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Abstract: A wedge barrier system includes a frame to be disposed within a foundation, for example a shallow foundation, a wedge barrier comprising fingers having an asset end pivotally connected to the frame at an asset side and a blocking member extending perpendicular to the fingers and connected at threat ends of each of the fingers and a drive mechanism located below the top side of the frame and connected to one of the fingers to move the wedge barrier between a non-deployed position with the wedge barrier disposed inside the frame and a deployed position with the blocking member located above the top side.
ACTIVE WEDGE BARRER

BACKGROUND

[0001] This section provides background information to facilitate a better understanding of the various aspects of the disclosure. It should be understood that the statements in this section of this document are to be read in this light, and not as admissions of prior art.

[0002] Security barriers are often utilized at motor vehicle entrances into facilities and property. The security barriers provide a means to selectively allow the entry of authorized vehicles. Typically these barriers are temporarily deployed to stop vehicles prior to confirming that the occupants and/or contents are authorized for entry and withdrawn to allow vehicles to pass. These barriers generally designed to withstand a ramming force from a motor vehicle when deployed.

SUMMARY

[0003] A wedge barrier system in accordance to an embodiment includes a frame to be disposed within a foundation, for example a shallow foundation, a wedge barrier comprising fingers having an asset end pivotally connected to the frame at an asset side and a blocking member extending perpendicular to the fingers and connected at threat ends of each of the fingers and a drive mechanism located below the top side of the frame and connected to one of the fingers to move the wedge barrier between a non-deployed position with the wedge barrier disposed inside the frame and a deployed position with the blocking member located above the top side.

[0004] In another example a wedge barrier system includes a frame to be disposed within a foundation, the frame having a top side, a laterally extending beam trough located at along a threat side, and laterally spaced apart finger troughs extending from an asset side to the beam trough; a wedge barrier comprising fingers aligned with the finger troughs, each finger having an asset end pivotally connected to the frame, and a blocking member extending perpendicular to the fingers and connected at threat ends of each of the fingers; and a drive mechanism connected to one of the fingers to move the wedge barrier between a non-deployed position with the wedge barrier disposed in the finger and beam troughs and a deployed position with the blocking member located above the top side, the drive mechanism
located below the top side. In accordance to one or more embodiments the system is a shallow mount system for example with the foundation having a depth of about twelve inches or less. In some embodiments at least one and in some instances only one of the fingers is a lifting finger pivotally connected to the frame by a hinge connection and the drive mechanism connected to the asset end of the lifting finger below the hinge connection.

[0005] This summary is provided to introduce a selection of concepts that are further described below in the detailed description. This summary is not intended to identify key or essential features of the claimed subject matter, nor is it intended to be used as an aid in limiting the scope of claimed subject matter.
The disclosure is best understood from the following detailed description when read with the accompanying figures. It is emphasized that, in accordance with standard practice in the industry, various features are not drawn to scale. In fact, the dimensions of various features may be arbitrarily increased or reduced for clarity of discussion.

Figure 1 illustrates an active wedge barrier system incorporated in a roadway in accordance to one or more aspects of the disclosure.

Figure 2 is a plan view of an active wedge barrier system in accordance to one or more aspects of the disclosure.

Figure 3 illustrates a portion of the active wedge barrier system along the line I-I of Figure 2 in accordance to one or more aspects of the disclosure.

Figure 4 is a side view through a finger trough portion of an active wedge barrier that is in a raised or deployed position in accordance to one or more aspects of the disclosure.

Figure 5 is a side view through a finger trough portion of an active wedge barrier that is in a non-deployed position in accordance to one or more aspects of the disclosure.

Figure 6 illustrates a foundation frame of an active wedge barrier system in accordance to one or more aspects.

Figure 7 illustrates in isolation a rail member utilized to form a finger trough portion of a foundation frame in accordance to one or more aspects of the disclosure.

