

## BASE MEMBER FOR A BOLLARD

The present disclosure relates to a base member for a bollard. In particular, but without limitation, the disclosure relates to a base member for a shallow-mount bollard barrier.

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The provision of vehicle impact barriers for use in vehicle highways or pedestrian highways, or both, often poses a significant engineering challenge.

10 A vehicle impact barrier must be of sufficient strength and engineering integrity to be able to withstand very high impact forces. Commonly, a plurality of bollards are collectively arrayed to provide the vehicle impact barrier. To enable each individual bollard of the barrier to be firmly, fixedly and permanently set into the ground, at least a portion of each bollard is buried in an excavated trench under the surface of the ground. The deeper the bollard forming the impact barrier is buried, the less likely it is  
15 to be pulled out of the ground when impacted by a vehicle. Therefore, when there are no constraints upon the depth of excavation for accommodating such an impact barrier, the engineering form and structure of the barrier may be relatively simple. However, when severe constraints are imposed on permissible excavation depths, the form and structure of the vehicle impact barrier must be very carefully considered to meet the  
20 stringent requirements imposed by the excavation depth limitations while simultaneously meeting the requirements associated with the necessary strength of the barrier.

## Summary

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In accordance with a first aspect, there is provided a base member for a bollard. The base member may be adapted for ground engagement by placement upon, or embedment within, a ground or floor surface. The base member may comprise a first rigid element and a second rigid element. Each rigid element may be integrally formed.  
30 Each rigid element may comprise a base plate and a wall extending substantially perpendicularly away from the base plate. The first rigid element may be fixed to the second rigid element. The base member may further comprise a lid. The lid may be fixed to the first rigid element and/or the second rigid element, such that the rigid elements and the lid collectively form a box section comprising a plurality of chambers  
35 defined between the lid, the first rigid element and the second rigid element.

The box section formed by the rigid elements and the lid has a high strength, which can withstand the forces imparted to the base member when a vehicle impacts a bollard attached to the base member. The base member is nevertheless simple and inexpensive to manufacture. Furthermore, its hollow structure allows the base member to be relatively light, which facilitates transport and installation of the base member.

The base member may be embedded in the ground by digging a trench and subsequently burying the base member therein. The base member may be adapted to form a part of a shallow-mount barrier. The shallow-mount barrier may comprise a plurality of base members, each base member having a bollard upstanding therefrom. In a shallow-mount barrier, the height of the base member is less than the height of the bollard. Shallow-mount barriers may require just a fraction of the excavation depth needed when installing a traditional bollard barrier. The shallow-mount barrier may require an excavation depth of less than 500mm for its installation. In some embodiments, the shallow-mount barriers may require an excavation depth ranging from 300mm to 40mm.

The installation of traditional bollard barriers is often problematic, as it requires the excavation of deep foundations. This can cause inconvenience due to the associated need to avoid underground services during excavation, or to relocate the underground services to allow excavation. Advantageously, a shallow-mount barrier does not require deep foundations to be excavated. Instead, a smaller excavation depth is required for burying the base members in the ground or floor surface. This makes the shallow-mount barrier disclosed herein suitable for securing sites where excavation depth is severely restricted, for example in urban areas.

Alternatively, the base member may be placed on the surface of the ground.

The base member may be formed from metal. For example, the base member may be formed from steel.

The first rigid element may be fixed to the second rigid element by welding. Alternatively or additionally, the first rigid element may be fixed to the second rigid

element by one or more fasteners. For example, the first rigid element may be fixed to the second rigid element using screws and/or bolts and nuts.

Each rigid element and/or the lid may be formed by folding sheet metal. For example, the first rigid element may be formed from a single bent piece of metal. Similarly, the second rigid element may be formed from a single bent piece of metal. The use of a folding process to form the rigid elements and/or the lid allows a base member with sufficient strength to withstand a vehicular impact to be manufactured quickly and inexpensively. Alternatively, the rigid elements and/or the lid may be formed by casting. For example, an appropriately shaped mould may be used to quickly manufacture a large number of individual rigid elements.

The first rigid element may comprise a first base plate, a first wall and a second wall. The first wall may be positioned at a first edge of the first base plate and the second wall may be positioned at a second edge of the first base plate. Both the first wall and the second wall may extend substantially perpendicularly away from the first base plate. In this manner, the first rigid element may have a substantially U-shaped profile.

The second rigid element may comprise a second base plate, a third wall and a fourth wall. The third wall may be positioned at a first edge of the second base plate. The fourth wall may be positioned at a second edge of the second base plate. Both the third wall and the fourth wall may extend substantially perpendicularly away from the second base plate. In this manner, the second rigid element may have a substantially U-shaped profile.

Advantageously, a base member constructed from one or more integrally formed rigid U-shaped elements can be manufactured quickly and easily. At the same time, the U-shaped structure of the rigid elements has sufficient strength to withstand the forces experienced by the base member during a vehicular impact. This means that the base members may be used to make a vehicle barrier that is capable of withstanding impacts from a heavy and/or fast-moving vehicle.

The second wall of the first rigid element may abut, and be fixed to, the third wall of the second rigid element.

The second rigid element may comprise a second base plate and a third wall, but no fourth wall. The third wall may be positioned at a first edge of the second base plate. The third wall may extend substantially perpendicularly away from the second base plate. In this manner, the second rigid element has a substantially L-shaped profile. A  
5 second edge of the second base plate may be fixed to the first rigid element. More specifically, the second edge of the second base plate may be fixed to the first base plate of the first rigid element and/or either one of the walls of the first rigid element.

Advantageously, a base member constructed from one or more integrally formed rigid  
10 L-shaped elements can be manufactured quickly and easily. At the same time, the L-shaped structure of the rigid elements has sufficient strength to withstand the forces experienced by the base member during a vehicular impact. This means that the base members may be used to make a vehicle barrier that is capable of withstanding  
15 impacts from a heavy and/or fast-moving vehicle.

