system to transfer the shear load from one leaf to another. Once in the driven (engaged) position, hydraulic jacks are use to clamp the fingers to a tight fit and shear transfer.

Advantages

This arrangement introduces more surface area for contact loading on the fingers, and more effective cross sectional area of steel for shear transfer of vehicular loading. The concept is also envisioned with a clamping mechanism to account for installation allowances for the installer that will be clamped into position during each actuation.

Disadvantages

The advantage of having multiple fingers to transfer the load is offset by vertical space to locate this type of system on an existing bridge. The multi-finger system also adds an inherent complexity of engaging all the fingers to an equal distance of throw, and limits the access to the components in this type of system.

Major Limitations

We anticipate no major individual limitations with developing this type of arrangement, but anticipate that the multi-finger concept will require a large assembly that may not fit in all bascule locations. (i.e. Rehabilitation vs. New Construction)

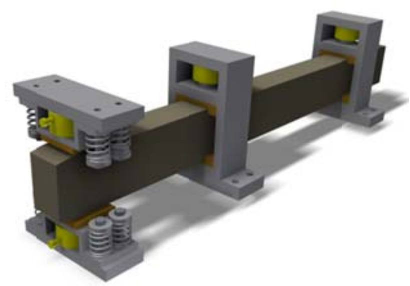
Evaluation of Scoring

This concept scored HIGH in areas of EFFECTIVENESS and DURABILITY. Due to the multi-component arrangement, the concept did not score as well in areas of CONSTRUCTABILTY, EMERGENCY DISENGAGEMENT PROCEDURES and MAINTENANCE.

4.5. CLAMPING LOCK

Description

This concept is essentially a traditional lock bar system that utilizes clamping hydraulic jacks at the receiver and front socket locations. The concept is detailed with springs that release the jack from engaging the lockbar horizontal surfaces. The releasing jack provides for clearance during the engagement and disengagement of the lock bar actuation.



Advantages

This concept provides an automatic wear adjustment component between the bar and the socket shoes, and is anticipated to require little or no maintenance with adjusting for wear at these locations. This system also provides for an increase allowable tolerance for construction installation. Lastly, the hydraulic jack system will act as an impact dampener (under extreme loading conditions) during the transfer of vehicular live load from mating leaves.

Disadvantages

The first notable disadvantage is that the hydraulic jack capacity at the sockets limits the amount of shear transfer between bascule leaves. The second notable disadvantage is the release jacks will require power and control at both bascule leaves for operation. The third notable disadvantage is the overall complexity of the system, and the foreseen maintenance issues that will likely be associated with this system.

Major Limitations

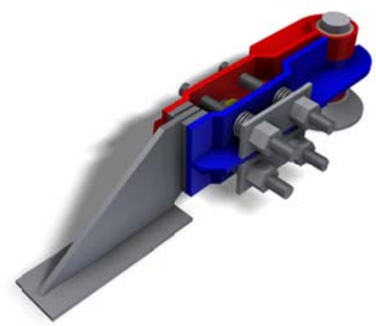
We anticipate no major limitations with developing this concept.

Evaluation of Scoring

This concept score AVERAGE in the area of EFFECTIVENESS due to the introduction of springs and the added complexity of the system. The concept scored varies in the area of CONSTRUCTABILITY due to the complexity for required power and control at both bascule leaves, but it also reduced the construction alignment requirements with the adjustable sockets. Lastly, the concept scored HIGH in the area of WEAR ACCOMMODATION, mainly based on the added clamping system and the anticipated benefits to the system by reducing the impact loads.

4.6. FIN BRAKE

Description



This concept is an entirely new concept that is not a derivative of an earlier system installed on any bridge to our knowledge. The system consists of a brake plate mounted vertically to the top of the bascule girder (similar to a sharks fin). The brake portion of the assembly clamps around the vertical fin plate providing the clamping force to transfer the vehicular live loads from the mating bascule leaves. It is anticipated that the brake pads will be of serrated type steel material in order to maximize the coefficient of friction for shear transfer of loads. The braking load will be held by the coil springs located between the brake links. The spring load is released to provide adequate clearance from the fin during the bridge operation. This concept allows for de-energizing the brake when the span is seated.

Advantages

The major advantage to this system is that it eliminates practically all installation tolerances for initial alignment during construction. The second significant advantage is the consideration that this unit can be installed to the top flange of a bascule girder as an additional measure to transfer vehicular loads.

Disadvantages

Since there is no vertical alignment of mating spans required for this system, we anticipate that this would be an additional system and would require the traditional lock bar system to be installed beneath the roadway deck as a "fail safe" system to ensure vertical alignment between leaves, and keep engagement in case the fin brake system were to fail in clamping.

Additional Considerations

The Fin Brake shoes will require a pivoting action in order to account for any misalignment between the mating leaves. Also, the Brake links (or arms) must be housed in order to effectively transfer the brake load to the bascule structure. Otherwise, all of the load will pry at the hinge point of the brake mechanism. We anticipate removal of shims at the existing lock bar mechanisms to allow for increased allowances for alignment tolerances.

Major Limitations

We anticipate no major limitations with developing this concept into a working prototype.

Evaluation of Scoring

This concept scored HIGH in the areas of CONSTRUCTABILITY and DURABILITY, and HIGH-AVERAGE in area of MAINTENANCE. The area of EFFECTIVENESS scored AVERAGE to LOW-AVERAGE based on the challenges of load transfer through the vertical plate and brake assembly. This concept will require further detailing to address these issues if selected for developing a prototype.

4.7. CYLINDRICAL NOSE-RECEIVER LOCK

Description

This concept is an entirely new concept that is not a derivative of an earlier system installed on any bridge to our knowledge. This system consists of a cylindrical nose end of a traditional lock bar component. The cylindrical receiver socket at the mating leaf is detailed with a cylindrical high strength bronze shoe. The cylindrical bar is to be spring loaded or hydraulically actuated in the longitudinal direction in order to compensate for wear over time, thus eliminated the maintenance requirements for periodic shimming of the shoe.

Advantages

This concept was developed in order to eliminate the need to shim the receiver shoe components.

Disadvantages

The concept does not account for automatic adjustment for wear at he front and rear guides, which can be altered by adding clamping jacks as detailed on some of the previously described concepts. This concept was limited in its development because of the major flaw at the receiver end.

Major Limitations

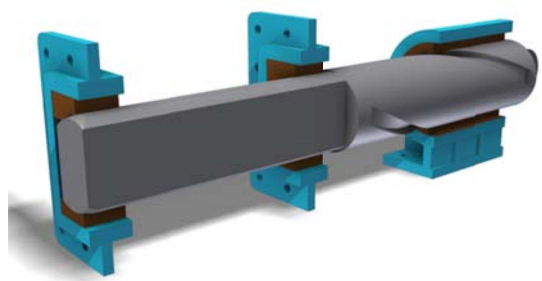
The major limitation of this system is the practicality of aligning and maintaining the cylindrical nose end of the lock bar and the mating receiver and shoe surface. The components require complicated machining, and do not offer any additional benefit when compared to the other concepts developed in this study. We have therefore eliminated this from further development and consideration.

Evaluation of Scoring

This concept score LOW in the areas of MAINTENANCE AND CONSTRUCTABILITY, and has therefore will not be developed further for this study.

4.8. CAM LOCK

Description



This concept is an entirely new concept that is not a derivative of and earlier system installed on any bridge to our knowledge. The system consist of an elliptical bar (in cross-section) that when driven horizontally into the mating leaf, also rotates about the longitudinal axis of the bar. The result is that the major axis of the ellipse turns approximately 90-degrees into engagement with the mating shoes of the receiver, and the front socket. It is envisioned that the ellipse will actually be a cam, and will increase slightly as the bar is rotated further than 90-degrees. This concept will eliminate the need to adjust the bronze shoes with shims, and adjustment for wear will be simplified by rotating the cam further into engagement.

Advantages

This concept allows for a very tight and actually an interference fit between the elliptical bar and sockets. The second notable advantage is the elimination of shimming to adjust for wear, and the simplification of adjusting the throw of the elliptical bar.

Disadvantages

The concept requires a complicated machining process for the elliptical bar cross section, and the mating shoes. Although we anticipate that the construction alignment will be improved from the issues experienced with traditional lock bars, this concept will likely introduce additional alignment issues during construction that are difficult to quantify at this time. The movement of the elliptical bar is more complicated than the traditional lock bar.

Major Limitations

We anticipate no major limitations with developing this concept into a working prototype.

Evaluation of Scoring

This concept scores vary with each major group of items, which were a result of the complexity of machining a system of this type and the maintenance required for this system. We refer to the Evaluation Matrix appended to this report for the detailed evaluation of each category.

4.9. EHM – INTERNALLY EXPANDED BAR

Description

This concept was introduced by EHM at the initial kick off session held at FDOT District 2 on September 28, 2011. The concept utilized a two part lock bar split horizontally along the length of the bar. Within the split of the bar, hydraulic jacks are housing during actuation of the bar. When the bar is fully extended into the receiver socket, the jacks pressurizing and expand the lock bar into contact with the receiver and guide shoes. This system provides for automatic wear at the socket and guide shoes.

Advantages

This system provides for automatic wear at the socket and guide shoes, and provides for a greater installation allowance during construction.

Disadvantages

The concept introduces the expansion jacks that must be pressurized for all times that the bridge is seated and traffic is passing. This will require some sort of accumulator system that will provide constant pressure to the jacks even in the event of loss of power at the bridge. The hydraulic system must travel with the bar which also introduces a level of complexity to the system. The split bar also introduces the need for additional height to the assembly to develop the same capacity as a standard bar.

Major Limitations

We anticipate no major limitations with developing this concept into a working prototype.

4.10. MOMENT LOCK BAR

Description

This concept has been developed and installed on notable bridges such as the Woodrow Wilson Memorial Bridge in Washington DC. The system installed was designed with two lock bars per girder overlapping to create horizontal distance and a couple to develop a moment transfer connection between the mating leaves. In order to develop this horizontal distance, the bascule girders were therefore overlapping, and eliminated the option of individual operation of a single leaf.

Since this study involves the implementation of the chosen concept onto existing structures, the geometry of overlapping bascule girders is outside the scope of this study. We have therefore modified the concept to involve a single lock bar with multiple receiving sockets to provide a moment connection between leaves.

Advantages

The moment connection maximizes the transfer at the toe and minimizes the deflection at mid span.

Disadvantages

The concept utilizes the traditional lock bar system and includes all the disadvantages experienced by the Department during construction and maintenance of this type of system. This system also introduces the complexity of the additional receiver socket at each location to create the moment connection.

Major Limitations

Since this study dictates the concepts must be suitable for retrofit to existing bridges, the single bar moment connection was analyzed. The analysis revealed that the bar dimensions grew exponentially in order to create the moment connection to a point that made this concept impractical to implement. As a result from the analysis portion of this study, this option was eliminated from the study as a viable option.

Evaluation of Scoring

The concept score HIGH to HIGH AVERAGE on most of the categories and sub-categories. As described in the Description section, this system has been successfully implemented with high quality results on an existing bridge. The geometry of the existing bascule bridges for this study has limited the use of this concept.

5. RECOMMENDATION (DRAFT)

The span lock systems have been evaluated with focus on two primary components, based on the objectives of FDOT. Analysis considered:

1. Alignment Constraints during Construction
2. Structural Effectiveness (lock contribution to overall structural system)

Each system was evaluated against the same criteria for consistency (See Appendix for Evaluation Matrix and Evaluation Criteria). Based on Preliminary (DRAFT) analysis, we recommend that the Improved Taper Lockbar be further developed for Preliminary Design

APPENDIX

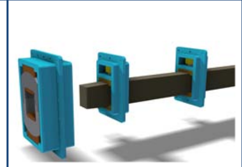
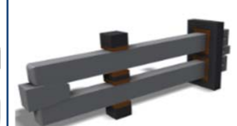
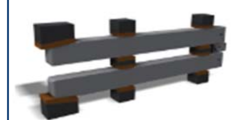
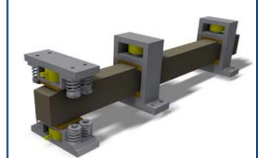
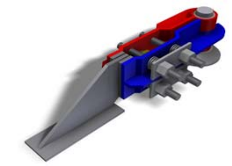
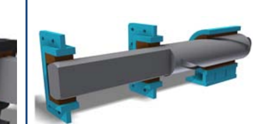
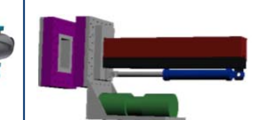
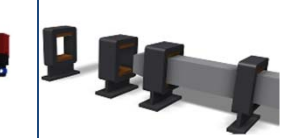
SPAN LOCK CONCEPTS ESTIMATED COST

CONCEPT	ESTIMATED COST	COST RELATIVE TO STANDARD SPAN LOCK (%)
STANDARD LOCK BAR (BASE COMPARISON)	$ 150,000.00	100.00%
IMPROVED TAPER	$ 200,000.00	133.11%
PINCER	$ 253,500.00	167.88%
JAW	$ 253,500.00	167.88%
FRICTION LOCK	$ 284,000.00	188.08%
CLAMPING LOCK	$ 199,000.00	131.79%
FIN BRAKE	$ 283,000.00	187.42%
CYLINDRICAL NOSE-RECEIVER	$ 216,750.00	143.54%
CAM	$ 256,000.00	169.54%
EHM INTERNALLY EXPANDED	$ 193,000.00	127.81%
MOMENT LOCK BAR	$ 640,000.00	423.84%

SPAN LOCK CONCEPTS EVALUATION CRITERIA

	CRITERIA (HIGH SCORE)	CRITERIA (LOW SCORE)	WEIGHT
EFFECTIVENESS			**20**
Vertical Deflection Under Live Load			
Capacity to transfer live load shear loads	Solid (small gap) connections	Pin, spring or cushion will transfer less shear than solid bar	
Resists leaf tip rotation	Two receiving sockets		
Allows for thermal expansion		clamping / springs and taper that result in horiz friction	
MAINTENANCE			**20**
Degree of Installation Complexity	Easy to install		
Maintenance Access		harder to access = 2	
Compexity of replacement parts			
Frequency of replacing wearing components	Clamps = 5 (self adjusting)	taper = 4 (will get some wear at spherical interface)	
EMERGENCY DISENGAGEMENT			**15**
Time of operation	single step operation = shorter time	more bars to hang up should take longer / also mult steps	
Simplicity	one bar is simplest = 4	lower as more comples	
Access	if it can be barrier mounted	roadway	
Size of maintenance staff required			
Required (special) equipment for procedure	1 step procedure = 4	multi step and/or heavy force required is 2 and 1 resp	
CONSTRUCTABILITY			**15**
Geometric Complexity		Spherical shapes & multiple parts scored lower	
Construction Tolerance requirements	Large receiver opening/expand bar	LC3 fit with housing / web & RC9 fit bar and shoe	
Testing requirements	one step interlock	testing	
Required modifications to structural interface			
Control system modification requirements	one step = 5, two step = 4		
Adaptability to Existing Structures			
Adaptablity to New Structures			
DURABILITY			**30**
Estimated service life	duration between repairs	duration between repairs	
Component wear accomodation	infinate adjustment = clamp lock	taper = 4, as the sphere will wear/no adjustemnt	
Synopsis of potential necessary repairs		repairs	