Figure 8 illustrates a finger wedge barrier and actuating device in isolation in accordance to one or more aspects of the disclosure.
DETAILED DESCRIPTION

[0015] It is to be understood that the following disclosure provides many different embodiments, or examples, for implementing different features of various embodiments. Specific examples of components and arrangements are described below to simplify the disclosure. These are, of course, merely examples and are not intended to be limiting. In addition, the disclosure may repeat reference numerals and/or letters in the various examples. This repetition is for the purpose of simplicity and clarity and does not in itself dictate a relationship between the various embodiments and/or configurations discussed.

[0016] As used herein, the terms connect, connection, connected, in connection with, and connecting may be used to mean in direct connection with or in connection with via one or more elements. Similarly, the terms couple, coupling, coupled, coupled together, and coupled with may be used to mean directly coupled together or coupled together via one or more elements. Terms such as up, down, top and bottom and other like terms indicating relative positions to a given point or element are may be utilized to more clearly describe some elements. Commonly, these terms relate to a reference point such as the surface of a roadway.

[0017] Referring to Figure 1, anti-ram active wedge vehicle barrier systems, generally denoted by the numeral 5, are illustrated incorporated into a roadway 7 for example at an entry point to a high security area. With additional reference to Figures 2 to 8, the wedge barrier system 5 includes a wedge barrier 10 that is mounted in a foundation 12 and installed in the roadway. For example, the wedge barrier 10 is pivotally connected with a foundation frame 14 that is located in the foundation so as to be pivoted from a non-deployed position as shown in the bottom lane of roadway 7 to a deployed position as illustrated in the top lane of roadway 7 to prevent the motor vehicle 9 approaching from an attack side from crossing the barrier to the asset side. In the deployed position a blocking member 16, e.g., beam, of the wedge barrier 10 is raised a distance above the surface (i.e., grade) of the roadway 7, for example to a blocking height of about 36 inches. In the non-deployed position as illustrated in the bottom lane of roadway 7 the wedge barrier 10 is recessed into the foundation 12 so as to be flush or substantially flush with the surface or grade 20 (Figure 3) of the foundation and roadway. For example, the wedge barrier 10 extends no more than about 0.5 inches above
the roadway surface. In accordance to embodiments the wedge barrier 10 is a shallow mount system, for example the foundation 12 may be limited to about twelve inches or less in vertical depth. In some embodiments, the roadway 7 may be prepared for installation of a wedge barrier system 5 by excavating to a depth of about twelve inches.

[0018] In accordance with at least some embodiments the barrier can be actuated from the non-deployed to the deployed position in less than about 2 seconds in emergency operations. Additionally the actuating or drive mechanism is intended to provide for routine raising and lowering of the wedge barrier 10, for example in some embodiments the barrier and driving mechanism are capable of at least 120 complete cycles per hour. In accordance to one or more embodiments the wedge barrier system 5 meets ASTM F2656-07 Condition/Penetration Rating M50/P1, which allows penetration of less than or equal to 3.3 feet when impacted by a medium-duty truck (e.g., 6,800 kg) at 50 miles per hour.

[0019] Figure 2 is a plan view of active wedge vehicle barrier system 5 in accordance to an embodiment and Figure 3 is a view along the line I-I of Figure 2 with the wedge barrier 10 removed to illustrate the foundation frame 14 and foundation 12. Foundation 12 is constructed of a concrete, and in some embodiments the concrete may not utilized reinforcement bars. In some embodiments the foundation frame 14 may include rods extending outward from the frame and into the concrete foundation 12. The foundation frame 14 may be located in a hole excavated in the roadway 7. Concrete foundation 12 can be poured such that the top surface or side 18 of the foundation frame 14 is substantially level with the surface 20 of foundation 12 as described for example with reference to Figure 1. In one or more embodiments, the concrete foundation 12 may be formed with the foundation frame 14 at a location remote from the install site. In accordance to some embodiments the active wedge barrier eliminates the need for reinforcement bars and for hot work at the installation site. In practice the active wedge barrier systems 5 are designed to have an installation time of less than one day.