The base member may comprise more than two rigid elements. The rigid elements may solely be U-shaped, or may be a combination of U-shaped and L-shaped elements. The rigid elements may be placed side-by-side along a common plane. Each rigid element may be fixed to one or more adjacent rigid elements.

20 The lid may comprise a top plate, a first shoulder and a second shoulder. The first shoulder may be positioned at a first edge of the top plate and may extend substantially perpendicularly away from the top plate. The second shoulder may be positioned at a second edge of the top plate and may extend substantially  
25 perpendicularly away from the top plate. The top plate, first shoulder and second shoulder may be integrally formed.

The first shoulder and the second shoulder may extend perpendicularly to the walls of each of the rigid elements, such that the walls and the base plates of the rigid elements  
30 and the top plate and the shoulders of the lid collectively form a substantially closed box. By forming a substantially closed box, the strength of the base member is further improved. This in turn improves the ability of the base member to withstand the forces imparted to it when a vehicle impacts a bollard attached to the base member.

The lid and/or one or more of the rigid elements may comprise an opening for receiving a leg. At least a portion of the leg may be configured to extend into one or more of the plurality of chambers within the box section. The leg can help to transfer some of the force of a vehicle impact away from a barrier and into the ground.

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The lid may comprise one or more openings for receiving a ballast material. The openings may be in communication with the chambers of the box section. Thus, the ballast material can be inserted into the chambers via the openings. The ballast material may at least partially fill one or more chambers of the box section.

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The base member may comprise a socket for receiving a bollard. The socket may be configured to support the bollard, particularly during a vehicular impact.

In an example in which the first and second rigid elements are U-shaped, the second wall of the first rigid element and the third wall of the second rigid element may each comprise a recess. The socket may extend through the recesses and be fixed to both the first rigid element and the second rigid element. For example, the socket may be welded to the recesses of the first and second rigid elements. In this manner, the second and third walls abut the socket, and provide additional support to the socket during a vehicular impact.

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The lid may comprise an aperture, and the socket may extend through the aperture. Alternatively or additionally, one or more of the base plates may comprise a recess and the socket may extend through the recess. The lid and base plate(s) thereby provide additional support to the socket, particularly during a vehicular impact. The socket may be welded to the periphery of the aperture and/or recess, to further improve the support provided to the socket.

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The socket may comprise one or more gusset plates, wherein the gusset plates are fixed to both the lid and a top end of the socket. The gusset plates provide additional support to the socket during a vehicular impact.

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The base member may further comprise one or more coupling portions. The one or more coupling portions may be configured to mate with a corresponding one or more coupling portions on an adjacent member of a barrier comprising the base member.

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The coupling portions may rigidly connect the base member to one or more additional base members. In this manner, a barrier may be assembled from a plurality of base members. The adjacent member of the barrier may be an intermediate member as described in more detail below, or may be another base member.

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The base member may further comprise a bollard fixed thereto.

In accordance with a second aspect, a barrier is provided. The barrier comprises a plurality of base members as described herein. At least some of the base members has a bollard fixed thereto. Each base member may be rigidly coupled to an adjacent base member via an intermediate member.

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The barrier may be provided in a disassembled form. More specifically, a barrier may be supplied as a kit of parts which can be assembled at the location at which the barrier is to be installed. By supplying the barrier as a kit of parts, its component parts can be more easily transported and stored than if the barrier were to be supplied in an assembled form.

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In accordance with a third aspect, a kit of parts for making a barrier is provided, the kit of parts comprising a base member and a bollard for attachment to the base member. The kit of parts optionally further comprises a leg for attachment to the base member.

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The terms "assembly" and "installation" are used interchangeably to refer to the process of constructing a barrier from its component parts at the location at which it is used to stop vehicles. In contrast, the terms "manufacture" and "manufacturing" refer to the process(es) of fabricating the component parts of the barrier, which are typically carried out in a factory rather than the location at which the barrier will eventually be used.

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### 30 **Brief Description of the Drawings**

Embodiments will now be described, purely by way of example, with reference to the accompanying drawings, in which like features are denoted by like reference signs, and in which:

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Figure 1 is an exploded isometric view of a barrier;

Figure 2 is an exploded isometric view of a single base member of the barrier of Figure 1;

Figure 3 is a partially-exploded isometric view of the base member of Figure 3;

5 Figure 4 is an isometric view of the base member of Figures 2 and 3 in an assembled form;

Figure 5 is a cross-sectional view of the base member of Figures 2 and 3 in an assembled form;

10 Figure 6 is an exploded isometric view of an intermediate member of the barrier of Figure 1;

Figure 7a is an isometric view of the barrier of Figure 1 in an assembled form;

Figure 7b is a plan view of the barrier of Figure 1 in an assembled form;

Figure 8a is a perspective view of the foundation of the base member of Figures 2 to 4;

15 Figures 8b and 8b are schematic cross-sectional views of the foundation of Figure 8a;

Figures 9a and 9b are schematic cross-sectional views of a second example of a foundation of a base member; and

20 Figures 10a and 10b are schematic cross-sectional views of a third example of a foundation of a base member.

### Detailed Description

25 In the drawings, like features are assigned like reference symbols. It will be understood that the use of terms such as vertical, horizontal, left, right etc. are for descriptive purposes only to aid comprehension, and thus do not preclude alternative orientations or configurations of the disclosed invention.

30 Figure 1 is an exploded isometric view of a barrier 100. The barrier 100 comprises two base members 102, 102' and an intermediate member 104. The base members 102, 102' are identical, so only base member 102 will be described in detail. A bollard 112 is fixed to each base member 102, 102'. Each base member 102, 102' supports a respective bollard 112, keeping the bollard in an upstanding position in normal use and resisting movement of the bollard during a vehicular impact.