SPAN LOCK CONCEPTS EVALUATION MATRIX

	IMPROVED TAPER	PINCER	JAW	FRICTION LOCK	CLAMPING LOCK	FIN BRAKE	CYLINDRICAL NOSE-RECEIVER	CAM	EHM INTERNALLY EXPANDED	MOMENT LOCK BAR
										
EFFECTIVENESS (20%)										
Vertical Deflection Under Live Load	4	4	4	4	3	4	4	4	3	5
Capacity to transfer live load shear loads	4	4	4	4	3	3	3	4	3	5
Resists leaf tip rotation	5	3	3	4	3	2	2	3	3	5
Allows for thermal expansion	5	2	2	2	2	2	5	2	2	5
MAINTENANCE (20%)										
Degree of Installation Complexity	4	2	2	1	4	4	3	4	4	4
Maintenance Access	3	2	2	1	2	3	2	2	2	3
Compexity of replacement parts	4	5	5	1	2	4	2	3	3	4
Frequency of replacing wearing components	4	4	4	5	5	5	4	5	5	4
EMERGENCY DISENGAGEMENT PROCEDURES (15%)										
Time of operation	4	5	5	3	4	5	5	5	4	5
Simplicity	4	4	4	1	3	5	4	2	3	4
Access	5	3	3	1	4	5	5	5	5	5
Size of maintenance staff required	5	4	4	1	3	5	5	5	4	5
Required (special) equipment for procedure	4	4	4	1	3	1	4	4	1	4
CONSTRUCTABILITY (15%)										
Geometric Complexity	3	4	4	2	3	5	1	2	3	4
Concerns)	4	3	3	2	4	5	1	3	4	3
Testing requirements	4	3	3	2	3	5	3	4	3	4
Required modifications to structural interface	5	2	2	1	4	5	1	4	4	4
Control system modification requirements	5	4	4	4	4	5	3	5	4	5
Adaptability to Existing Structures										
Adaptablity to New Structures										
DURABILITY (30%)										
Estimated service life	5	5	5	2	3	5	5	5	3	5
Component wear accomodation	4	4	4	5	5	5	1	4	5	2
Synopsis of potential necessary repairs	5	4	4	1	3	5	2	4	3	4
COST										
Total initial cost of new system - Design, Construction, CEI, Post Design	$ 201,000	$ 253,500	$ 253,500	$ 284,000	$ 199,000	$ 283,000	$ 216,750	$ 256,000	$ 193,000	$ 640,000
Cost Relative to Standard Span Lock (%)	133.11%	167.88%	167.88%	188.08%	131.79%	187.42%	143.54%	169.54%	127.81%	423.84%
Life cycle cost										
SCORING										
Average Weighted Score	4.34	3.68	3.68	2.44	3.35	4.23	3.01	3.82	3.4	4.14
Weighted score (Avg Score/Relative Cost)	**3.26**	**2.19**	**2.19**	**1.30**	**2.54**	**2.26**	**2.10**	**2.25**	**2.66**	**0.98**

EVALUATION OF POSITIVE GRIP SPAN LOCKS
CONCEPTS EVALUATION PLANS

DRAFT

1/17/2012

PREPARED FOR
FLORIDA DEPARTMENT OF TRANSPORTATION

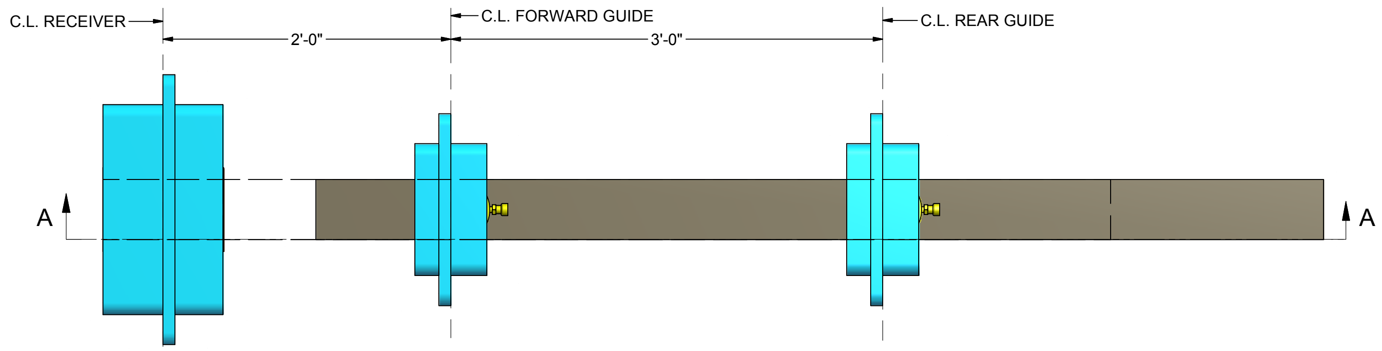
BY
HARDESTY & HANOVER, LLP

DRAWING LIST

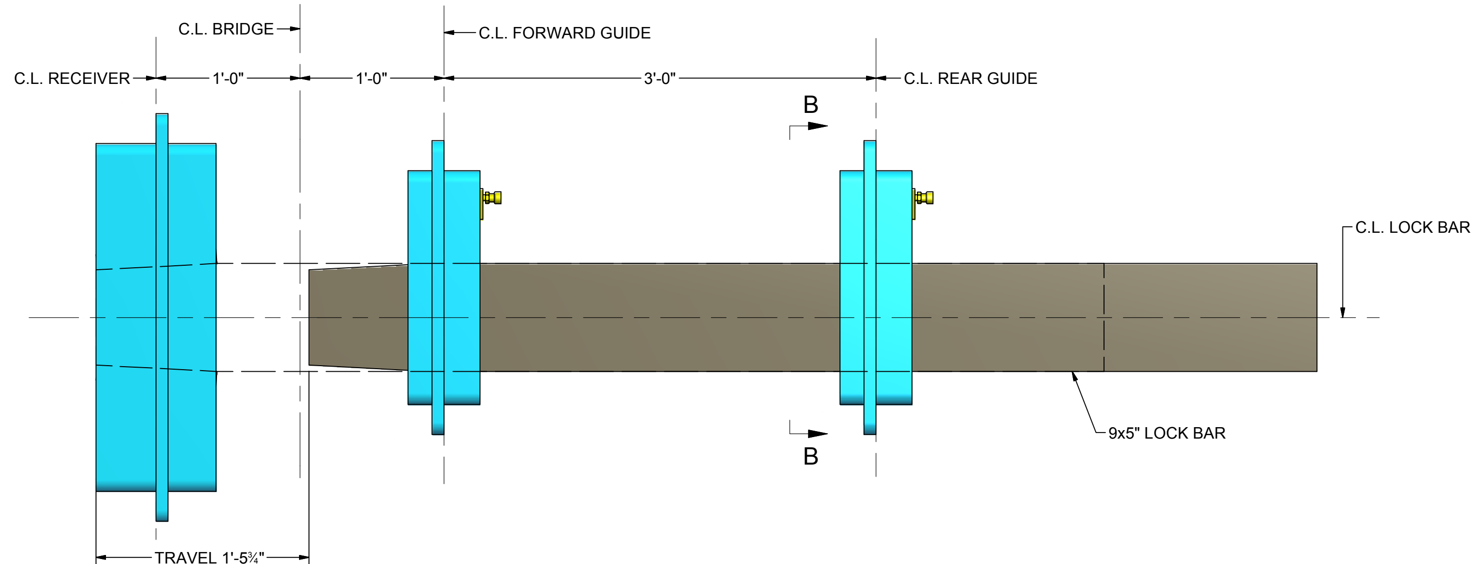
REVISIONS

DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

DRAWN BY: BHK	STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION			SHEET TITLE:	REF. DWG. NO.
CHECKED BY: DST					
DESIGNED BY:	ROAD NO.	COUNTY	FINANCIAL PROJECT ID	PROJECT NAME: EVALUATION OF POSITIVE GRIP SPAN LOCKS	SHEET NO. 1
CHECKED BY:					



PLAN



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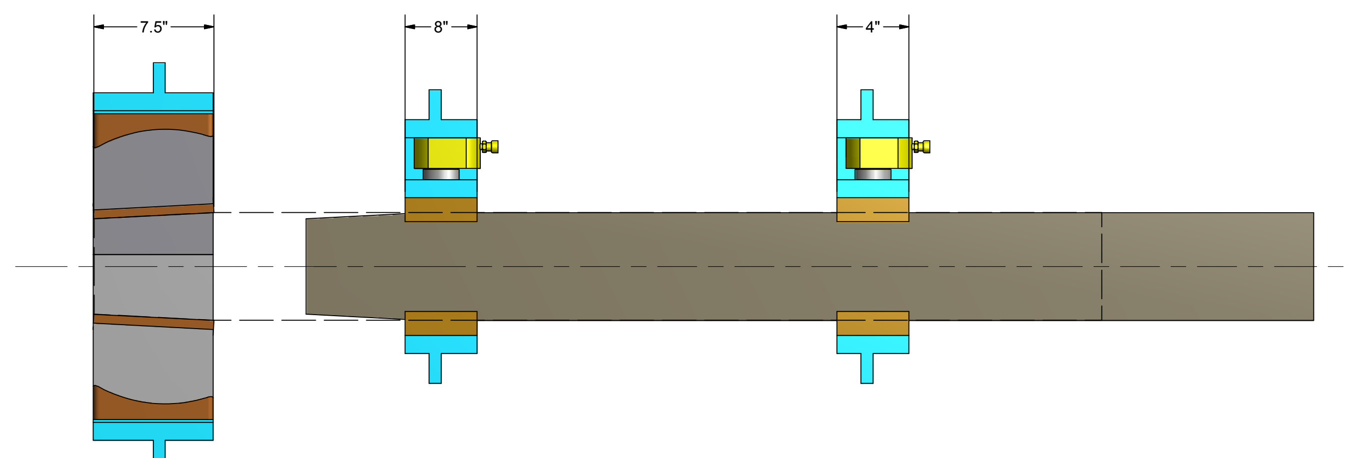
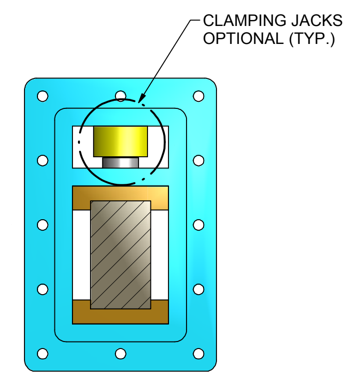


SECTION A-A



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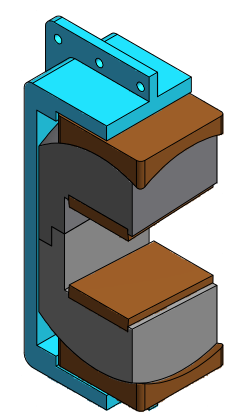
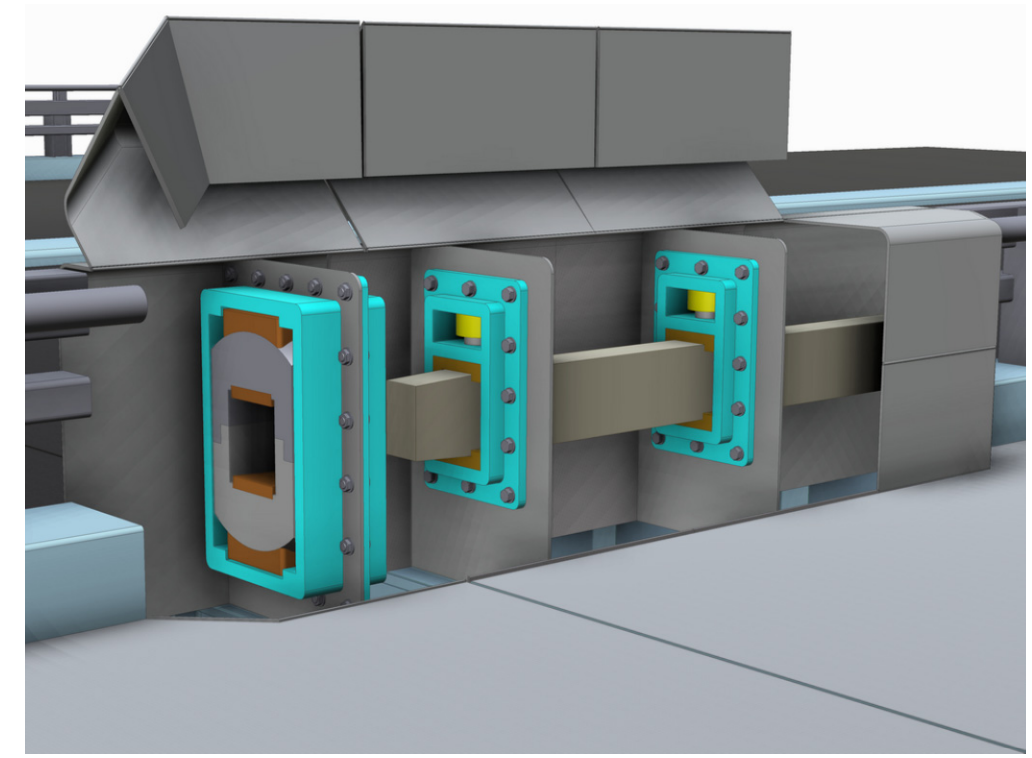
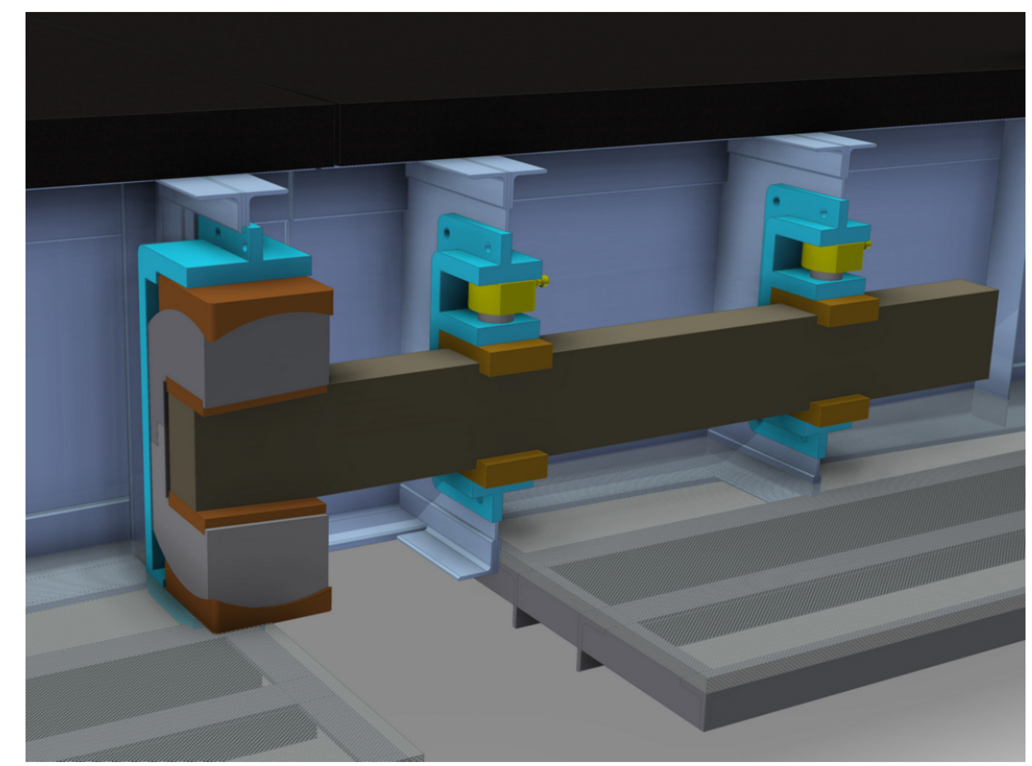