[0020] In accordance to an embodiment the foundation 12 is constructed of a concrete having a strength for example of about 3,500 PSI or greater. The depth 22 of the foundation may be for example about 12 inches. A lower portion of the foundation frame 14 may extend below the concrete foundation 12 into a substrate for example to provide for water drainage. The length 24 from the threat or attack side 11 of the foundation 12 to the asset side 13 of the
foundation 12 may be for example about twelve feet. The width 26 of the foundation 12 varies with the lateral length of the blocking member 16, i.e., the width of the wedge barrier 10. Standard width barriers are no less than about 8 feet and no more than about 14 feet 6 inches, although other width barriers may be utilized. In the depicted Figure 2 the width 26 of the foundation 12 is for example about 12 feet for a blocking member 16 width 28 (Figure 8) of 8 feet. In accordance to at least one embodiment, the width 26 of the foundation 12 is about 18 feet 6 inches for a width 28 of the wedge barrier 10 of about 14 feet 6 inches.

[0021] As depicted in Figures 2 and 8, the wedge barrier 10 comprises a blocking member 16 which has a length 28 that forms the width of the wedge barrier. The blocking member is supported by and pivotally connected to the foundation frame 14 by support members 30, also referred to from time to time as fingers members. In accordance to some embodiments the hinge system includes a greaseless bushing system. In the depicted embodiments, four support members 30 are utilized with a blocking member length of 8 feet and 14 feet 6 inches. In at least one embodiment, the blocking member 16 is constructed for example of a 6-inch by 6-inch steel member and the support members 30 are I-beam structures.

[0022] The support members 30 are spaced apart and extend perpendicular to the blocking member 16. Each support member 30 has a threat or attack end 29 connected (e.g. welded) to the blocking member 16 and an asset end 31 that is pivotally connected to the foundation frame 14, for example by a pin 32. The pins 32 may be part of a hinge system such as bearings 34, for example pillow block bearings as illustrated in Figures 4 and 5. For example, two bearings 34 for each finger member 30 may be utilized.

[0023] At least one of the support members 30 is operationally connected to drive mechanism 36, which is illustrated for example in Figures 2, 6 and 8. Drive mechanism 36 is a linear mechanism such as, and without limitation, a screw actuator and motor or a hydraulic ram. One example of a motor is an IP68 electromechanical stainless steel motor. In accordance to embodiments there is no spring other assistance, e.g., compressed air, needed for operation. Drive mechanism 36 is located on the asset side of the wedge barrier 10 and below the surface 20 of the foundation 12. As depicted in Figure 8 the linear drive mechanism 36 is shown having a linear shaft 37 which is attached at a connection plate 38 located on the bottom side 40 of the support member 30 identified specifically as the lifting support member 42 (e.g., lifting finger). In the depicted embodiment, a single drive
mechanism 36 is used to actuate the wedge barrier 10 between the deployed and non-deployed positions. Drive mechanism 36 is located in a compartment 44 (Figures 1, 2, 6) of the foundation frame on the asset side of the wedge barrier, i.e. on the opposite side of support members 30 from blocking member 16. In Figure 6 the drive mechanism 36 is located behind the asset-side wall 46 with a shaft of the mechanism extending through the asset-side wall 46 to connect to the wedge barrier as illustrated in Figure 8. The drive mechanism 36 is positioned below the top side 18 of the foundation frame 14 and connected to the lifting support member below the top surface of the foundation frame and below the surface of the foundation. This compartment 44 may be covered with a lid, e.g., a steel plate, for example as illustrated in Figure 1 so as to be accessible from the surface for repair and maintenance. The location of the drive mechanism 36 provides protection to the mechanism for example from explosives when the wedge barrier is in the deployed position. The location and use of a linear drive also facilitates repair and replacement of the mechanism with the wedge barrier 10 in the non-deployed position. Compartment 44 also serves as a position to locate control elements, such as electronics, processors, and the like.

