ADVANTAGES OF AMERICAN HIGHWAY PRODUCTS AHP TYPE 1 EXPANDABLE MANHOLE RISER

The purpose of this document is to present the merits of the AHP Type 1 Expandable Manhole Riser design. Advantages are laid out in A, B, C and D below.

A. AHP Type 1 Expandable Riser is Free of Destructive Lever-Out Effect

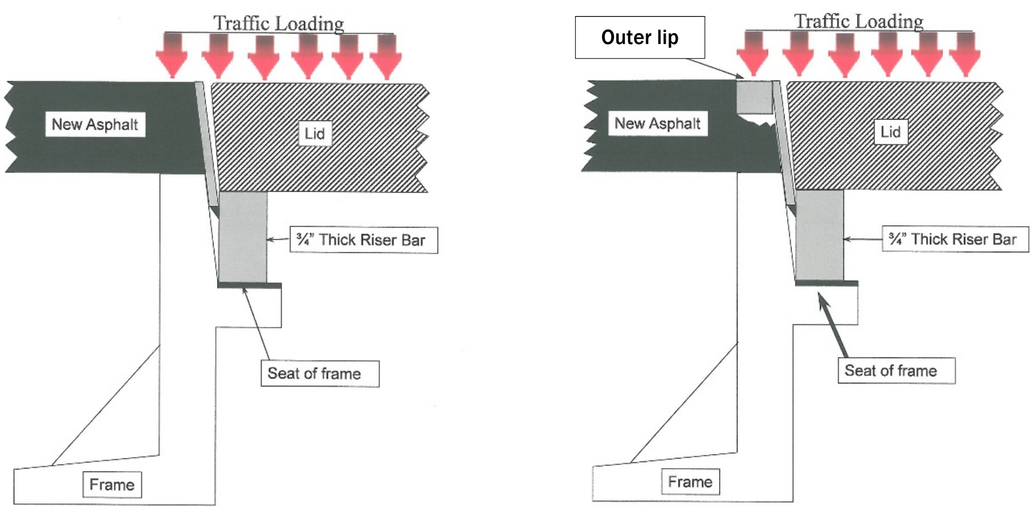


Diagram 1. Profile of AHP Type 1 (left) versus that of bar welded on top of riser assembly

A common design in use, on account of its rim outer lip, is to blame for the development of an appreciable amount of leverage as a vehicle passes over the riser/lid assembly. Such a force is produced on the other side of the fulcrum and reacts upward on the entire assembly with magnitude enough to surpass the assembly weight in some cases. Such can cause the assembly to begin to work loose from the asphalt and finally even to rise out of its embedded position! The above events have actually been reported with solid risers that employ a square bar lip, where the lid finally bounced out onto the street top, leaving the entire opening suddenly exposed.

With the outer rim lip removed the AHP Type 1 Expandable Riser will not leverage out of asphalt and the welds will hold more reliably.

1. The AHP Type 1 Manhole Riser boasts a hold-down safety factor in magnitude of ten times that of the type with rim lip on account of the high moment that is created by the rim lip with its outermost traffic-contact point located commonly at a horizontal distance of ¾" away from where the riser contacts the seat of frame. As the calculations for sample cases indicate, the lever-fulcrum force produced can be enough to overcome the weight of the entire assembly. The weight of traffic shown is for the static condition. In actual moving traffic the leveraging effects are only compounded.

Calculations of pullout force comparison between AHP Type 1 Expandable Riser versus that of bar welded on top of riser assembly or solid cast iron riser.
For sake of clarity we will initially neglect any frictional force, forces such as may be present via compression fit or setscrews.

By the Law of Moments the sum of the moments in a body = zero
($\Sigma M_B = 0$)
if the body is not in motion. The body is then said to be "in equilibrium".

When, however, the sum of the moments do not equal zero the body is said to be "unbalanced". An unbalanced body is "in motion".

In the following analysis we will solve for the forces acting on the body (the riser / lid assembly, or "the assembly") less the weight of the assembly.

Thus we will see how much force acts upward at the center of gravity, then we compare that force to the weight of the assembly. If it exceeds the weight of the assembly (and neglecting side forces as mentioned above) we have an assembly out of balance (in motion). This clearly demonstrates how important proper side forces are, then, in retaining the riser within the frame.

The two cases in the analysis below demonstrate that the (upward) force F_3 produced by cantilever is far more in case II than in case I.

Preliminary Data

Weight of Lid used in this comparative analysis is 1" thick with a diameter of 23.5" and weighs 125 lbs. A 23.75" Diameter Manhole Riser 1.5" in height weighs 25 lbs.