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The base member 102 comprises a socket 116 for receiving the bollard 112 therein. The base member 102 comprises a first coupling portion 105 positioned at a first edge of the base member 102. The base member 102 further comprises a second coupling portion 113 positioned at a second edge of the base member 102. The first edge of the base member 102 is located opposite to the second edge of the base member 102.

The intermediate member 104 comprises a pair of third coupling portions 111, 109 positioned at a first edge and a second edge of the intermediate member 104 respectively. The third coupling portions 109, 111 are complementary to both the first coupling portion 105 and the second coupling portion 113. For example, the third coupling portion 111 at the first edge of the intermediate member 104 is complementary to the first coupling portion 105 at the first edge of the base member 102, and the third coupling portion 109 at the second edge of the intermediate member 104 is complementary to the second coupling portion 113 at the second edge of the base member 102'. The third coupling portion 111 at the first edge of the intermediate member 104 may be identical to the third coupling portion 109 at the second edge of the intermediate member 104.

The intermediate member 104 is configured to rigidly connect the two base members 102, 102'. When the barrier 100 is assembled, the base members 102, 102' and the intermediate member 104 extend in a common plane. The common plane may coincide with a surface (e.g., the base of an excavation) in which the barrier 100 is to be installed. The third coupling portions 111, 109 of the intermediate member 104 are configured to engage with a respective coupling portion 105, 113 of a respective base member 102, 102' when the base members 102, 102' are translated along the common plane relative to the intermediate member 104, as will be further described with reference to Figures 7a and 7b.

The base members 102, 102' and the intermediate member 104 are adapted for ground engagement by embedment within a ground or floor surface. More specifically, when the barrier 100 is assembled on-site, each base member 102, 102' and the intermediate member 104 are buried within a ground or floor surface.

The barrier 100 is a shallow-mount bollard barrier. A "shallow-mount" bollard barrier is the term generally given to ground-engaging bollards, often for use in impact-resistant

barriers, possessing a significant laterally extending base member (e.g. the base members 102, 102'), fixed at a base of the respective upstanding bollards (e.g. bollard 112), for engaging and extending across the ground at the base of an excavation which is subsequently filled in to bury the base member (e.g. with earth, concrete or tarmac).

5 The base member provides support to the upstanding bollard, and resistance to the forces that may be applied to the bollard by a vehicular impact, and requires a much shallower excavation to accommodate it than is required for other types of impact-resistant bollard barriers.

10 The base member 102 will now be described with reference to Figures 2, 3, 4 and 5. Figures 2, 3, 4 and 5 illustrate the base member 102 at successive stages of its manufacturing and assembly processes. As mentioned previously, the term "manufacturing" refers to the process of fabricating the component parts of a barrier, whereas the term "assembly" refers to the process of constructing a barrier from its  
15 component parts at the location at which it is used to stop vehicles. Figure 2 is an exploded view of the base member 102, and illustrates the base member 102 at a relatively early stage of the manufacturing process. Figure 3 is a partially-exploded view of the base member 102, and illustrates the base member 102 at the end of the manufacturing process. Figures 4 and 5 illustrate the base member 102 at the end of  
20 the assembly process.

The base member 102 comprises a lid 210, a foundation 211 and the socket 116. The foundation 211 comprises a plurality of rigid elements. In the example shown in Figures 2 to 5, the plurality of rigid elements comprises four U-shaped rigid elements 300, 302,  
25 304, 306.

A first U-shaped element 300 comprises a first wall 268, a first base plate 290 and a second wall 262a (best seen in Figure 2). The first wall 268 and the second wall 262a are connected to the first base plate 290. Both the first wall 268 and the second wall  
30 262a are substantially perpendicular to the first base plate 290. In some embodiments, the first wall 268, the second wall 262a and the first base plate 290 are integrally formed. For example, the first wall 268, the second wall 262a and the first base plate 290 may be formed from a single bent metal sheet.

A second U-shaped element 302 comprises a third wall 262b, a second base plate 292 and a fourth wall 260a (best seen in Figure 2). The third wall 262b and the fourth wall 260a are connected to the second base plate 292. Both the third wall 262b and the fourth wall 260a are substantially perpendicular to the second base plate 292. In some embodiments, the third wall 262b, the fourth wall 260a and the second base plate 292 are integrally formed. For example, the third wall 262b, the fourth wall 260a and the second base plate 292 may be formed from a single bent metal sheet.

A third U-shaped element 304 comprises a fifth wall 260b, a third base plate 294 and a sixth wall 258a (best seen in Figure 2). The fifth wall 260b and the sixth wall 258a are connected to the third base plate 294. Both the fifth wall 260b and the sixth wall 258a are substantially perpendicular to the third base plate 294. In some embodiments, the fifth wall 260b, the sixth wall 258a and the third base plate 294 are integrally formed. For example, the fifth wall 260b, the sixth wall 258a and the third base plate 294 may be formed from a single bent metal sheet.

A fourth U-shaped element 306 comprises a seventh wall 258b, a fourth base plate 296 and an eighth wall 240. The seventh wall 258b and the eighth wall 240 are connected to the fourth base plate 296. Both the seventh wall 258b and the eighth wall 240 are substantially perpendicular to the fourth base plate 296. In some embodiments, the seventh wall 258b, the eighth wall 240 and the fourth base plate 296 are integrally formed. For example, the seventh wall 258b, the eighth wall 240 and the fourth base plate 296 may be formed from a single bent metal sheet.

The second wall 262a of the first U-shaped element 300 is connected to the third wall 262b of the second U-shaped element 302. The fourth wall 260a of the second U-shaped element 302 is connected to the fifth wall 260b of the third U-shaped element 304. The sixth wall 258a of the third U-shaped element 304 is connected to the seventh wall 258b of the fourth U-shaped element 306. In this manner, the four U-shaped elements collectively form a single unit.