[0024] Referring to Figure 6 an example of a foundation frame 14 is described in conjunction with the other figures. The depicted foundation frame 14 includes a laterally extending rear, asset-side wall 46 and a front, threat or attack-side wall 48 that extend for example parallel to one another. In Figure 6 the asset and threat walls 46, 48 comprise for example structural steel channel. A lateral beam trough 50 is formed long the inside of the attack-side wall 48 to dispose the blocking member 16 when the wedge barrier is in the non-deployed position, see e.g., Figure 5. Rails 52 are connected, e.g., welded, at an asset end 53 to the inside of the asset-side wall 46 and extend toward the attack-side wall 48. The outer most rails 52 extend to the attack-side wall 48 and as illustrated in Figures 2 and 6 beyond the attack-side wall 48. The attack-side wall 48 may be connected to the outer most rails 52.

[0025] Rails 52 are arranged in cooperative pairs, each pair of rails forming a finger trough 54 sized to dispose one of the finger support members 30. With reference in particular to Figure 3, each pair of rails 54 also forms an anchor track or channel 56 immediately below the finger trough 54. The anchor track or channel 56 may have a wider lateral opening than the finger trough 54 for trapping a sliding anchor as further described below with reference to Figures 4 and 5. As illustrated in Figure 3, the cooperative pairs of rails 52 may be connected
at a bottom side 19 of the foundation frame by a floor 58. An orifice 60 is shown formed through the asset ends 53 of the rails for passing the pin 32 (Figure 2) to pivotally connect the support members 30. Figures 2 and 6 also illustrates surface accessible compartments 45 formed by the foundation frame and extending between the asset ends 53 of the rails 52 of adjacent finger troughs 54 to provide surface access to the hinged connection of the finger supports to the foundation frame.

[0026] Figure 7 illustrates an example of a rail 52 formed by opposite facing c-channel structural members (52a, 52b) stacked on top of one another and interconnected, e.g., by welding, with the open sides of the respective channel members facing away from each other so that the finger trough 54 and the anchor channel 56 will have different widths. The orifice 60 for disposing the hinge pin for connection of the wedge barrier is formed through the top structural member 52a at the asset end 53. In some embodiments a reinforcement plate 62 is attached to the rail 52 with the port 60 formed through the plate and the rail. The reinforcement plate 62 can provide additional strength to withstand the force of a motor vehicle impacting the deployed wedge barrier. In Figure 8 reinforcement plates 62 are also shown attached at the asset ends 31 of the support members 30 to provide additional strength around the hole through which the hinge pin is disposed.

[0027] Referring now in particular to Figures 4 and 5, in conjunction with the other figures, an impact absorbing linkage 64 is shown connecting the wedge barrier 10 to the foundation frame 14. For example, absorbing linkage 64 includes one or more cables 66 (e.g., wire rope) connected at a first end 65 to the attack end 29 of the finger support member 30 and connected at a second end to a sliding anchor 68 which is disposed in the anchor channel 56. Sliding anchor 68 may be a block or other device trapped in and axially moveable along the channel 56. A sleeve 70, e.g., conduit, may be disposed about the one or more cables 66 between the first and second ends 65, 67 to provide some rigidity to the cables for example to assist in moving the sliding anchor 68 when actuating the wedge barrier 10 between the deployed and non-deployed positions.

[0028] The following test data is illustrative of an active wedge barrier system 5 in accordance to embodiments of this disclosure. A wedge barrier 10 having a lateral width of 8 feet was impacted by an International, medium duty truck, having a gross vehicle weight of 6,837 kg according to ASTM F2656-07 M50 standards. The wedge barrier was installed in a
foundation with an excavation depth of 12 inches, a distance 24 (Figure 2) from front to back of 12 feet and distance 26 from side to side of 12 feet with concrete having a minimum strength of 3,500 PSI. The tested wedge barrier system satisfied the ASTM F2656-07 Condition/Penetration Rating M50/P1 which allows less than 33 feet. The wedge barrier 10 stopped the motor vehicle traveling at a speed of 49.7 miles per hour, the barrier remaining intact and the opening remaining blocked by the wedge barrier. After the impact the truck's engine was not running, the vehicle was not drivable and a follow on vehicle could not pass the wedge barrier.