Weight of assembly is

Lid = 125 lbs.

AHP Type 1 Expandable Manhole Riser (Case I) = 25 lbs.

Manhole Riser with Lip or Cast Iron Manhole Riser (Case II) = 35 lbs.

F_1 = WEIGHT OF LID + WEIGHT OF MANHOLE RISER = WEIGHT OF ASSEMBLY

Thus, Case I: **F1 = 125 + 25 = 150 lbs.**

Case II: **F1 = 125 + 35 = 160 lbs.**

Let STATIC WEIGHT OF TRAFFIC, F_2 = 11,250 lbs.

HALF DIAMETER OF LID, R = 11.75" (This is where resultant forces act relative to fulcrum point)

Resultant Force

F_3 = (What we must solve for in each of Case I and II)

Sum of the moments about the Fulcrum (point B):

$\Sigma M_B = 0$

$F_2S - F_3R = 0$

Thus, **$F_3 = F_2S / R$**

And PULLOUT FORCE, **$F_P = F_3 - F_1$**

Case I (AHP Type 1 Expandable Manhole Riser)

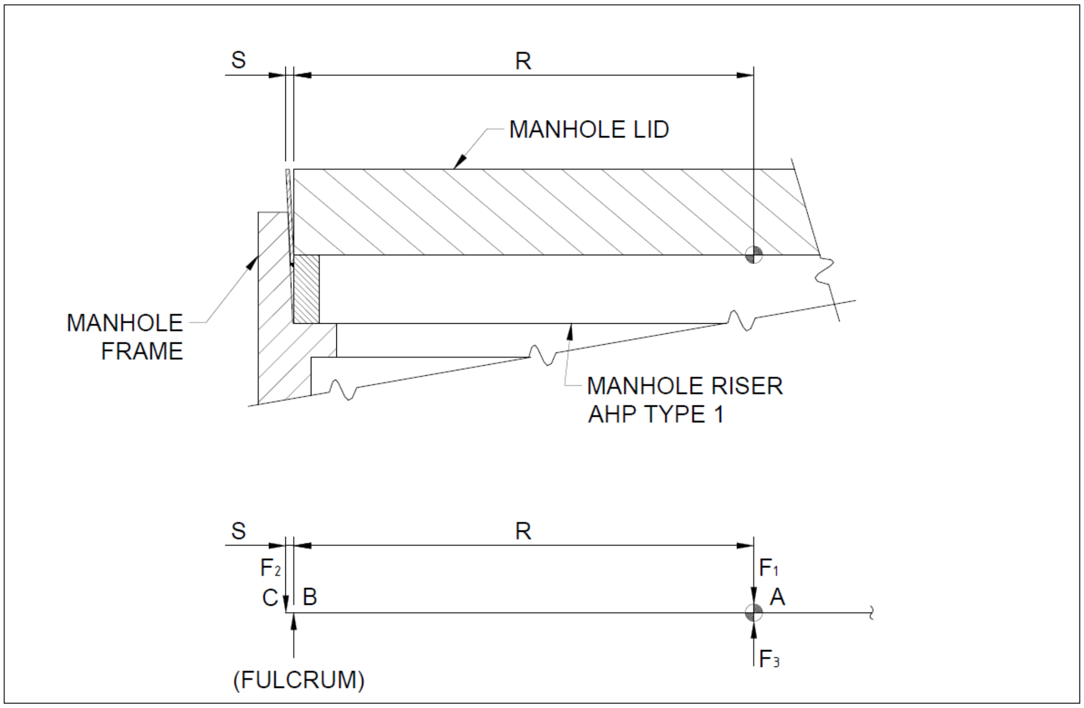


Diagram 2. AHP Type 1 Expandable Riser Example: Riser assembly in manhole frame (above), Free-body diagram of riser assembly (below)

Let S = .23"

Then

$F_3 = F_2S / R$

F_3 = 11,250 * .23 / 11.75

F_3 = 220 lbs.