DETAIL 1 - SPHERICAL RECEIVER



IMPROVED TAPER LOCK BAR INSIDE BARRIER



IMPROVED TAPER LOCK BAR UNDER SIDEWALK

REVISIONS

DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

DRAWN BY: BHK
CHECKED BY: DST
DESIGNED BY: BH
CHECKED BY: GAF

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID

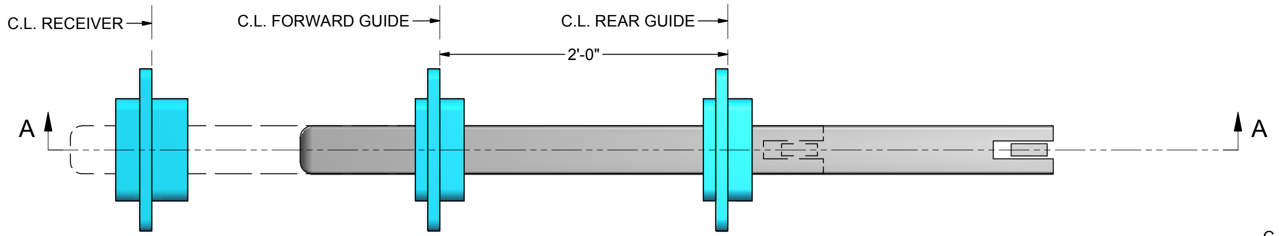
SHEET TITLE: IMPROVED TAPER LOCK BAR

PROJECT NAME: EVALUATION OF POSITIVE GRIP SPAN LOCKS

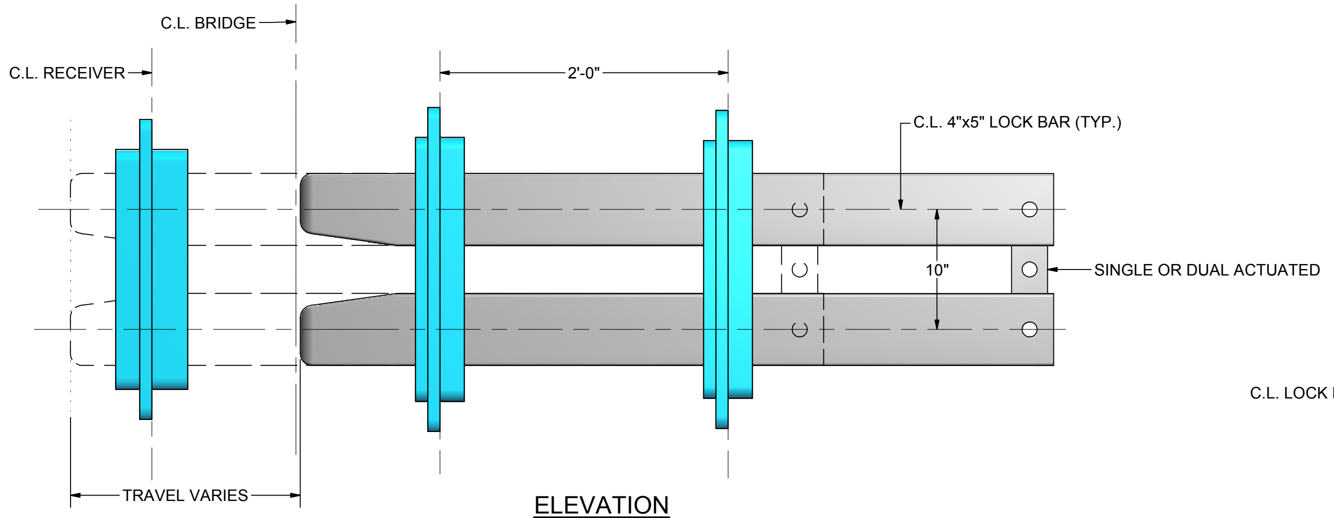
REF. DWG. NO.

SHEET NO. 2

1/17/2012 C:_PROJECTS\02718.00 - FDOT Spanlock Study\2000_Study\Schematics\FDOT_Spanlock_Study_Concepts.idw



PLAN



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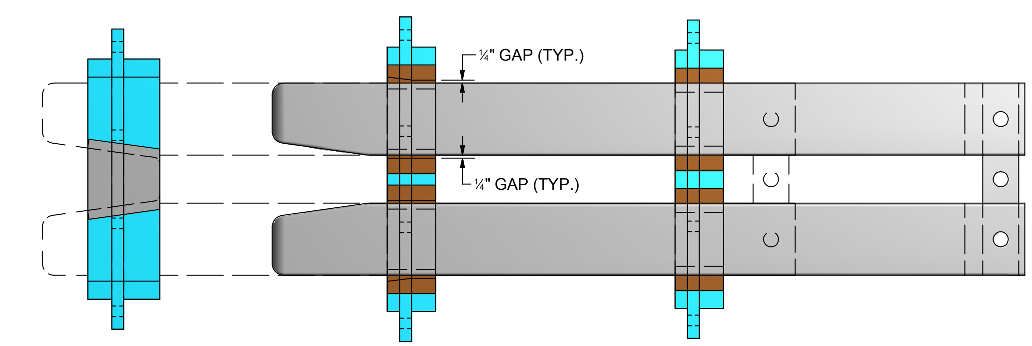
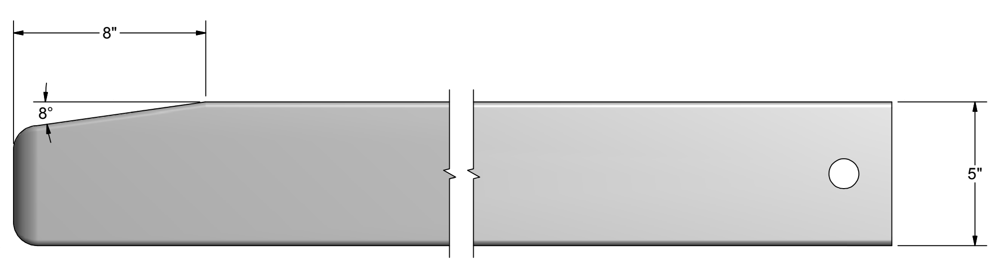
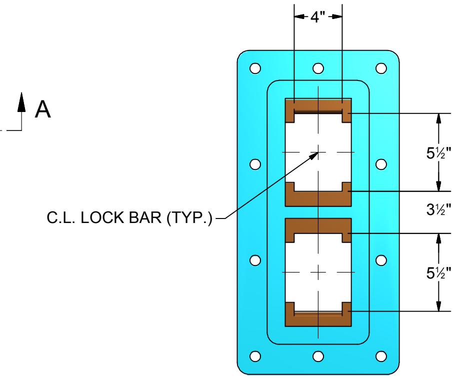


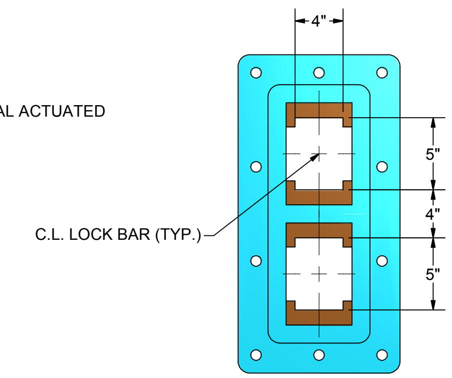
SECTION A-A



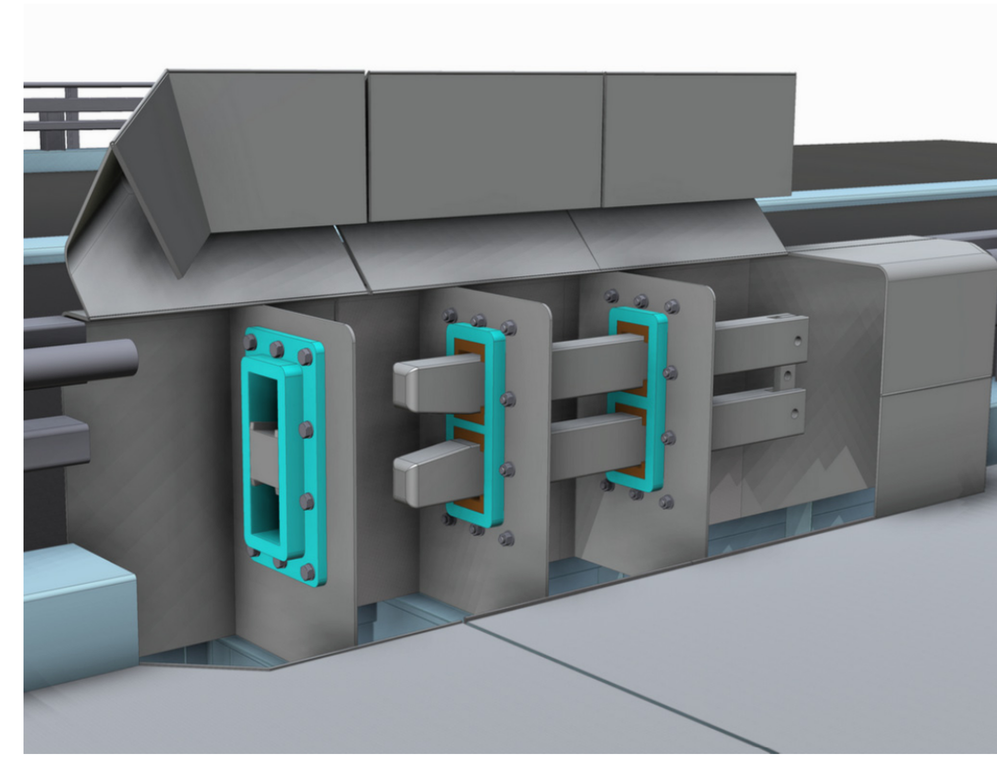
DETAIL 3 - 4x5 LOCK BAR



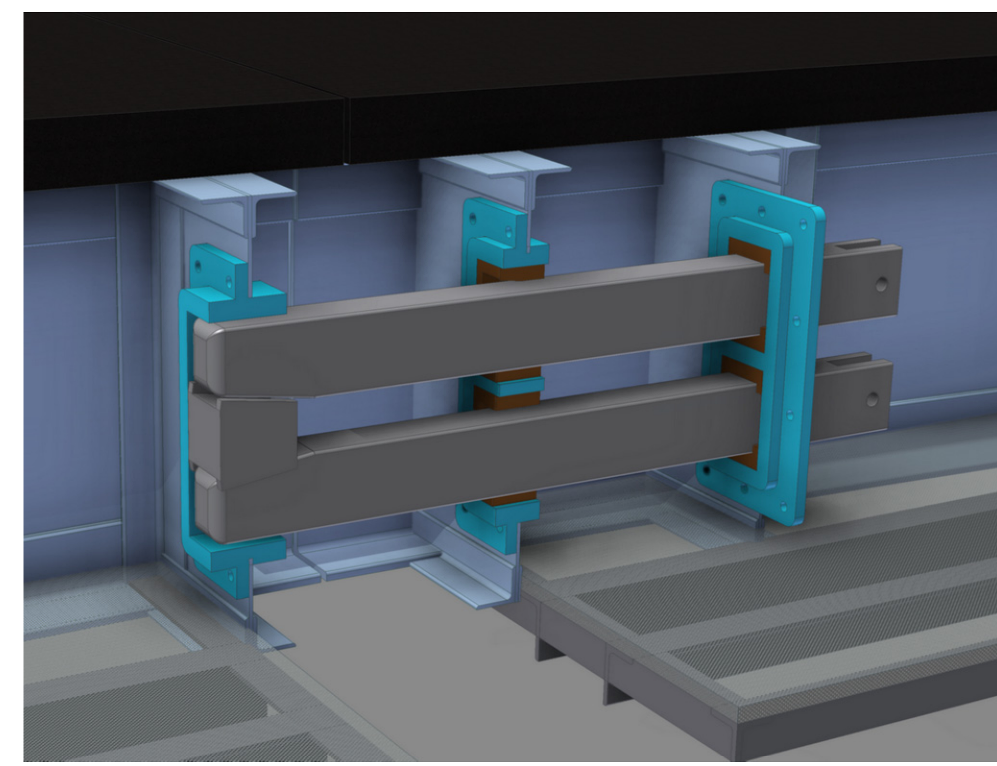
DETAIL 1 - FORWARD GUIDE



DETAIL 2 - REAR GUIDE



PINCER IN BARRIER



PINCER UNDER SIDEWALK

REVISIONS

DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

DRAWN BY: BHK
CHECKED BY: DST
DESIGNED BY: GAF
CHECKED BY: BH

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID

SHEET TITLE: PINCER ALTERNATIVE

PROJECT NAME: EVALUATION OF POSITIVE GRIP SPAN LOCKS

REF. DWG. NO.