In the example shown in Figures 2 to 5, the foundation 211 comprises four U-shaped elements. However, in other embodiments the foundation 211 may comprise two, three, five, or more U-shaped elements. Additionally or alternatively, some of the U-shaped elements may be replaced by L-shaped elements. For example, the second

and third U-shaped elements may be replaced by corresponding L-shaped elements (e.g. the L-shaped elements that do not have the fourth wall 260a and the seventh 258a of the respective U-shaped elements). Examples of foundations with different numbers of U-shaped elements, or a mixture of U-shaped and L-shaped elements are described below with reference to Figures 9a, 9b, 10a and 10b.

The first base plate 290, the second base plate 292, the third base plate 294 and the fourth base plate 296 collectively form a bottom plate. When assembled, the bottom plate is parallel to the top plate 216 of the lid 210. The first wall 268, the second wall 262a, the third wall 262b, the fourth wall 260a, the fifth wall 260b, the sixth wall 258a, the seventh wall 258b and the eighth wall 240 are connected to, and effectively sandwiched between, the first bottom plate and the top plate 216.

By making the foundation 211 from a plurality of integrally formed rigid elements (such as the U-shaped elements 300, 302, 304, 306), the base member 102 can be manufactured quickly and inexpensively, while also having a robust structural integrity.

The second U-shaped element 302 comprises a first recess 221a, and the third U-shaped element 306 comprises a second recess 221a. Recess 221a is formed in the second base plate 292 and the fourth wall 260a of the second U-shaped element 302, and recess 221b is formed in the fifth wall 260b and the third base plate 294 of the third U-shaped element 304. The recesses 221a, 221b collectively define a hole that is configured to receive the socket 116. In the example shown, the hole formed by the recesses 221a, 221b has a circular. The socket 116 is fixed to fourth wall 260a, the fifth wall 260b, the second base plate 292 and the third base plate 294 (e.g., by welding the socket 116 to the first and second recesses 221a, 221b).

The lid 210 is configured to slot over the foundation 211. The lid 210 is substantially U-shaped. The lid 210 comprises a first shoulder 212, a top plate 216 and a second shoulder 218. The first shoulder 212 and the second shoulder 218 are connected to the top plate 216. Both the first shoulder 212 and the second shoulder 218 are substantially perpendicular to the top plate 216. In some embodiments, the first shoulder 212, the top plate 216 and the second shoulder 218 are integrally formed. For example, the first shoulder 212, the top plate 216 and the second shoulder 218 may be formed from a single bent metal sheet. By forming the lid 210 from a single U-shaped

piece of metal, the lid 210 may be manufactured quickly and inexpensively, while maintaining adequate strength to withstand the force of a vehicular impact.

5 The second shoulder 218 defines a third edge of the base member 102 and the first shoulder 212 defines a fourth edge of the base member 102. When the base member 102 is manufactured, the third edge of the base member 102 is adjacent to both the first and second edges of first base member 102. The fourth edge of the base member 102 is adjacent to both the first and second edges of the base member 102, and opposite to the third edge.

10 The top plate 216 comprises an aperture 220. The aperture 220 is configured to receive the socket 116. In the example shown, the aperture 220 is circular. When assembled, the first bollard 112 is inserted through the aperture 220 and into the first socket 116. After being inserted into the first socket 116, the first bollard 112 cannot  
15 easily be displaced by a vehicular impact.

The U-shaped elements 300, 302, 304, 306 and the lid 210 collectively form a box section, which can be seen best in Figure 5. In other words, the U-shaped elements 300, 302, 304, 306 and the lid 210 collectively have a substantially hollow square or  
20 rectangular cross section. Furthermore, the box section comprises a plurality of chambers 370, 372, 374, 376. A first chamber 370 is defined by the first U-shaped element 300 and the lid 210. A second chamber 372 is defined by the second U-shaped element 302 and the lid 210. A third chamber 374 is defined by the third U-shaped element 304 and the lid 210. A fourth chamber 376 is defined by the fourth U-shaped element 306 and the lid 210. Each chamber 370, 372, 374, 376 also has a box  
25 section. The box section formed by the U-shaped elements 300, 302, 304, 306 and the lid 210 has a high structural integrity, which can withstand the forces imparted to the base member 102 when a vehicle impacts the bollard 112. The base member 102 is nevertheless simple and inexpensive to manufacture, whilst also being relatively light  
30 (which facilitates transport and installation).

The socket 116 optionally comprises one or more gusset plates 299. The gusset plates 299 are connected to an outer surface of the socket 116. More specifically, the gusset plates 299 are connected to an upper portion of the outer surface of the socket 116.  
35 The gusset plates 299 are configured to brace the upper portion of the socket 116

against the top plate 216. In some embodiments, the gusset plates 299 are present along the whole outer perimeter of the socket 116. Alternatively, the gusset plates 299 are only present on the side of the socket 116 furthest away from the anticipated direction of a vehicular impact, so as to strengthen the socket 116 and in turn provide additional support to first bollard 112.

The top plate 216 optionally further comprises a plurality of openings 214 for receiving a ballast material. Only three openings 214 are labelled in Figure 2, but the example shown in the figures comprises twelve openings. The ballast material may comprise concrete, cement, sand, asphalt, tarmac and/or gravel. The ballast material may be inserted through the plurality of openings 214 in the top plate 216. In this manner, the ballast material may fill in the volume defined between the lid 210 and the foundation 211 of the base member 102. The ballast material may allow for a better engagement between a third coupling portion 111, 109 of the intermediate member 104 and a respective one of the first and second coupling portions 105, 113 of the base member 102.