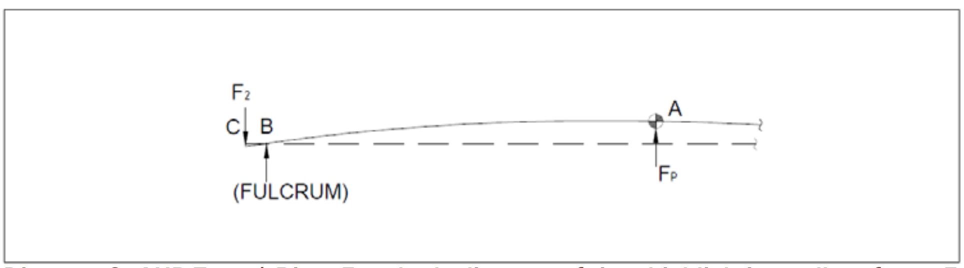


Diagram 3. AHP Type 1 Riser Free-body diagram of riser highlighting pullout force, F_P

PULLOUT FORCE, $F_P = F_3 - F_1$

F_P = 220 – 150 = 70 (upward) *(equilibrium weight = 7,663) lbs.)*

OBSERVE: Since F_P result is a positive value in Case I, system is 70 lbs. unbalanced.

The unbalanced force then must be overcome by additional design features. One such feature is at work when AHP Type 1 Expandable Riser is expanded into frame achieving full circumferential engagement. A pull out force, tested by McGuard LLC concluded it took 8,000lbs (F_{ULT}) (see page 8) to move expanded riser (see pg. 8). Because friction forces caused by expansion forces far outweigh unbalance lift out forces, the riser holds fast.

SAFETY FACTOR, S.F. = F_{ULT} / F_P

S.F. = 8,000/70 or

SAFETY FACTOR, S.F. = 114

Case II (Solid Riser or Expandable Manhole Riser with Lip Bar)

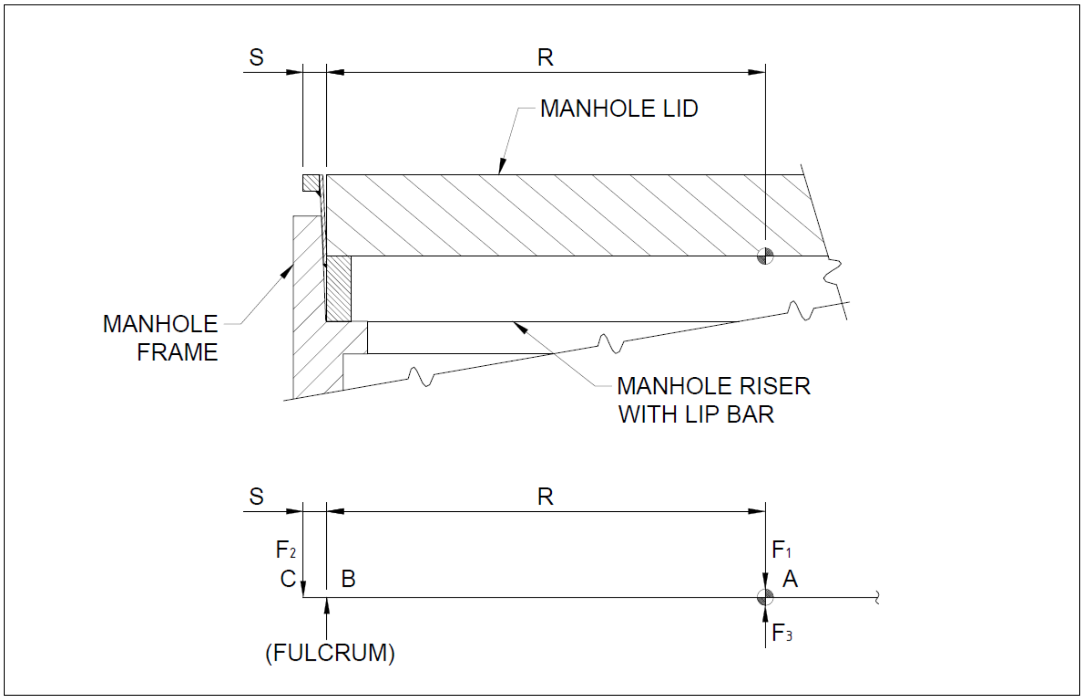


Diagram 4. Manhole Riser with Lip Bar Example: Riser assembly in manhole frame (above), Free-body diagram of riser assembly (below)

Let **S = .75"**

Then

$F_3 = F_2S / R$

$F_3 = 11250 * .75 / 11.75$

$F_3 =$ 718 lbs.