SHEET NO. 3

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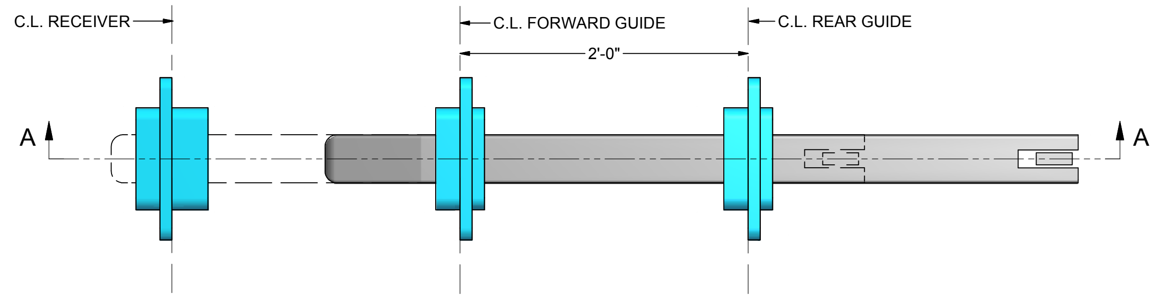
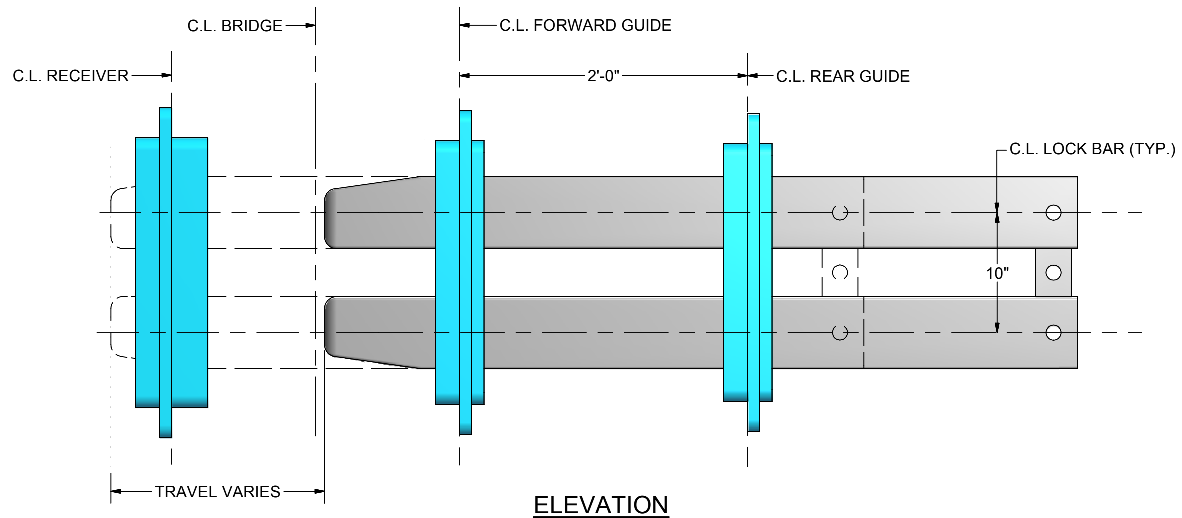


PLAN



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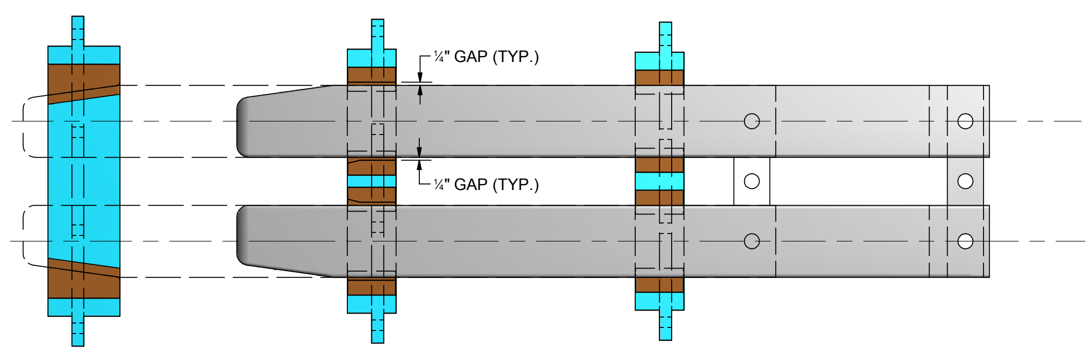
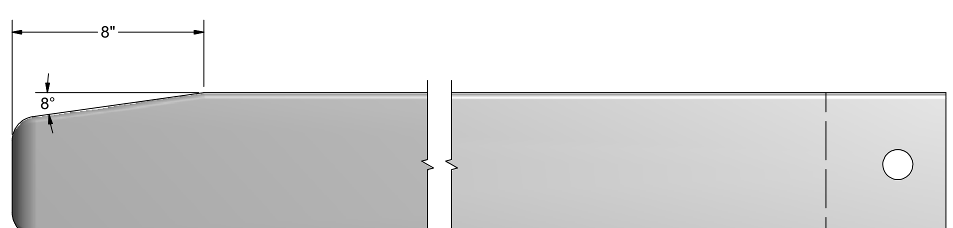
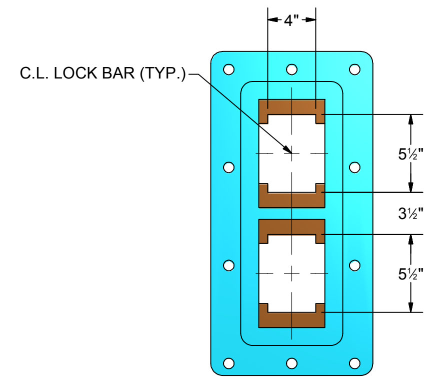


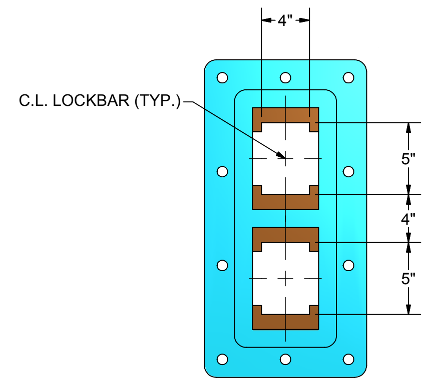
SECTION A-A



DETAIL 3 - 4x5 LOCK BAR



DETAIL 1 - FORWARD GUIDE



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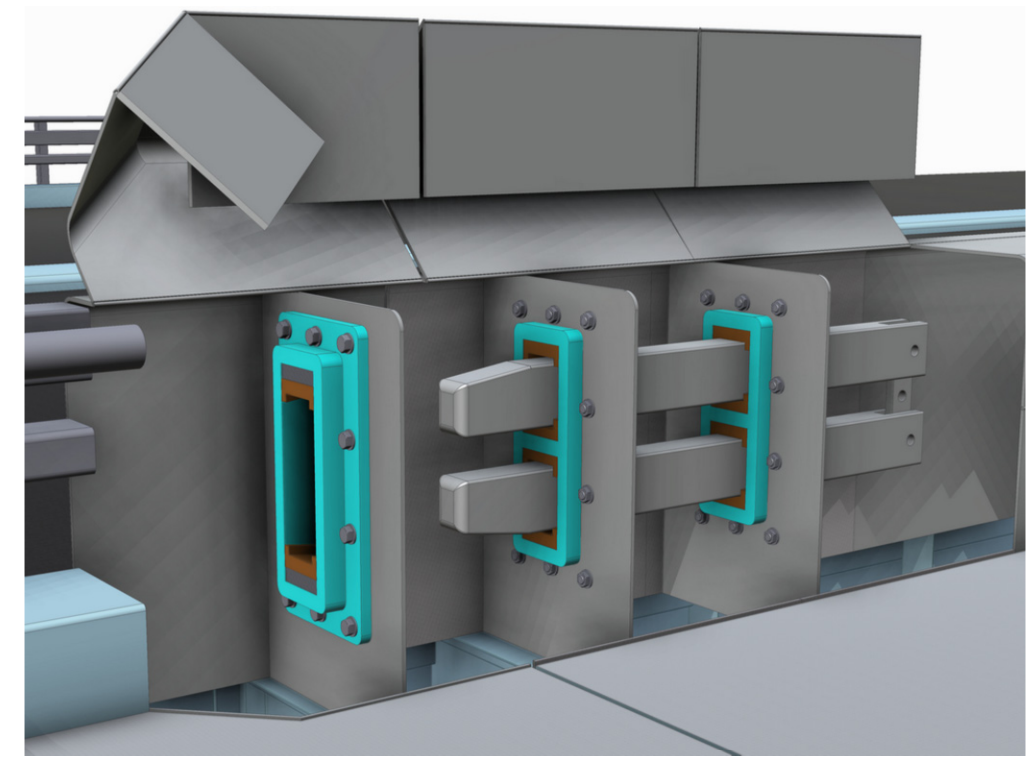
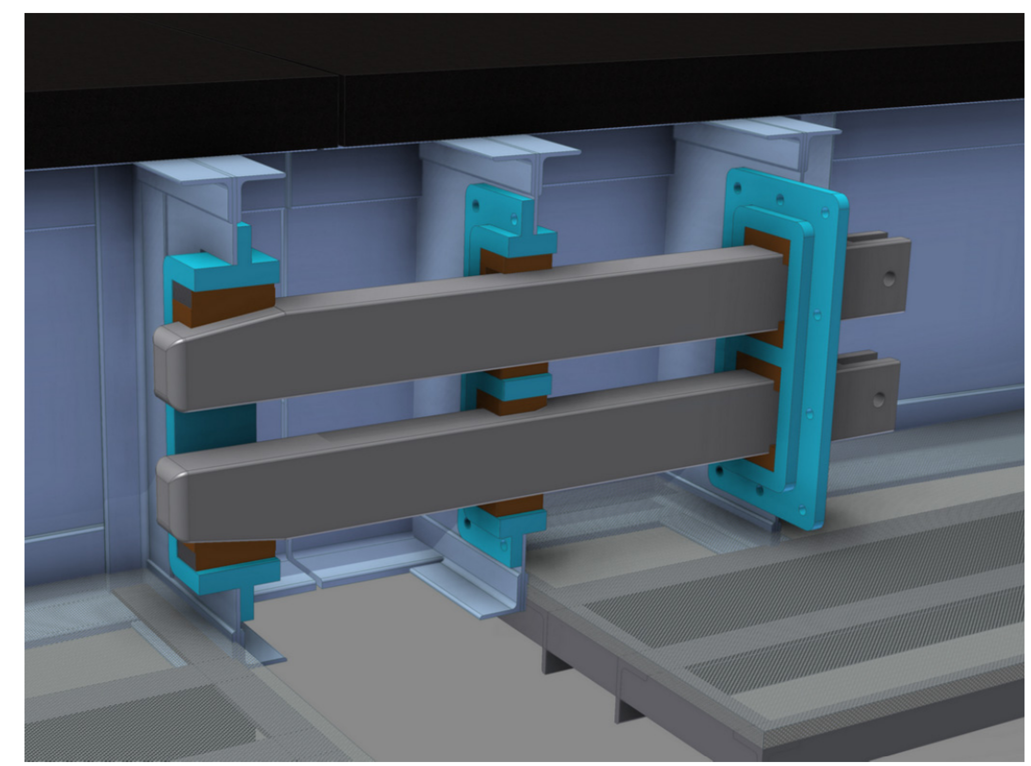


JAW IN BARRIER



JAW UNDER SIDEWALK

REVISIONS

DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

DRAWN BY: BHK
CHECKED BY: DST
DESIGNED BY: GAF
CHECKED BY: BH

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID

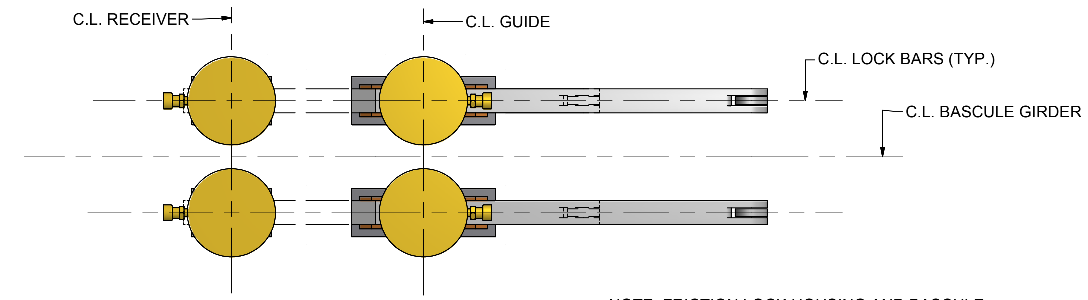
SHEET TITLE: JAW

PROJECT NAME: EVALUATION OF POSITIVE GRIP SPAN LOCKS

REF. DWG. NO.

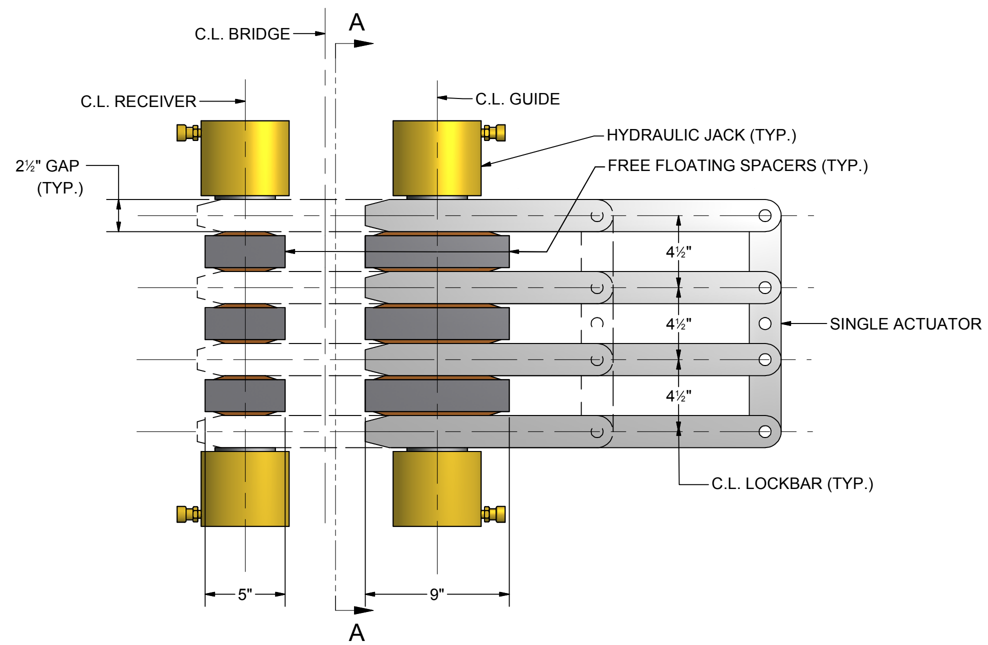
SHEET NO. 4

1/17/2012 C:_PROJECTS\02718.00 - FDOT Spanlock Study\2000_Study\Schematics\FDOT_Spanlock_Study_Concepts.idw



PLAN

NOTE: FRICTION LOCK HOUSING AND BASCULE GIRDER NOT SHOWN FOR CLARITY



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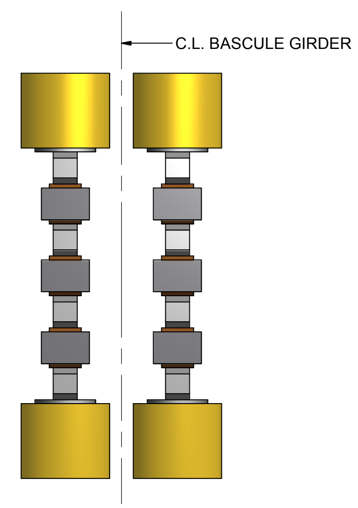
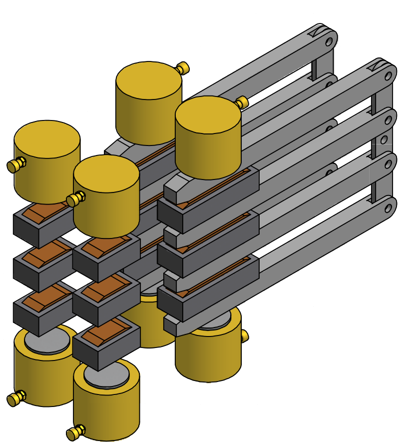
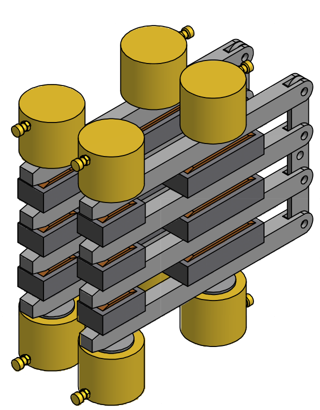