The first coupling portion 105 comprises a first slot 244, a second slot 246, a third slot 242, a fourth slot 248, a fifth slot 250, a sixth slot 254, a seventh slot 252 and an eighth slot 256. The first slot 244, the third slot 242, the fifth slot 250 and the seventh slot 252 are located within (in other words, pass through) the eighth wall 240. The second slot 246, the fourth slot 248, the sixth slot 254 and the eighth slot 256 are located within the sixth wall 258a and the seventh wall 258b. The second slot 246 is aligned with, and spaced apart from, the first slot 244, such that the first slot 244 and the second slot 246 collectively form a continuous channel. The fourth slot 248 is aligned with, and spaced apart from, the third slot 242, such that the fourth slot 248 and the third slot 242 collectively form a continuous channel. The sixth slot 254 is aligned with, and spaced apart from, the fifth slot 250, such that the sixth slot 254 and the fifth slot 250 collectively form a continuous channel. The seventh slot 256 is aligned with, and spaced apart from, the eighth slot 252, such that the seventh slot 256 and the eighth slot 252 collectively form a continuous channel.

The second coupling portion 113 comprises a first slot 276, a second slot 280, a third slot 274, a fourth slot 278, a fifth slot 272, a sixth slot 264, a seventh slot 270 and an eighth slot 266. The first slot 276, the third slot 274, the fifth slot 272 and the seventh

slot 270 are located within the first wall 268. The second slot 280, the fourth slot 278, the sixth slot 264 and the eighth slot 266 are located within the second wall 262a and the third wall 262b. The second slot 280 is aligned with, and spaced apart from, the first slot 276, such that the first slot 276 and the second slot 280 collectively form a continuous channel. The fourth slot 278 is aligned with, and spaced apart from, the third slot 274, such that the fourth slot 278 and the third slot 274 collectively form a continuous channel. The sixth slot 264 is aligned with, and spaced apart from, the fifth slot 272, such that the sixth slot 264 and the fifth slot 272 collectively form a continuous channel. The seventh slot 270 is aligned with, and spaced apart from, the eighth slot 266, such that the seventh slot 270 and the eighth slot 266 collectively form a continuous channel.

All of the slots 244, 246, 242, 248, 250, 254, 252, 256, 276, 280, 274, 278, 272, 264, 270, 266 are contained within a volume defined between the top plate 216 and the bottom plate.

The base member 102 optionally further comprises a leg 222. The leg 222 comprises one or more rails, which may be substantially parallel to each other. In the example shown in Figures 2 to 4, the leg 222 comprises a first rail 232, a second rail 230, a third rail 224 and a fourth rail 226. The first rail 232, the second rail 230, the third rail 224 and the fourth rail 226 are connected together using perpendicularly placed connecting bars 236, 234, 228 and 227. The distal ends of the first rail 232, the second rail 230, the third rail 224 and the fourth rail 226 are configured to slot through a first group of recesses 251 in the second shoulder 218, channels defined by the second U-shaped element 203 and the third U-shaped element 304, and into a second group of recesses 241 in the first shoulder 212.

In the embodiment shown, the leg 222 comprises four rails 232, 230, 224, 226. However, in different embodiments the leg 222 may comprise any number of rails. For example, the leg 222 may comprise one, two, three, five, six, or more rails. Similarly, the leg 222 may comprise any number of connecting bars. For example, the leg 222 may comprise, one, two, four, five, or more connecting bars. The leg 222 is omitted from Figure 5 for the sake of visual clarity.

Advantageously, when vehicle impact forces are imparted to the bollard 112, some of the impact load is transferred from the bollard 112 to the leg 222 through the base member 102. This provides an efficient means of load transfer away from the barrier 100 and into the ground.

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Prior to assembly, the bollard 112 and the leg 222 may not be connected to the base member 102. For example, the bollard 112, the leg 222 and the base member 102 may be transported separately and only assembled on-site. This allows for a more efficient transportation of parts, as the individual elements can be easily stacked. Further, this improves the flexibility of the assembly process. For example, once on-site, an engineer can determine which base member (e.g. 102, 102') should receive the leg 222 in order to avoid any obstacles (e.g. underground services or street furniture) along the trajectory of the barrier 102. In other words, the leg 222 is optional. The leg may be omitted from a particular base member 102, 102' if the leg 222 would interfere with obstacles, or if the leg 222 is deemed to be unnecessary in view of the magnitude of the vehicle impact forces that a barrier is designed to withstand.

Figure 6 shows an exploded isometric view of the intermediate member 104. The intermediate member 104 comprises a second top plate 500 and a second bottom plate 515. The second top plate 500 is parallel to the second bottom plate 515. The intermediate member 104 further comprises two supporting plates 517, 519. The two supporting plates 517, 519 are sandwiched between, and connected to, both of the second top plate 500 and the second bottom plate 515.

The third coupling portion 111 at the first edge of the intermediate member 104 comprises a first arm 518, a second arm 520, a third arm 522 and a fourth arm 510. The first arm 518, the second arm 520, the third arm 522 and the fourth arm 510 are substantially parallel to each other and extend away from the first edge of the intermediate member 104.

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The third coupling portion 109 at the second edge of the intermediate member 104 comprises a fifth arm 516, a sixth arm 514, a seventh arm 512 and an eighth arm 513. The fifth arm 516, the sixth arm 514, the seventh arm 512 and the eighth arm 513 are substantially parallel to each other and extend away from the second edge of the intermediate member 104.