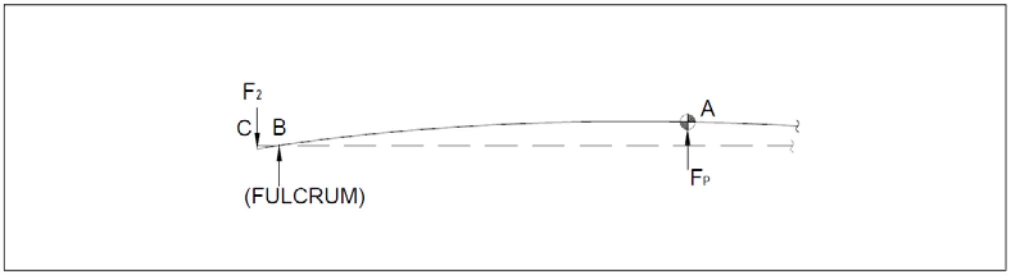


Diagram 5. Manhole Riser with Lip Bar Free-body diagram of highlighting pullout force, F_P

PULLOUT FORCE, $F_P = F_3 - F_1$

F_P = 718 - 160 = 558 (upward) ***(equilibrium weight = 2,507lbs)***

OBSERVE: Since F_P result is a positive value in Case II, system is 558 lbs. unbalanced.

The unbalanced force then must be overcome by additional design features, and once again, as in Case I, we can overcome the unbalanced force when AHP Type 1 Expandable Riser is expanded into frame, except resulting in a different safety factor (due to the use of rim lip in Case II):

SAFETY FACTOR, S.F. = F_{ULT} / F_P

S.F. = 8,000/558 or

SAFETY FACTOR, S.F. = 14

Conclusion:
The AHP Type 1 Expandable Riser (Case I) provides holding power with a (114) safety factor **ten** times greater than the (14) safety factor of the version shown in Case II.

2. When a rim lip is *not* used, the forces acting on the weld produced by traffic shift from significant bending-tensile stress and little shear stress to mostly shear stress, as can be observed from the geometry (see Diagram 1) in concert with the higher moment observed in above analysis. The bending moment in weld in the AHP Type 1 Expandable Riser design is thus less than 1/3 the magnitude of that found in the square bar rim lip design.

B. AHP Type 1 Expandable Manhole Riser Has Superior Corrosion-Resistance

The competitors provide only a painted 12 or 14 gauge sheet metal skirt against corrosion, whereby AHP expandable riser comes with a galvanized 12 gauge material, which is superior to risers dipped in paint.

C. AHP Type 1 Expandable Manhole Riser Offers an Optimized Press-In-Bearing Fit

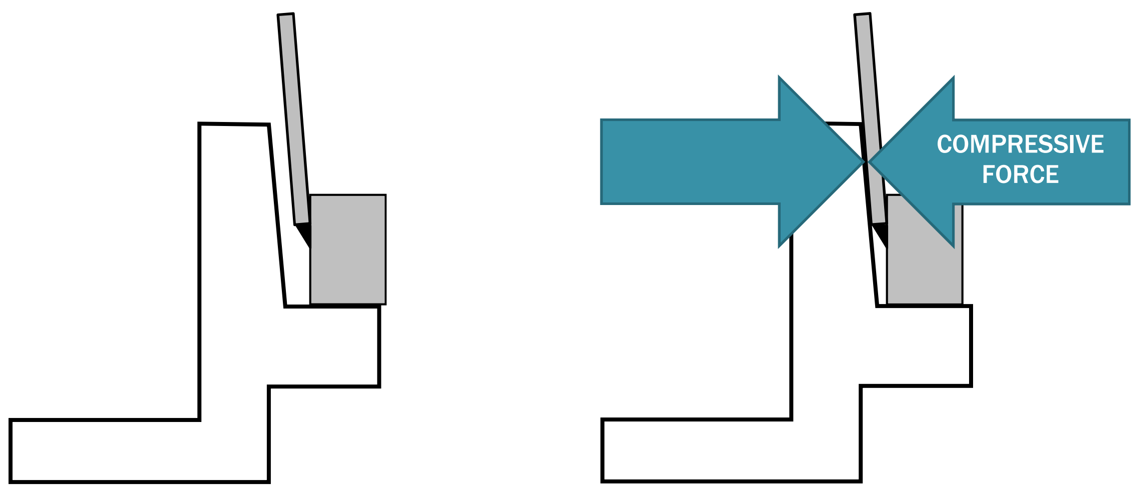
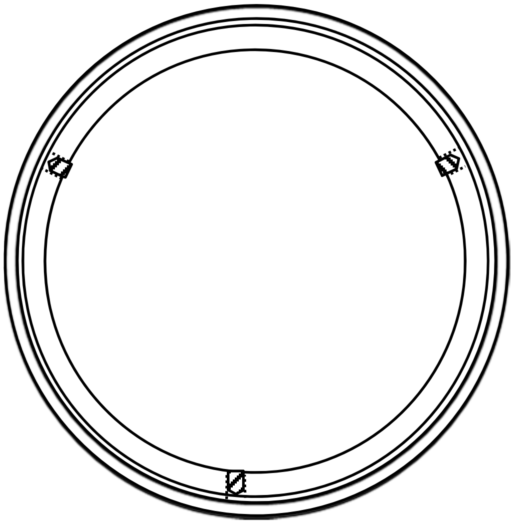


Diagram 6. Riser prior to expansion (left) and riser after expanded into frame (right)

1. The taper of the 12 gauge material is flared at an angle which compresses against frame vertical surface which contains the lid. This compression creates full circumferential engagement of skirt against interior of frame (above, right).