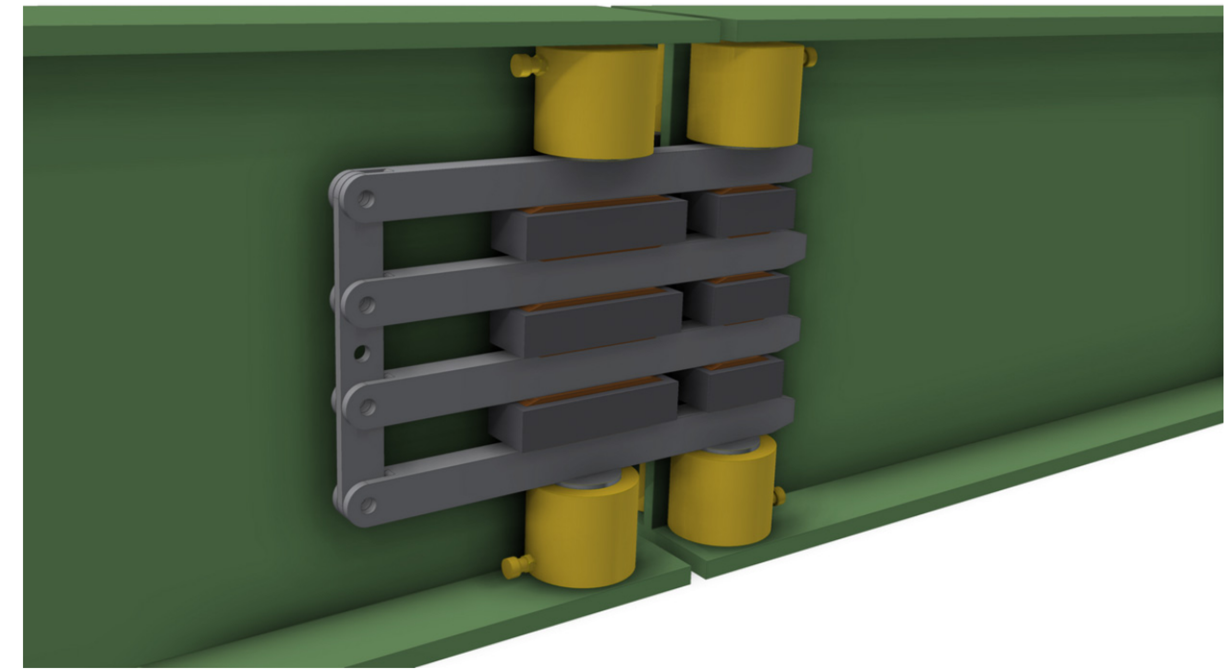
SECTION A-A



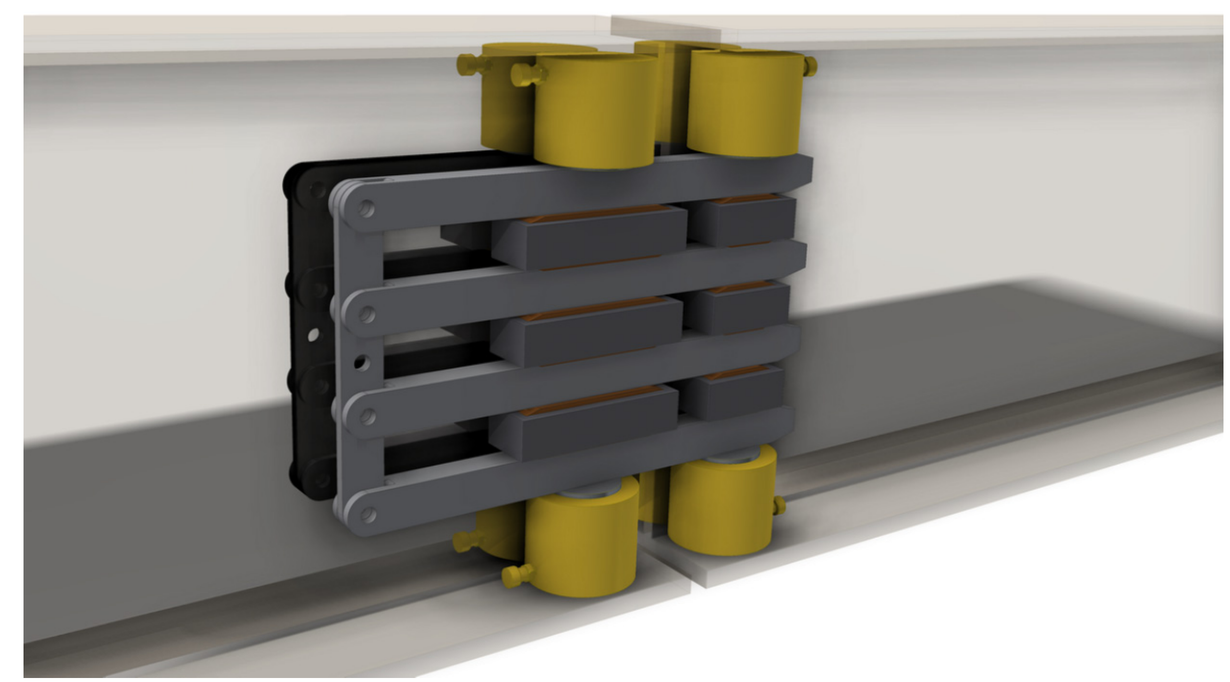
FRICTION LOCK RETRACTED



FRICTION LOCK EXTENDED



FRICTION LOCK MOUNTED TO BASCULE GIRDERS



FRICTION LOCK MOUNTED TO BASCULE GIRDERS (BASCULE GIRDERS HIDDEN)

REVISIONS

DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

DRAWN BY: BHK
CHECKED BY: DST
DESIGNED BY:
CHECKED BY:

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID

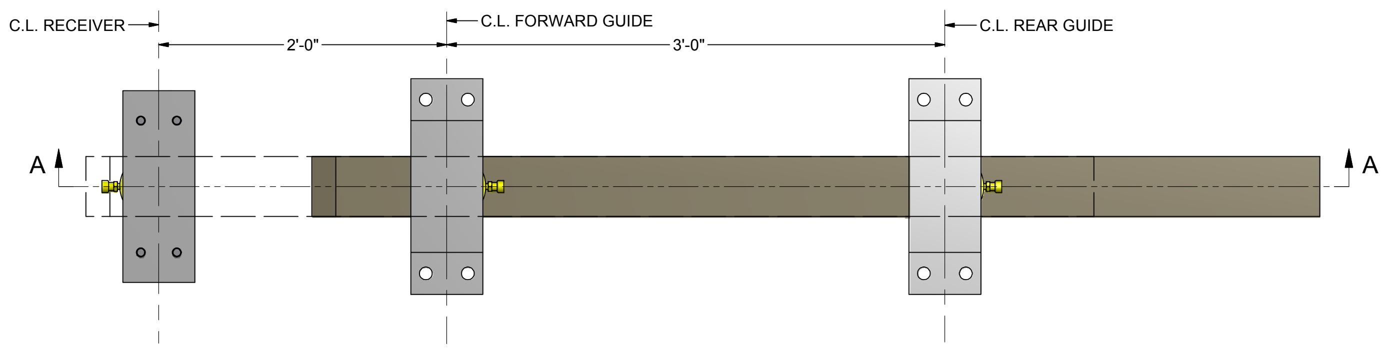
SHEET TITLE: FRICTION LOCK

PROJECT NAME: EVALUATION OF POSITIVE GRIP SPAN LOCKS

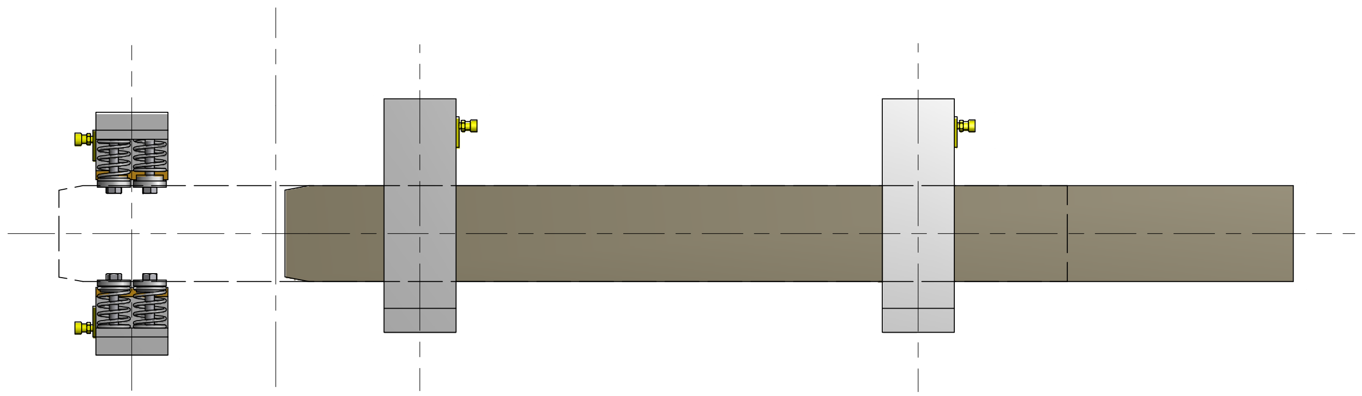
REF. DWG. NO.

SHEET NO. 5

1/17/2012 C:_PROJECTS\02718.00 - FDOT Spanlock Study\2000_Study\Schematics\FDOT_Spanlock_Study_Concepts.idw



PLAN



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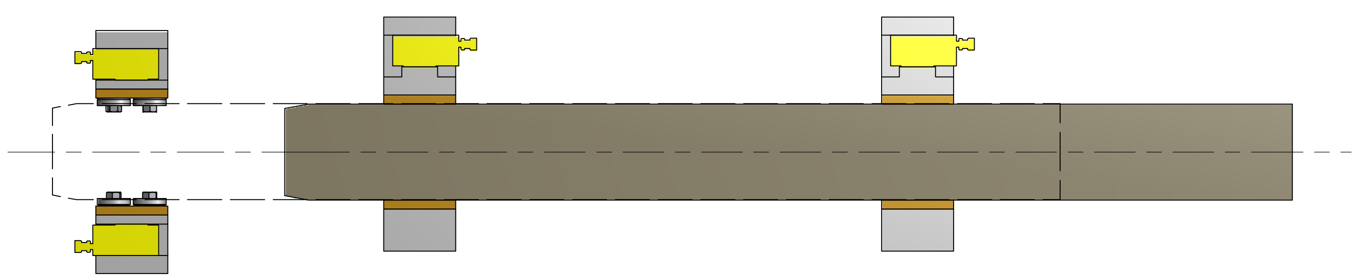
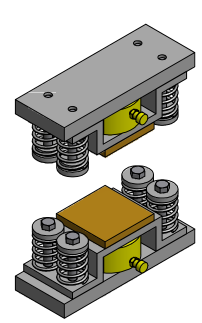
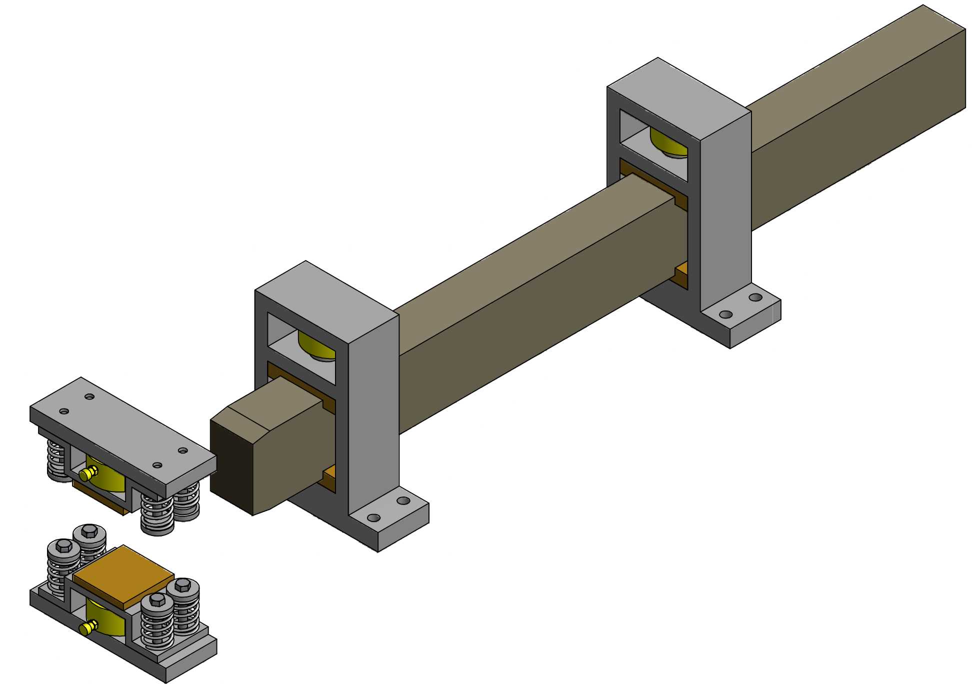


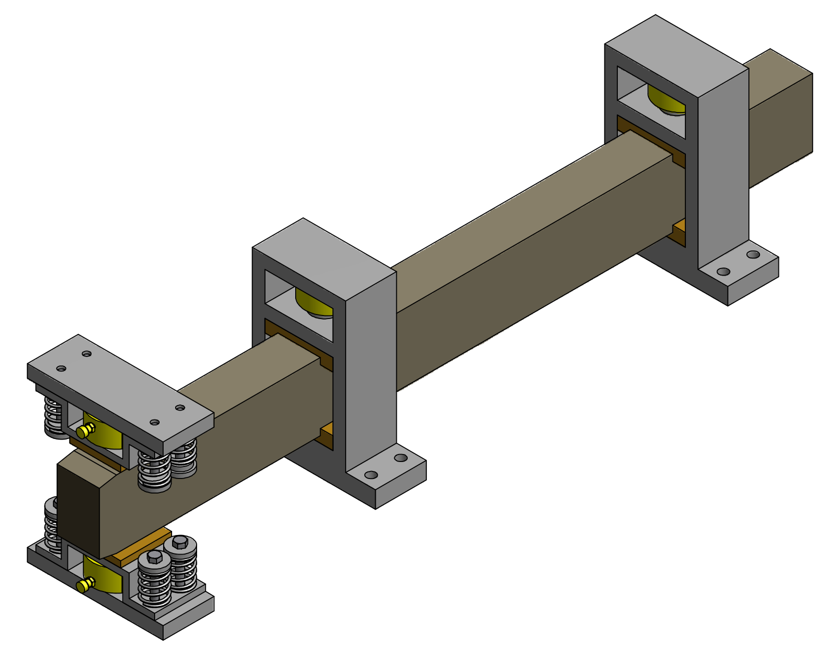
SECTION A-A



DETAIL 1 - CLAMPING RECEIVER



CLAMPING LOCK BAR RETRACTED



CLAMPING LOCK BAR EXTENDED

REVISIONS

DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

DRAWN BY: BHK
CHECKED BY: DST
DESIGNED BY: BH
CHECKED BY: GAF

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID

SHEET TITLE: CLAMPING LOCK

PROJECT NAME: EVALUATION OF POSITIVE GRIP SPAN LOCKS

REF. DWG. NO.