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- As shown in Figure 6, the first arm 518 and the fifth arm 516 are formed by a single continuous bar; the second arm 520 and the sixth arm 514 are formed by a single continuous bar; the third arm 522 and the seventh arm 512 are formed by a single continuous bar; and the fourth arm 510 and the eighth arm 513 are formed by a single continuous bar. All of the arms 518, 520, 510, 522, 516, 514, 512 and 513 are connected to, and sandwiched between, the second bottom plate 515 and the second top plate 500.
- 10 The second top plate 500 comprises a plurality of (in this case, two) openings 502, 504 for receiving a ballast material. The ballast material may comprise concrete, cement, sand, asphalt, tarmac and/or gravel. The ballast material may be inserted through the two openings 502, 504 in the second top plate 500. In this manner, the ballast material may fill in the volume defined between the second top plate 500 and the second bottom plate 515 of the intermediate member 104. The ballast material may allow for a better engagement between third coupling portions 111, 109 of the intermediate member 104 and the respective first and second coupling portions 105, 113 of a respective base member 102, 102'.
- 20 The second top plate 500 of the intermediate member 104 optionally further comprises a first tab 506 and a second tab 508. The first tab 506 and the second tab 508 are integrally formed with the second top plate 500. The first tab 506 is positioned at the first edge of the intermediate member 104 and the second tab 508 is positioned at the second edge of the intermediate member 104. The first and/or second tab 506, 508 may be detached from the second top plate 500 by snapping them off along a respective cut line (not shown in the figures). By detaching the tabs 506, 508 from the second top plate 500, an angle of connection between the base members 102, 102' can be adjusted during assembly of the barrier 100.
- 30 Figure 7a shows an isometric view of the assembled barrier 100 and Figure 7b shows a plan view of the assembled barrier 100. For the sake of clarity, the bollards 112 are omitted from Figure 7a.
- 35 During assembly, the base members 102, 102' are translated along the common plane relative to the intermediate member 104 until the first coupling portion 105 of base

member 102 engages the third coupling portion 111 at the first edge of the intermediate member 104, and the second coupling portion 113 of base member 102' engages the third coupling portion 109 at the second edge of the intermediate member 104.

5 As the base member 102 is translated along the common plane relative to the intermediate member 104, the respective arms of the third coupling portion 111 fit into the respective slots of the first coupling portion 105. More specifically, the first arm 518 fits through both the first slot 244 and the second slot 246, the second arm 520 fits through both the third slot 242 and the fourth slot 248, the third arm 522 fits through  
10 both the fifth slot 250 and the sixth slot 254, and the fourth arm 510 fits through both the seventh slot 252 and the eighth slot 256.

As the other base member 102' is translated along the common plane relative to the intermediate member 104, the respective arms of the third coupling portion 111 fit into  
15 the respective slots of the second coupling portion 113 of the base member 102'. More specifically, the fifth arm 516 fits through both the first slot 276 and the second slot 280, the sixth arm 514 fits through both the third slot 274 and the fourth slot 278, the seventh arm 512 fits through both the fifth slot 272 and the sixth slot 264, and the eighth arm 513 fits through both the seventh slot 270 and the eighth slot 266.

20 Each arm fits into the respective slots to rigidly connect the intermediate member 104 to each of the base members 102, 102'. Advantageously, the continuous passages created by the slots prevent the arms of the third coupling portions 111, 109 from rotating within the first coupling portion 105 and the second coupling portion 113. In this  
25 manner, the intermediate member 104 is prevented from rotating relative to the base members 102, 102' during a vehicular impact. This not only improves the structural integrity of the barrier 100, but also ensures that the energy of a vehicular impact is spread out across different sections of barrier 100, rather than being focused on a single impact point.

30 In Figures 7a and 7b, the intermediate member 104 connects base member 102 to 102' at a 180° angle. In other words, base member 102 and base member 102' extend along a straight line. The angle of connection between each base member 102, 102' and the intermediate member 104 can be adjusted by up to 5° during assembly of the  
35 barrier 100 by detaching the tabs 506, 508 from the second top plate 500. Detaching

the tabs 506, 508 allows each base member 102, 102' to be rotated slightly in the common plane of the base members 102, 102' and the intermediate member 104. This allows the barrier 100 to follow a curved (or otherwise non-linear) path.

- 5 After the third coupling portions 111, 109 are engaged with the respective first coupling portion 105 and the second coupling portion 113, the ballast material is inserted through the openings 214 in the top plate 216, and the openings 502, 504 in the second top plate 500.
- 10 The ballast material fills in the space between the third coupling portions 111, 109 and the respective first 105 and second 113 coupling portions, thereby immobilising the arms of the third coupling portions 111, 109 within the slots of the first 105 and second 113 coupling portions. As such, the ballast material allows for a better engagement between the third coupling portions 111, 109 and the first 105 and second 113 coupling
- 15 portions.

The ballast material may remove the need for welding the respective coupling portions 105, 111, 109, 113 together during installation. This eliminates the time-consuming process of having to weld the individual elements together on-site during the assembly

20 of the barrier 100. In conventional barriers, the respective coupling portions need to be welded together which burns off the galvanized surface at the weld area leading to an increased risk of corrosion. By using the ballast material to improve the engagement between the respective coupling portions 105, 111, 109, 113, the risk of corrosion is reduced or eliminated.

25 In the above embodiment the third coupling portions 111, 109 are depicted as arms and the first 105 and second 113 coupling portions are depicted as slots. However, in a second embodiment (not shown), the third coupling portions 111, 109 comprise a plurality of slots and the first 105 and second 113 coupling portions comprise two or

30 more corresponding arms (i.e. the position of the arms and slots on the respective coupling portions is swapped).

An example process of manufacturing the base member 102 will now be described. The U-shaped elements 300, 302, 304, 306 and the lid 210 are formed from a metal

35 sheet. For example, a metal sheet may be stamped or laser cut, and the resulting

workpieces may be folded (e.g., by pressing) to form the U-shaped elements 300, 302, 304, 306 and the lid 210. Alternatively, the U-shaped elements 300, 302, 304, 306 and the lid 210 may be formed by a casting process, by extrusion followed by laser cutting, or by cold-rolling followed by laser cutting. The socket 116 is formed by cutting a length  
5 of metal pipe. The U-shaped elements 300, 302, 304, 306 are then fixed to one another to form the foundation 211. For example, each U-shaped element may be welded to an adjacent U-shaped element. Alternatively or additionally, each U-shaped element may be fixed to an adjacent element using one or more bolts and nuts. The foundation 211 then fixed to the lid 210. For example, the lid 210 may be welded to each U-shaped  
10 element 300, 302, 304, 306 of the foundation 211. The socket 116 is then pushed through the aperture 220 in the lid 210, and fixed to the lid 210 and/or the foundation 211. For example, the socket 116 may be welded to either or both of the lid 210 or the foundation 211. One or more gusset plates 299 may optionally be welded to the socket 116 and the lid 210. The base member 102 is thus formed.