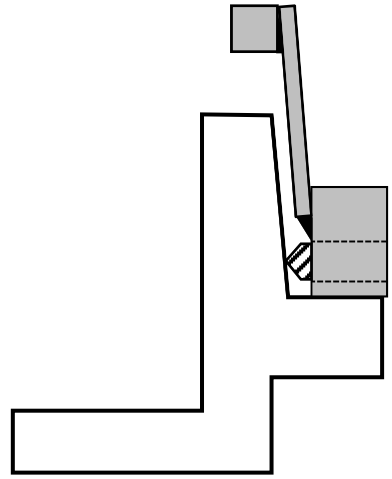


Diagram 7. Solid Riser showing Setscrews

2. The taper just mentioned is far more effective in holding the riser down than the point of three small setscrews for three reasons.

    a. A setscrew can find imperfections and voids in existing and even new frames and at times drive the riser upward out of its home position as a screw or bolt is rotated.

    b. Setscrews provide resistive forces only along horizontal axis. The “vertical” surface which the set screw point makes contact with is actually at a slight taper. Such taper will not hold vertical loading on three setscrew points with nearly the same consistency or reliability as will the full circumferential expansion against the entire tapered surface (locking taper).

    c. With any corrosion setscrews tend to lose grip as contact surface disintegrates and falls away. With the taper lock design on the other hand, in the event of corrosion the rust particles tend to stay put, and the result is a tighter rather than looser grip on manhole frame interior.

3. Proper paving results are far more achievable with AHP Type 1 Expandable Riser. Referring again to Diagram 1 (left) above, we note that when a paving roller compacts asphalt, a superior more complete compaction results with AHP Type 1 Expandable riser because the smooth vertical uninterrupted surface from bottom to top permits 100% contact with and filling, and compaction of asphalt. In contrast when a square bar lip is present (Diagram 1, right) it blocks the flow of asphalt, defeating full compaction, and in fact leaving a void just

below the lip. The lip-free AHP Type 1 Expandable Riser thus eliminates the following three problems associated with the void left just under the edge lip after paving.

a. The void encourages pavement crumbling into void from forces of traffic.

b. The void effects a loss of asphalt adhesion due to creeping effect of void, leading to premature breakdown.

c. The void allows water to enter void with destructive freezing water forces to ensue.

D. AHP Type 1 Expandable Riser Costs Less

Due to the absence of ½" square bar rim, the costs in material, preparation, welding and painting the square bar are eliminated for a total savings of $20.00 per riser.
Due to not needing setscrews or bolts to secure the riser in the frame an additional cost savings of $10.00 is realized. The two together combine for a total savings of $<u>30.00 less per riser</u>.

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ENGINEERING REPORT

Regarding: AHP 24" x ¾" SQ. RING

Outline:

- Ø 26" Neenah Foundry R-1593 cast iron frame used for testing (Fig. 1)
- Ø 24" x ¾" Square AHP Ring
- Installed ring with AHP Tool (screwdriver)
- 24" x 1" composite disk – Press Pad.

Results:

The AHP Ring test was performed on a test fixture (Fig. 2) using a hydraulic cylinder to apply a center load on the 24" x 1" press pad. The AHP ring was placed and expanded into the 24" clear opening of the frame. The force to move the ring in the frame, or push out force, was 8,000 pounds.

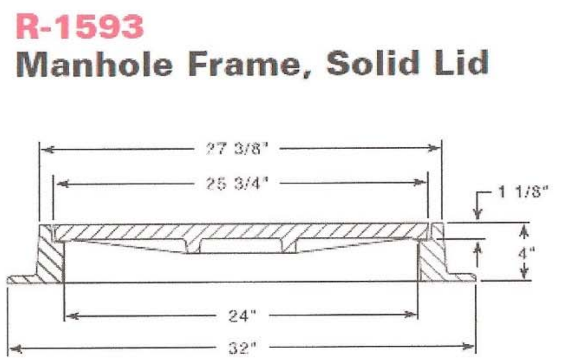

Figure 1

Figure 2