SHEET NO. 6

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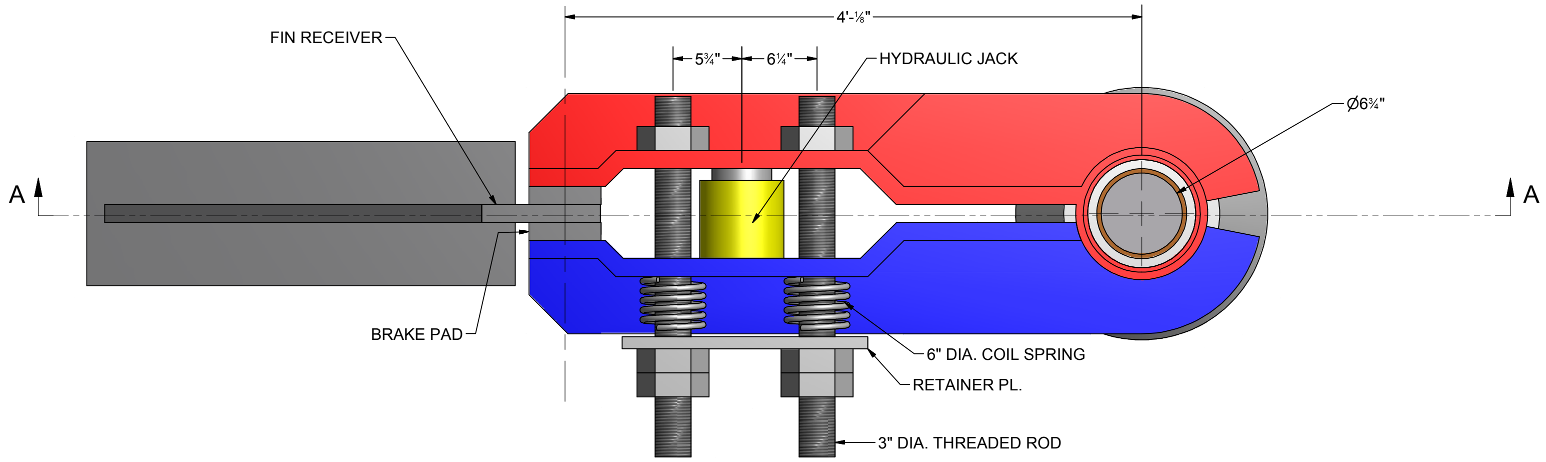
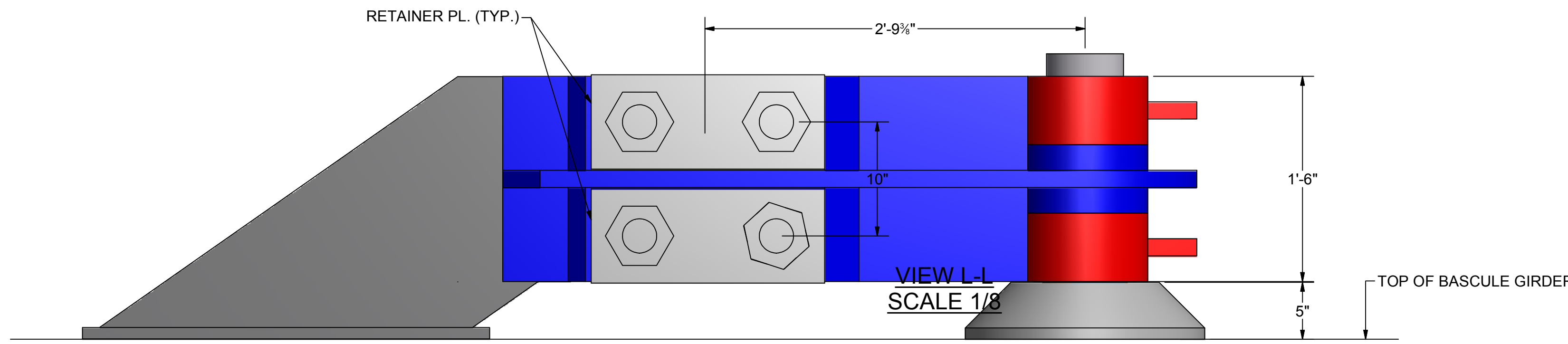
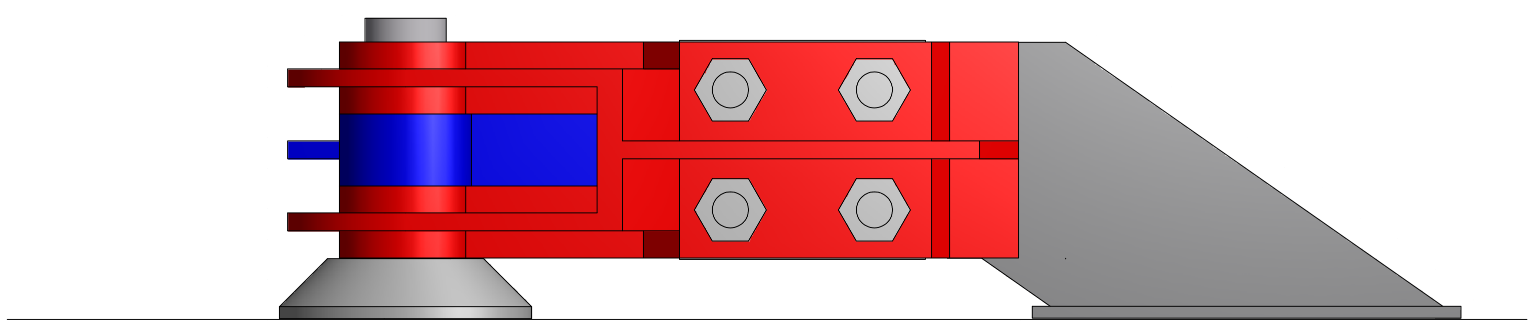


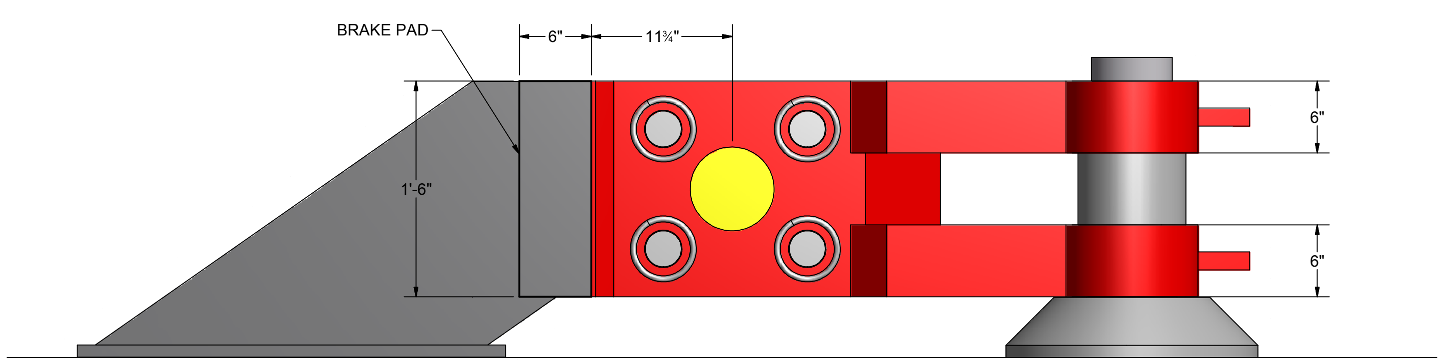
PLAN



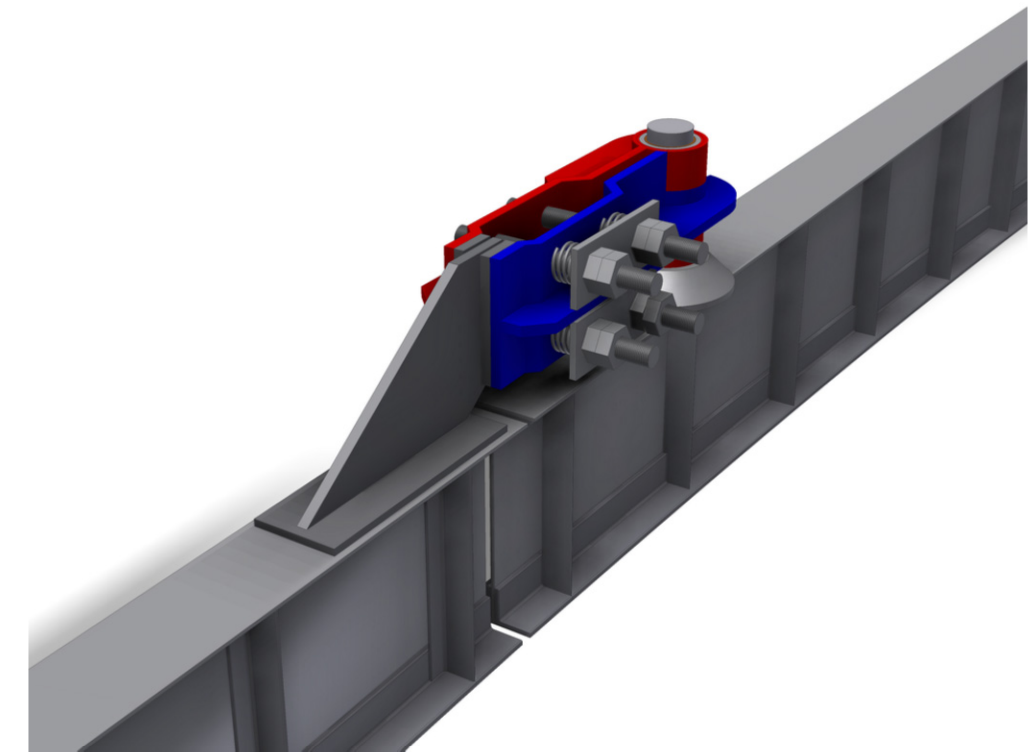
ELEVATION (OUTSIDE)



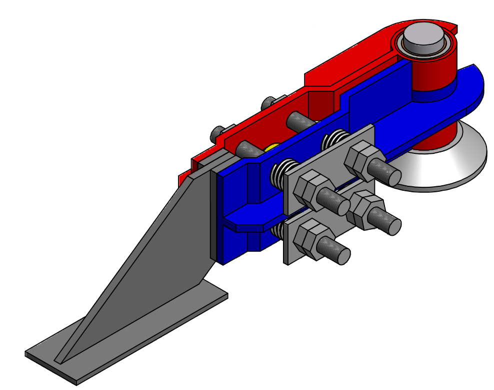
ELEVATION (INSIDE)



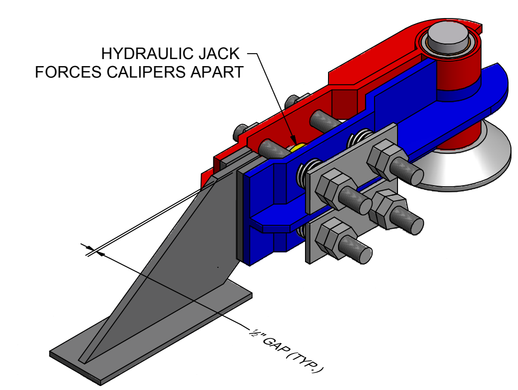
SECTION A-A



FIN BRAKE LOCK MOUNTED ON BASCULE GIRDERS



FIN BRAKE LOCKED



FIN BRAKE UNLOCKED

REVISIONS

DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

DRAWN BY: BHK
CHECKED BY: DST
DESIGNED BY: SAM
CHECKED BY: GAF/BH

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

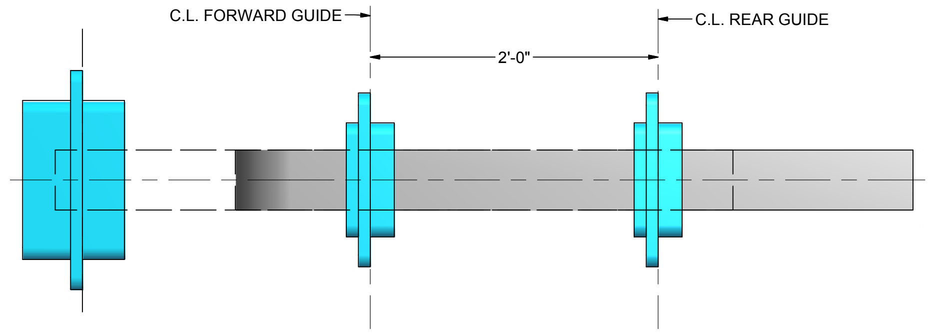
ROAD NO.	COUNTY	FINANCIAL PROJECT ID

SHEET TITLE: FIN BRAKE LOCK

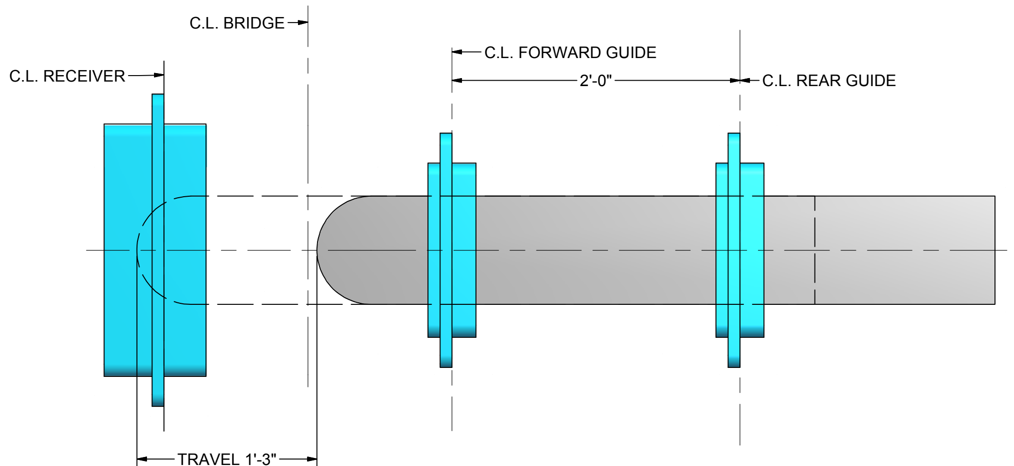
PROJECT NAME: EVALUATION OF POSITIVE GRIP SPAN LOCKS

REF. DWG. NO.