[0029] The foregoing outlines features of several embodiments so that those skilled in the art may better understand the aspects of the disclosure. Those skilled in the art should appreciate that they may readily use the disclosure as a basis for designing or modifying other processes and structures for carrying out the same purposes and/or achieving the same advantages of the embodiments introduced herein. Those skilled in the art should also realize that such equivalent constructions do not depart from the spirit and scope of the disclosure, and that they may make various changes, substitutions and alterations herein without departing from the spirit and scope of the disclosure. The scope of the invention should be determined only by the language of the claims that follow. The term "comprising" within the claims is intended to mean "including at least" such that the recited listing of elements in a claim are an open group. The terms "a," "an" and other singular terms are intended to include the plural forms thereof unless specifically excluded.
WHAT IS CLAIMED IS:

1. A system, comprising:
   a frame to be disposed within a foundation, the frame having a top side, a laterally extending beam trough located at along a threat side, and laterally spaced apart finger troughs extending from an asset side to the beam trough;
   a wedge barrier comprising fingers aligned with the finger troughs, each finger having an asset end pivotally connected to the frame, and a blocking member extending perpendicular to the fingers and connected at threat ends of each of the fingers; and
   a drive mechanism connected to one of the fingers to move the wedge barrier between a non-deployed position with the wedge barrier disposed in the finger and beam troughs and a deployed position with the blocking member located above the top side, the drive mechanism located below the top side.

2. The system of claim 1, wherein the drive mechanism is a linear drive connected to the asset end of the one finger.

3. The system of claim 1, wherein the one of the fingers is a lifting finger pivotally connected to the frame by a hinge connection and the drive mechanism is connected to the asset end of the lifting finger below the hinge connection.

4. The system of claim 1, comprising a linkage having a first end connected to the wedge barrier proximate to the blocking member and a second end connected to the frame.

5. The system of claim 1, wherein each of the fingers comprises a linkage connected at a first end to the finger and connected at a second end to the frame.

6. The system of claim 1, comprising a linkage having a first end connected to the wedge barrier proximate to the blocking member and a second end moveably connected to the frame to move axially in the direction between the asset side and the
threat side as the wedge barrier is moved between the deployed and the non-deployed positions.

7. The system of claim 6, wherein the linkage comprises a cable and a sleeve disposed about the cable to provide rigidity to the cable.

8. The system of claim 1, wherein each finger comprises a linkage connected at a first end to the finger and connected to the frame at a second end by an anchor that is moveably disposed in a track that is located below the respective finger trough.

9. The system of claim 1, comprising a linkage having a first end connected to the wedge barrier proximate to the blocking member and a second end moveably connected to the frame to move axially in the direction between the asset side and the threat side as the wedge barrier is moved between the deployed and the non-deployed positions; and the drive mechanism is a linear drive connected to the asset end of the one finger.

10. The system of claim 1, wherein the drive mechanism is a linear drive connected to the asset end of the one finger; and each finger comprises a linkage connected at a first end to the finger and connected to the frame at a second end by an anchor that is moveably disposed in a track that is located below the respective finger trough.

11. The system of claim 1, comprising a linkage having a first end connected to the wedge barrier proximate to the blocking member and a second end moveably connected to the frame to move axially in the direction between the asset side and the threat side as the wedge barrier is moved between the deployed and the non-deployed positions; and wherein the one of the fingers is a lifting finger pivotally connected to the frame by a hinge connection and the drive mechanism is connected to the asset end of the lifting finger below the hinge connection.
12. The system of claim 1, wherein each finger comprises a linkage connected at a first end to the finger and connected to the frame at a second end by an anchor that is moveably disposed in a track that is located below the respective finger trough; and wherein the one of the fingers is a lifting finger pivotally connected to the frame by a hinge connection and the drive mechanism is connected to the asset end of the lifting finger below the hinge connection.

13. An active wedge vehicle barrier system installed in a motor vehicle roadway, the system comprising:
   a frame disposed within a foundation and located in a roadway, the frame having a top side substantially level with a surface of the foundation, a laterally extending beam trough located at along a threat side, and laterally spaced apart finger troughs extending from an asset side to the beam trough;
   a wedge barrier comprising fingers aligned with the finger troughs, each finger having an asset end pivotally connected to the frame, and a blocking member extending perpendicular to the fingers and connected at threat ends of each of the fingers; and
   a drive mechanism connected to one of the fingers to move the wedge barrier between a non-deployed position with the wedge barrier disposed in the finger and beam troughs and a deployed position with the blocking member located above the top side, the drive mechanism located below the top side.