15

The cross-sectional shape of the foundation 211 of the base member 102 will now be described with reference to Figures 8a, 8b and 8c. Figure 8b is a schematic cross-sectional view of the foundation 211 through a vertical plane that intersects the line A-A shown in Figure 8a. Line A-A passes through the centre of the socket 116, and is perpendicular to the walls of the four U-shaped elements 300, 302, 304, 306. Figure 8b  
20 is a schematic cross-sectional view of the foundation 211 through a vertical plane that intersects the line B-B shown in Figure 8a. Line B-B is perpendicular to the walls of the four U-shaped elements 300, 302, 304, 306, and passes through a point between the socket 116 and the third edge of the base member 102. Figures 8a to 8c illustrate how the socket 116 passes through recesses 221a, 221b in the second U-shaped element  
25 302 and the third U-shaped element 304. The fourth wall 260a and the fifth wall 260b abut (and may be welded to) the socket 116, such that the fourth and fifth walls 260a, 260b support the lower region of the socket 116 during a vehicular impact. This improves the ability of the barrier 100 to withstand vehicular impacts.

30

An alternative example of a foundation 911 of a base member is shown in Figures 9a and 9b. In contrast to the foundation 211 discussed previously, the foundation 911 comprises five U-shaped rigid elements 900, 902, 904, 906, 908. Figures 9a and 9b are schematic cross-sectional views of the foundation 911 through vertical cross-sectional planes corresponding to those of Figures 8b and 8c, respectively. The cross-  
35

sectional plane of Figure 9a passes through the centre of the socket 916, and is perpendicular to the walls of the five U-shaped elements 900, 902, 904, 906, 908. The vertical plane of Figure 9b passes through a point between the socket 116 and the third edge of the base member 102, and is perpendicular to the walls of the five U-shaped elements 900, 902, 904, 906, 908. The socket 916 passes through a recess in the base plate 994 of the third U-shaped element 904. Unlike foundation 211, the socket 916 of foundation 911 does not pass through recesses in the walls of any of the U-shaped elements. Thus, foundation 911 can be manufactured with fewer cutting steps than foundation 211, but its socket 916 is less well supported.

Another example of a foundation 1011 of a base member is shown in Figures 10a and 10b. The foundation 1011 comprises a combination of L-shaped rigid elements and U-shaped rigid elements. More specifically, the foundation 1011 comprises three L-shaped elements 1000, 1002, 1004, and one U-shaped element 1006, as will now be described.

A first L-shaped element 1000 comprises a first wall 1068 and a first base plate 1090. The first wall 1068 is connected to, and is substantially perpendicular to, the first base plate 1090. In some embodiments, the first wall 1068 is integrally formed with the first base plate 1090. For example, the first wall 1068 and the first base plate 1090 may be formed from a single bent metal sheet.

A second L-shaped element 1002 comprises a second wall 1062 and a second base plate 1092. The second wall 1062 is connected to, and is substantially perpendicular to, the second base plate 1092. In some embodiments, the second wall 1062 is integrally formed with the second base plate 1092. For example, the second wall 1062 and the second base plate 1092 may be formed from a single bent metal sheet.

A third L-shaped element 1004 comprises a third wall 1060 and a third base plate 1094. The third wall 1060 is connected to, and is substantially perpendicular to, the third base plate 1094. In some embodiments, the third wall 1060 is integrally formed with the third base plate 1094. For example, the third wall 1060 and the third base plate 1094 may be formed from a single bent metal sheet.

A first U-shaped element 1006 comprises a fourth wall 1058, a fourth base plate 1096 and a fifth wall 1040. The fourth wall 1058 and the fifth wall 1040 are connected to the fourth base plate 1096. Both the fourth wall 1058 and the fifth wall 1040 are substantially perpendicular to the fourth base plate 1096. In some embodiments, the fourth wall 1058, the fifth wall 1040 and the fourth base plate 1096 are integrally formed. For example, the fourth wall 1058, the fifth wall 1040 and the fourth base plate 1096 may be formed from a single bent metal sheet.

The first base plate 1090 of the first L-shaped element 1000 is connected to the second wall 1062 of the second L-shaped element 1002. The second base plate 1092 of the second L-shaped element 1002 is connected to the third wall 1060 of the third L-shaped element 1004. The third base plate 1094 of the third L-shaped element 1004 is connected to the fourth wall 1058 of the first U-shaped element 1006. In this manner, the three L-shaped elements and the single U-shaped element collectively form a single unit.

A socket 1016 passes through recesses in the second base plate 1092 and the third wall 1060 of the third L-shaped element 1004. The third wall 1060 abuts (and may be welded to) the socket 1016, such that the third wall 1060 supports the lower region of the socket 1016 during a vehicular impact. This improves the ability of the barrier 100 to withstand vehicular impacts.

A foundation comprising a combination of L-shaped elements and U-shaped elements, such as foundation 1011, requires less material (and, therefore, is lighter and easier to transport and assemble) than a foundation comprising only U-shaped rigid elements. However, a foundation comprising a combination of L-shaped elements and U-shaped elements may have a lower ability to withstand impacts than a foundation comprising only U-shaped elements.

The foundations 211, 911, 811 shown in Figures 8a to 10b are purely examples of how foundations may be constructed. Base members having foundations with other constructions are contemplated. As mentioned above, a foundation may comprise two, three, five, or more U-shaped rigid elements. Additionally or alternatively, some or all of the U-shaped rigid elements may be replaced by L-shaped rigid elements. That is, a foundation may comprise two, three, five, or more L-shaped rigid elements. Additionally

or alternatively, a foundation may comprise rigid elements having a different profile, such as rigid elements with an H-shaped or T-shaped cross-section. Furthermore, the U-shaped, L-shaped, H-shaped and/or T-shaped rigid elements may be at any suitable orientation within the foundation of the base member, provided that the rigid elements and lid collectively form a box section.