SHEET NO. 7



PLAN



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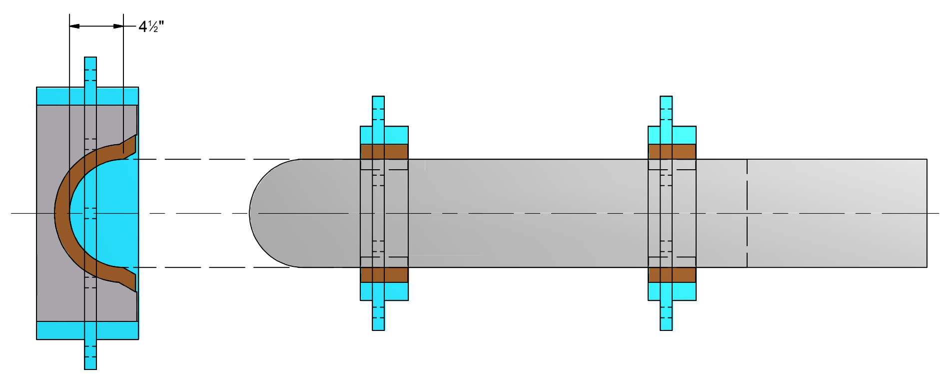
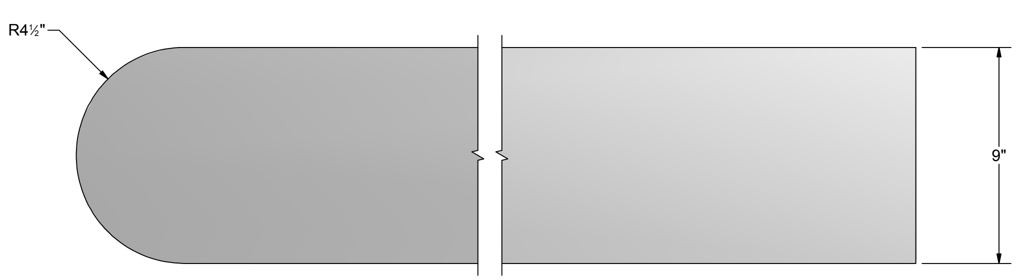
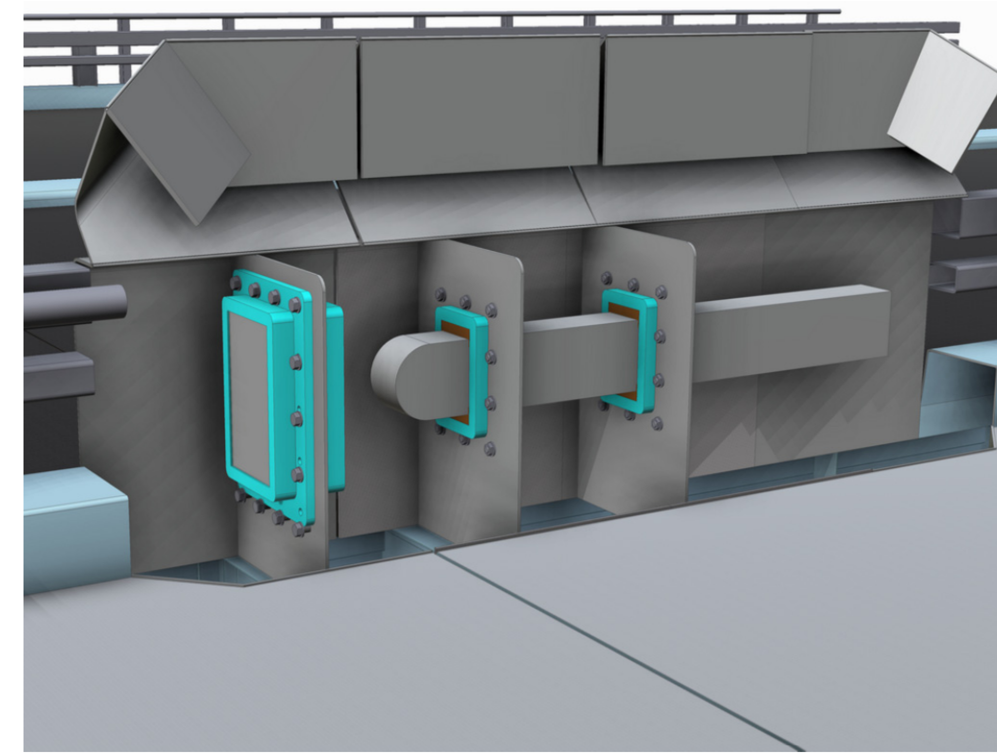


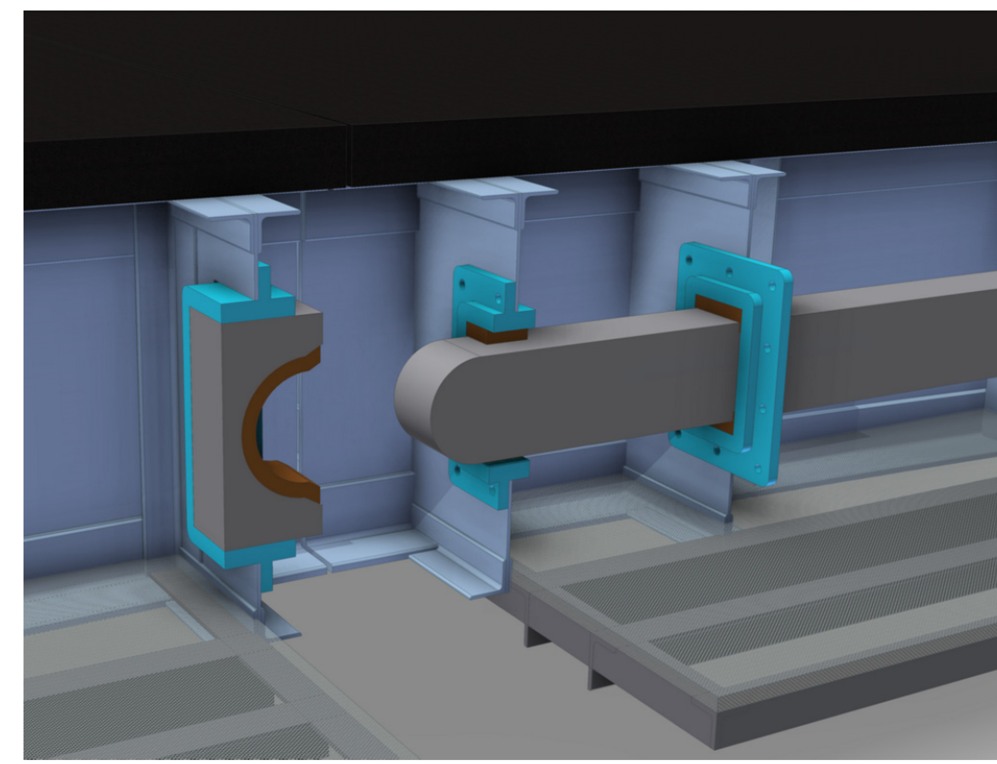
SECTION A-A



DETAIL 1 - 9x5 LOCK BAR



CYLINDRICAL NOSE-RECEIVER LOCK BAR IN BARRIER



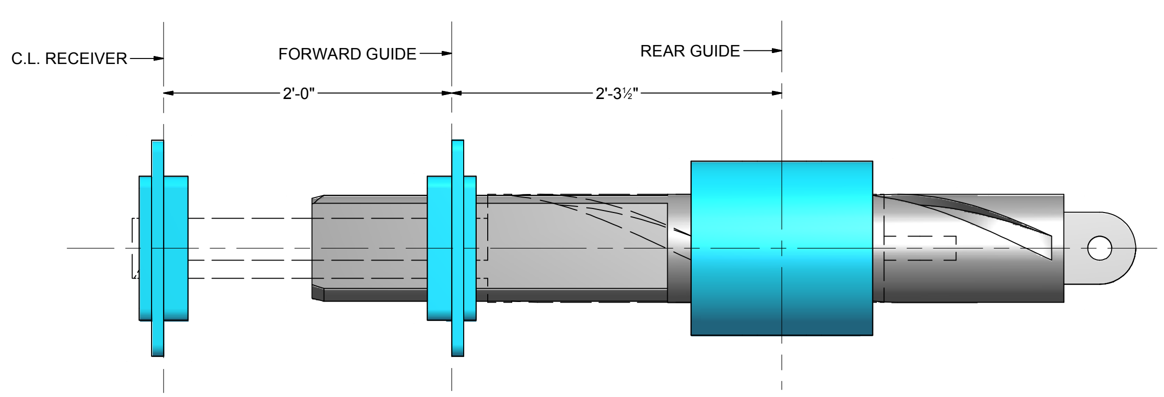
CYLINDRICAL NOSE-RECEIVER LOCK BAR UNDER SIDEWALK

REVISIONS

DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

DRAWN BY: BHK CHECKED BY: DST DESIGNED BY: BH CHECKED BY: GAF	STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION ROAD NO. / COUNTY / FINANCIAL PROJECT ID	SHEET TITLE: CYLINDRICAL NOSE-RECEIVER LOCK BAR PROJECT NAME: EVALUATION OF POSITIVE GRIP SPAN LOCKS	REF. DWG. NO. SHEET NO. 8

1/17/2012 C:_PROJECTS\02718.00 - FDOT Spanlock Study\2000_Study\Schematics\FDOT_Spanlock_Study_Concepts.idw



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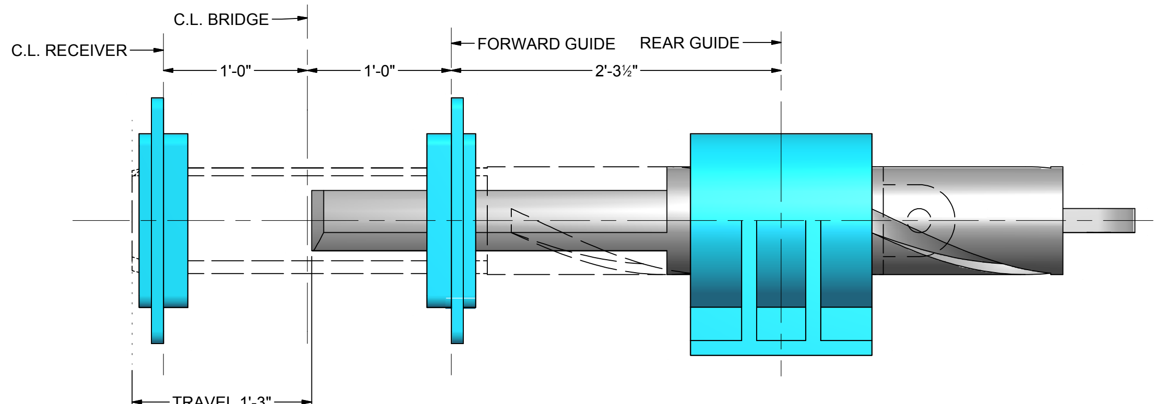

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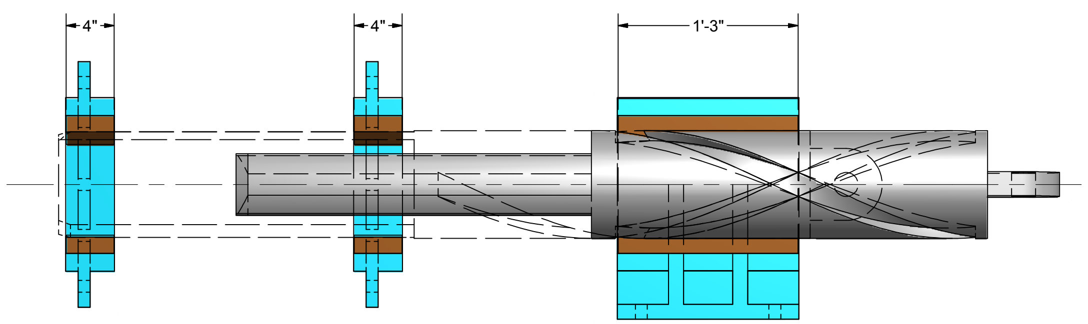
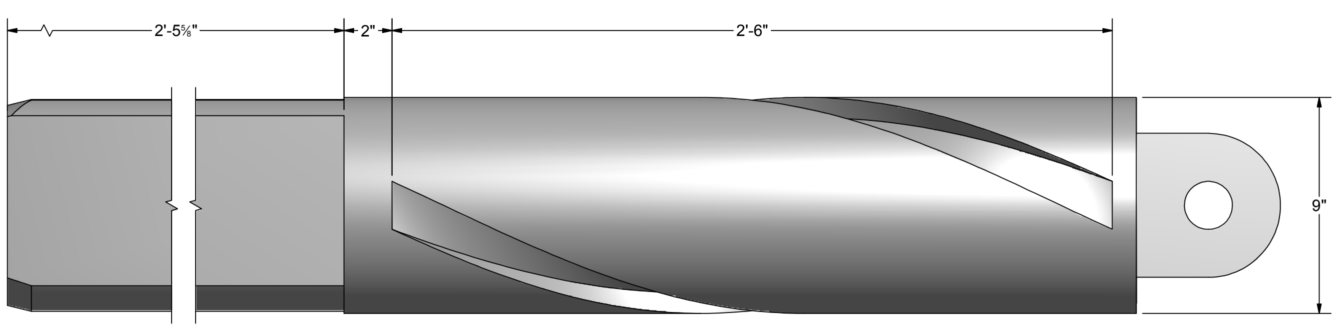
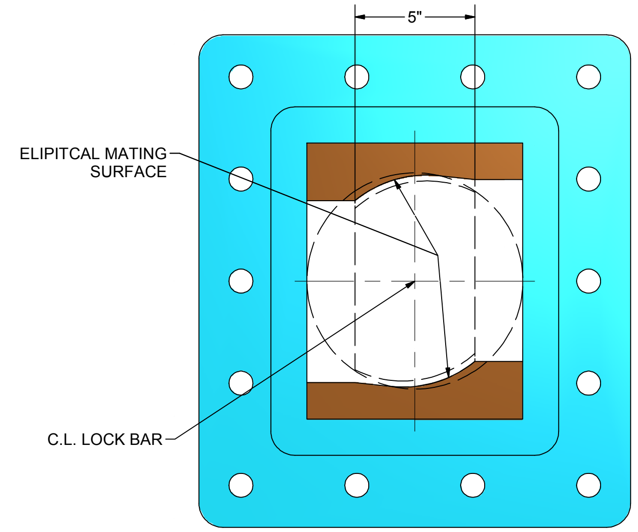


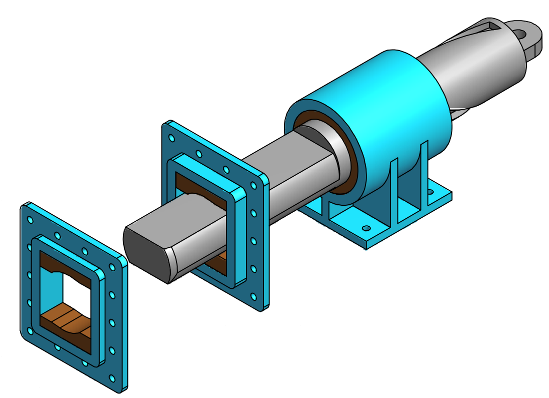
SECTION A-A



DETAIL 2 - LOCK BAR



DETAIL 1 - FORWARD GUIDE AND RECEIVER



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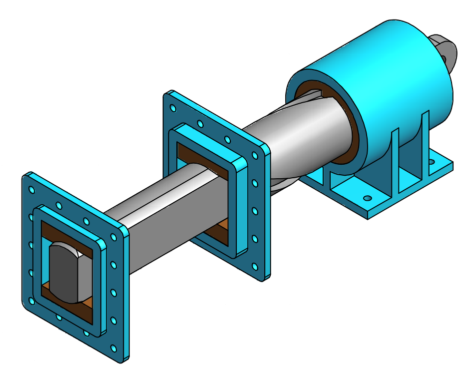