14. The system of claim 13, wherein the foundation is about 12 inches or less in depth.

15. The system of claim 13, wherein the one of the fingers is a lifting finger pivotally connected to the frame by a hinge connection and the drive mechanism is connected to the asset end of the lifting finger below the hinge connection.

16. The system of claim 13, comprising a linkage having a first end connected to the wedge barrier proximate to the blocking member and a second end moveably connected to the frame to move axially in the direction between the asset side and the threat side as the wedge barrier is moved between the deployed and the non-deployed positions.
17. The system of claim 16, wherein the second end of the linkage is connected to an anchor that is moveably disposed in a track that is located below one of the finger troughs.

18. The system of claim 13, comprising a linkage having a first end connected to the wedge barrier proximate to the blocking member and a second end moveably connected to the frame to move axially in the direction between the asset side and the threat side as the wedge barrier is moved between the deployed and the non-deployed positions; and wherein the one of the fingers is a lifting finger pivotally connected to the frame by a hinge connection and the drive mechanism is connected to the asset end of the lifting finger below the hinge connection.

19. A method, comprising:
operating an active wedge vehicle barrier system installed in a motor vehicle roadway, the system comprising:
a frame disposed within a foundation and located in a roadway, the frame having a top side substantially level with a surface of the foundation, a laterally extending beam trough located at along a threat side, and laterally spaced apart finger troughs extending from an asset side to the beam trough;
a wedge barrier comprising fingers aligned with the finger troughs, each finger having an asset end pivotally connected to the frame, and a blocking member extending perpendicular to the fingers and connected at threat ends of each of the fingers; and
a drive mechanism located below the top side and connected to one of the fingers to move the wedge barrier between a non-deployed position with the wedge barrier disposed in the finger and beam troughs and a deployed position with the blocking member located above the top side, the drive mechanism located below the top side; moving the wedge barrier to a deployed position.
20. The method of claim 19, wherein the system comprises a linkage having a first end connected to the wedge barrier proximate to the blocking member and a second end moveably connected to the frame to move axially in the direction between the asset side and the threat side as the wedge barrier is moved between the deployed and the non-deployed positions; and wherein the one of the fingers is a lifting finger pivotally connected to the frame by a hinge connection and the drive mechanism is connected to the asset end of the lifting finger below the hinge connection.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - E01 F 13/08 (2015.01)
CPC - E01 F 13/08 (2015.12)

According to International Patent Classification (IPC) or to both national classification and IPC.

B. **FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC(8) - E01F 13/00, 13/02, 13/04, 13/06, 13/08, 13/10, 13/12 (2015.01)
CPC - E01F 13/00, 13/02, 13/02B, 13/04, 13/04A, 13/04E, 13/06, 13/08, 13/085, 13/10, 13/105, 13/12, 13/123, 13/126 (2015.12)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

USPC - 49/33, 49, 131, 132, 133, 134; 404/6, 9, 11 (Keyword delimited)

Electronic database consulted during the international search (name of database and, where practicable, search terms used)

PatBase, Google Patents, Google, Google Scholar, YouTube.

Search terms used: neusch, innovations, barrier, wedge, beam, trough, roadway, threat, frame.

C. **DOCUMENTS CONSIDERED TO BE RELEVANT**

<table>
<thead>
<tr>
<th>Category*</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>US 7,320,557 B1 (POTTER) 22 January 2008 (22.01.2008) entire document</td>
<td>1, 2, 13, 14, 19</td>
</tr>
</tbody>
</table>

[See patent family annex.]

Further documents are listed in the continuation of Box C.

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Date of the actual completion of the international search

17 December 2015

Date of mailing of the international search report

21 JAN 2016

Name and mailing address of the ISA/

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