Although the lid 210 shown in Figures 2 to 5 is U-shaped, lids with other shapes are contemplated. For example, the lid may be L-shaped or planar. The lid may have any suitable shape, provided that the rigid elements and lid collectively form a box section. The chambers 370, 372, 374, 376 need not be fully enclosed by the lid 210. For example, the first shoulder 212 and/or the second shoulder 218 could be omitted, such that some or all of the chambers 370, 372, 374, 376 are open at either or both ends.

The example base member 102 disclosed herein has the lid 210 positioned above the foundation 211 when the barrier 100 is installed. However, the terms "lid" and "foundation" should not be construed as requiring this particular orientation. For example, the lid 210 and foundation 211 could be inverted, such that the lid 210 is positioned below the foundation 211 when the barrier is installed. In this case, the socket 112 may also be inverted, such that the bollard 112 projects upwards from the foundation 211.

Although the bollards illustrated herein have a circular cross-section, the present disclosure can be applied to bollards with other shapes (e.g., bollards with oval, square, rectangular, polygonal or irregular cross-sections). In such cases, the shape of the sockets of the base members will complement the shape of the bollards.

It will also be understood that the barrier 100 can have any number of base members and/or intermediate members. Further, each base member may comprise more than one bollard, or even no bollards at all. Sometimes, a portion of the barrier may be required to not have any upstanding bollards (e.g., to provide a break in the barrier, thus allow vehicles to pass through a specific area in the barrier). By allowing one or more base members not to have any bollards, a break in the barrier is facilitated while allowing the barrier to maintain a continuous line of underground base members and/or intermediate members along which a force of a vehicular impact may be spread.

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It will be appreciated by the person of skill in the art that various modifications may be made to the above described embodiments without departing from the scope of the invention. Any embodiment described herein is not necessarily to be construed as preferred or advantageous over other embodiments.

**CLAIMS**

1. A base member for a bollard, the base member being adapted for ground engagement by placement upon, or embedment within, a ground or floor surface, the  
5 base member comprising:  
first and second rigid elements, each rigid element being integrally formed and comprising a base plate and a wall extending substantially perpendicularly away from the base plate, the first rigid element being fixed to the second rigid element; and  
a lid fixed to the first rigid element and/or the second rigid element, such that  
10 the rigid elements and lid collectively form a box section comprising a plurality of chambers defined between the lid, the first rigid element and the second rigid element.
2. A base member according to claim 1, wherein each rigid element and/or the lid is formed by folding sheet metal.  
15
3. A base member according to claim 1 or claim 2, wherein the first rigid element comprises a first base plate, a first wall and a second wall, the first wall being positioned at a first edge of the first base plate and the second wall being positioned at a second edge of the first base plate, wherein both the first wall and the second wall  
20 extend substantially perpendicularly away from the first base plate.
4. A base member according to claim 3, wherein the second rigid element comprises a second base plate, a third wall and a fourth wall, the third wall being positioned at a first edge of the second base plate and the fourth wall being positioned  
25 at a second edge of the second base plate, wherein both the third wall and the fourth wall extend substantially perpendicularly away from the second base plate.
5. A base member according to claim 4, wherein the second wall of the first rigid element abuts, and is fixed to, the third wall of the second rigid element.  
30
6. A base member according to claim 3, wherein the second rigid element comprises a second base plate and a third wall, the third wall being positioned at a first edge of the second base plate and extending substantially perpendicularly away from the second base plate.  
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7. A base member according to claim 6, wherein a second edge of the second base plate is fixed to the first rigid element.

5 8. A base member according to any of the preceding claims, wherein the lid comprises a top plate, a first shoulder and a second shoulder, wherein the first shoulder is positioned at a first edge of the top plate and extends substantially perpendicularly away from the top plate and the second shoulder is positioned at a second edge of the top plate and extends substantially perpendicularly away from the top plate.

10

9. A base member according to claim 8, wherein the first shoulder and the second shoulder extend perpendicularly to the walls of each of the rigid elements, such that the walls and the base plates of the rigid elements and the top plate and the shoulders of the lid collectively form a substantially closed box.

15

10. A base member according to any of the preceding claims, wherein the lid comprises one or more openings for receiving a ballast material.

20 11. A base member according to any one of the preceding claims, further comprising a socket for receiving a bollard.

25 12. A base member according to claim 11 when directly or indirectly dependent upon claim 5, wherein the second wall of the first rigid element and the third wall of the second rigid element each comprise a recess, and wherein the socket extends through the recesses and is fixed to both the first rigid element and the second rigid element.

30 13. A base member according to claim 11 or claim 12, wherein:  
the lid comprises an aperture and the socket extends through the aperture;  
and/or  
one or more of the base plates comprise a recess and the socket extends through the recess.

35 14. A base member according to any of claims 11 to 13, wherein the socket comprises one or more gusset plates, the gusset plates being fixed to both the lid and a top end of the socket.

15. A base member according to any of the preceding claims, further comprising:  
one or more coupling portions,  
wherein the one or more coupling portions are configured to mate with a  
5 corresponding one or more coupling portions on an adjacent member of a barrier  
comprising the base member, to rigidly connect the base member to one or more  
additional base members.
16. A base member according to any of the preceding claims, wherein the lid and/or  
10 one or more of the rigid elements comprise an opening for receiving a leg, and wherein  
at least a portion of the leg is configured to extend into one or more of the plurality of  
chambers within the box section.
17. A base member according to any of the preceding claims, further comprising a  
15 bollard fixed thereto.
- 18 A barrier comprising a plurality of base members according to any of the  
preceding claims.
- 20 19. A kit of parts comprising:  
a base member according to any of claims 1 to 16; and  
a bollard for attachment to the base member.
- 25 20. A kit of parts according to claim 19, further comprising a leg for attachment to  
the base member.