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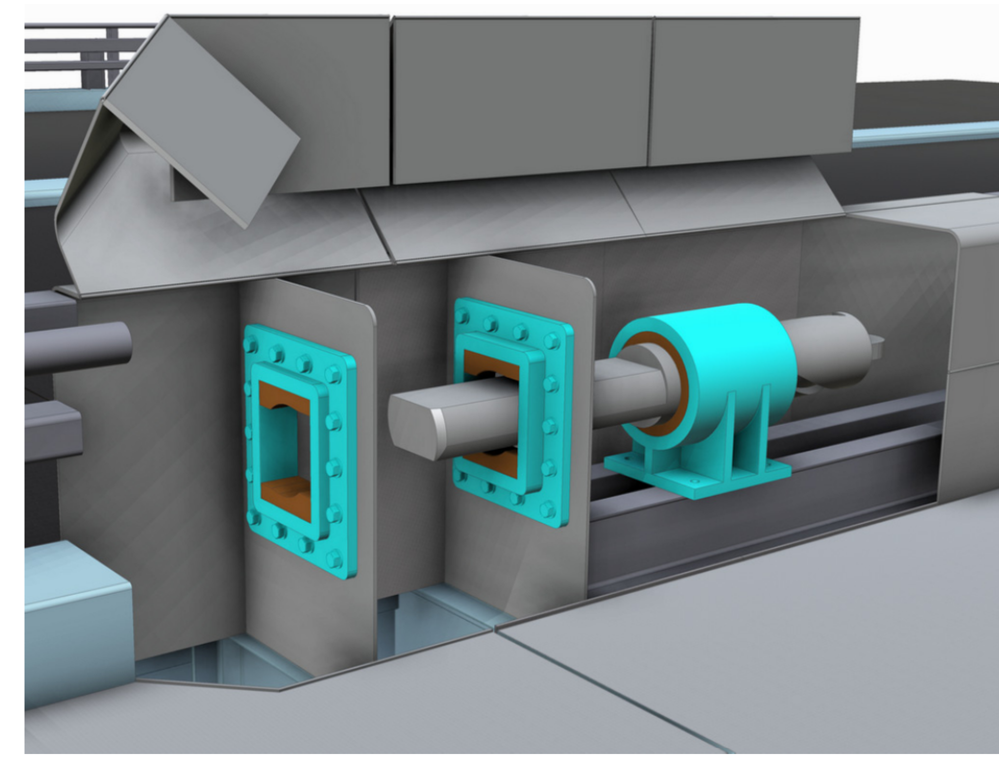
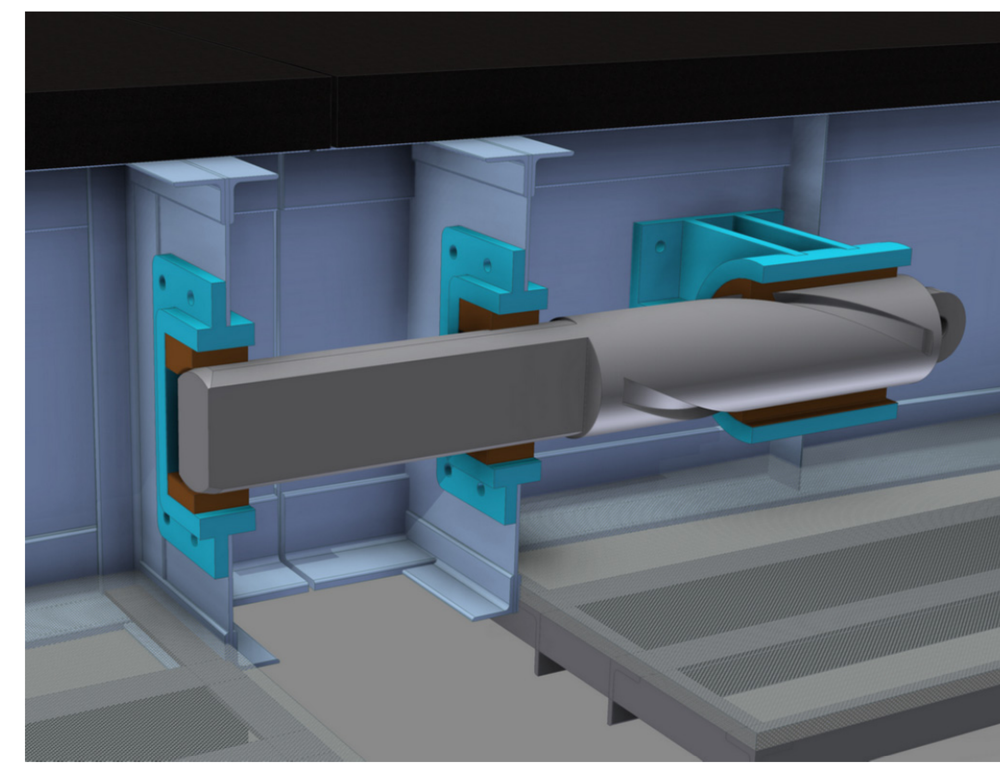


CAM LOCK IN BARRIER

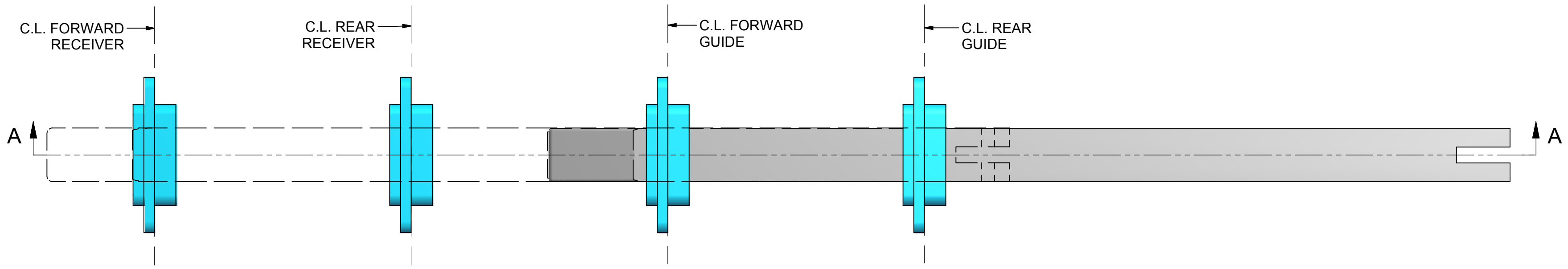


CAM LOCK UNDER SIDEWALK

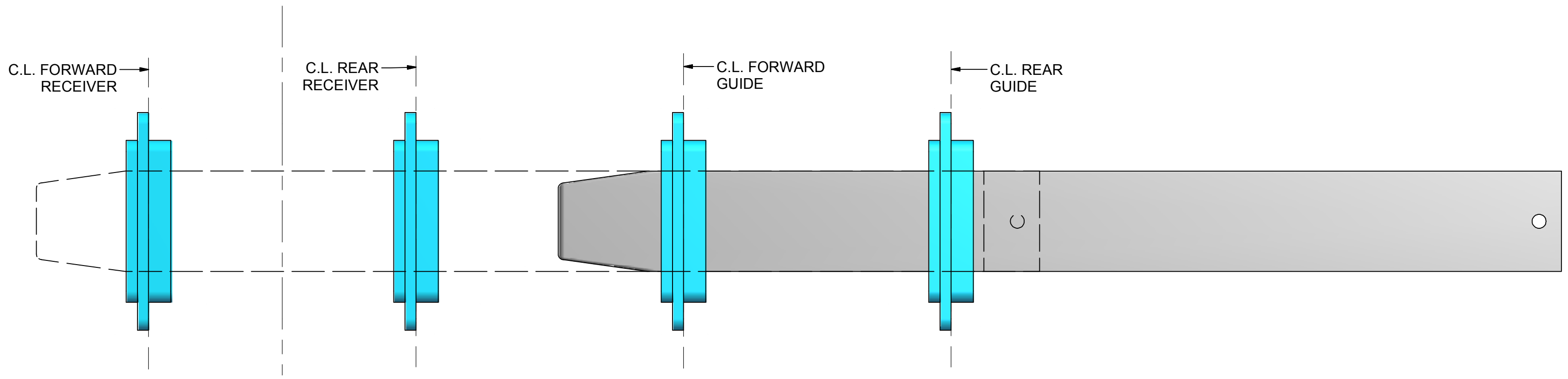
REVISIONS

DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

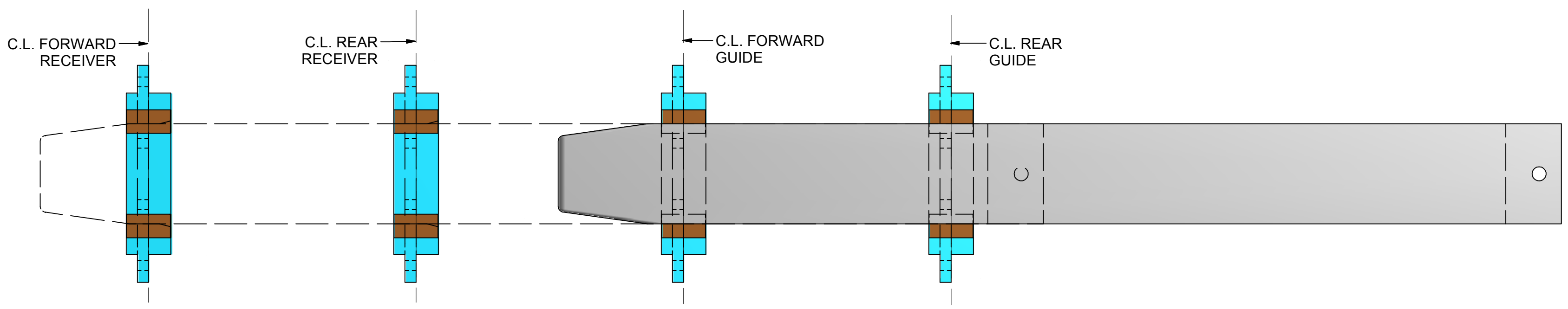
DRAWN BY: BHK	STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION	SHEET TITLE: CAM ACTUATED LOCK BAR	REF. DWG. NO.
CHECKED BY: DST	ROAD NO. / COUNTY / FINANCIAL PROJECT ID		
DESIGNED BY: SAM		PROJECT NAME: EVALUATION OF POSITIVE GRIP SPAN LOCKS	SHEET NO. 9
CHECKED BY: GAF			



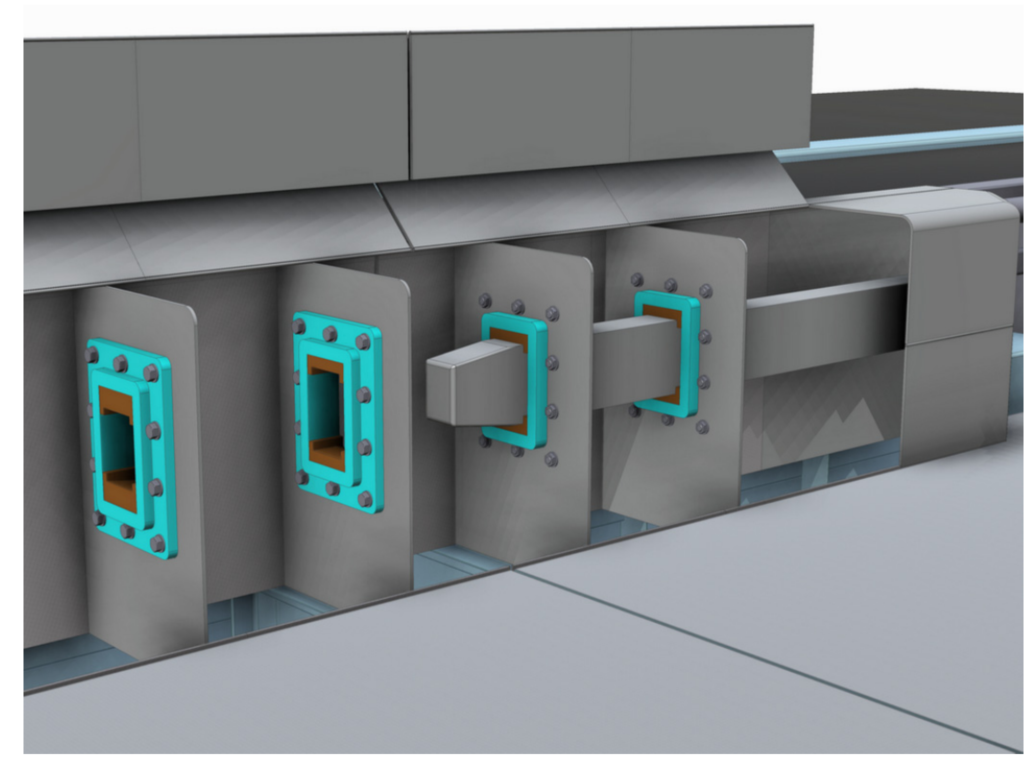
PLAN



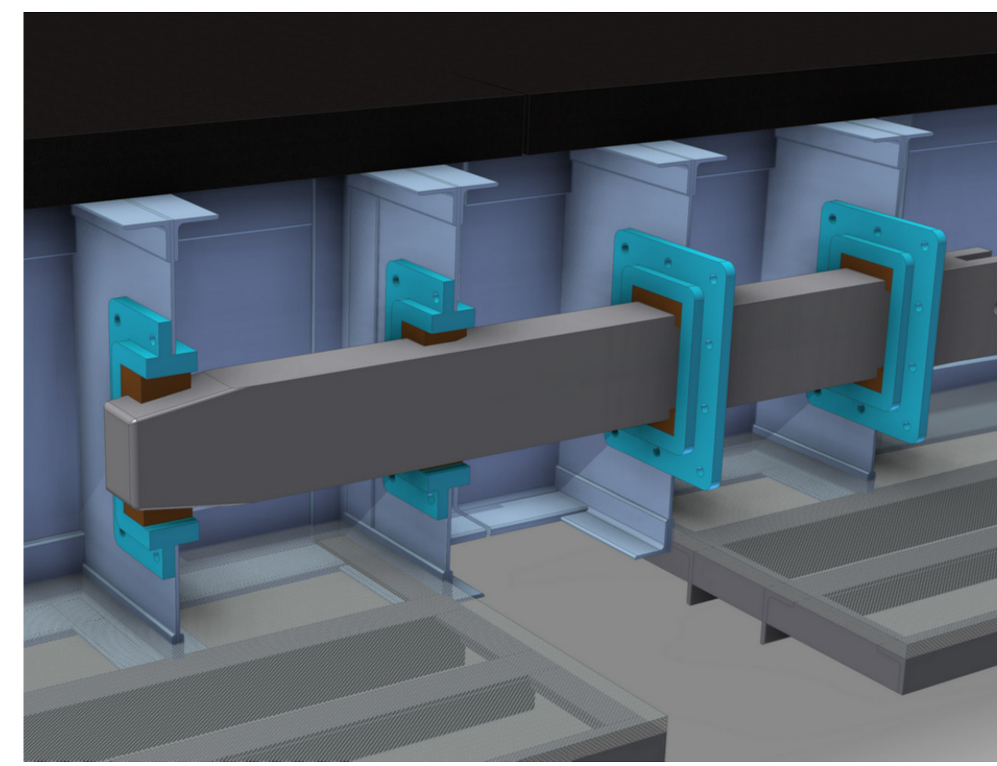
ELEVATION



SECTION A-A



MOMENT LOCK BAR IN BARRIER



MOMENT LOCK BAR UNDER SIDEWALK

REVISIONS

DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

DRAWN BY: BHK	STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION			SHEET TITLE: MOMENT LOCK
CHECKED BY: DST				REF. DWG. NO.
DESIGNED BY: GAF	ROAD NO.	COUNTY	FINANCIAL PROJECT ID	PROJECT NAME: EVALUATION OF POSITIVE GRIP SPAN LOCKS
CHECKED BY: BH				SHEET NO. 10

1/17/2012 C:_PROJECTS\02718.00 - FDOT Spanlock Study\2000_Study\Schematics\FDOT_Spanlock_Study_Concepts.idw