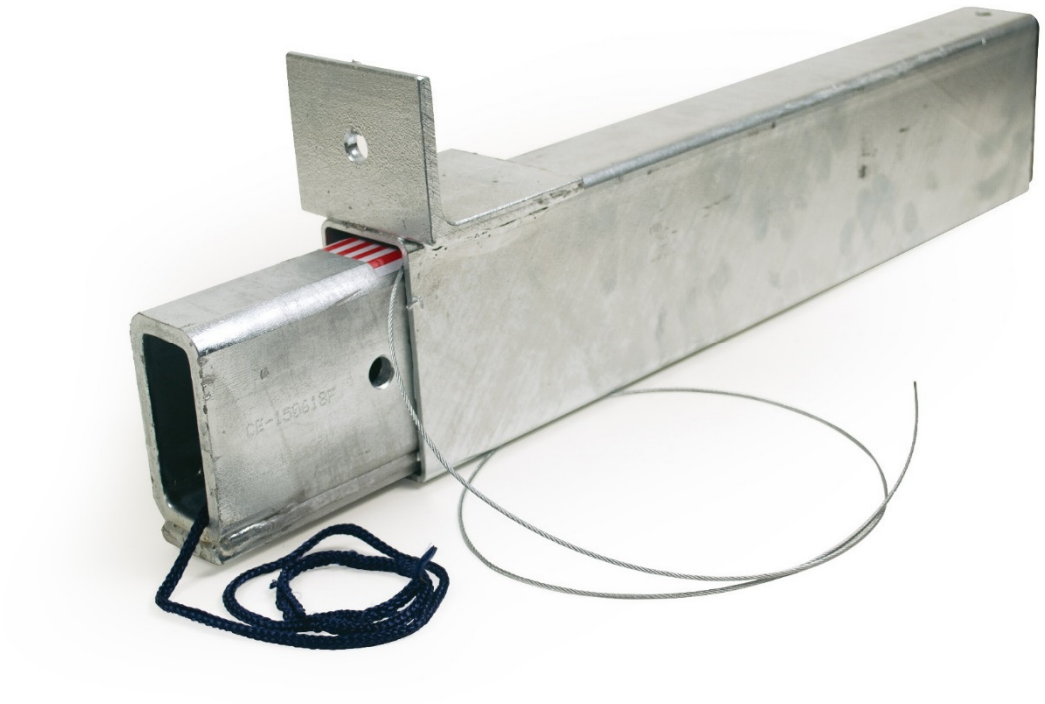
An Introduction to



THE SHOOTER

YOUR **CONNECTION** CONNECTION

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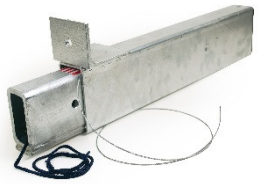

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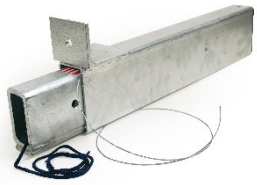
A complete technical manual that includes information specific to engineering, production, and erection can be found at www.jvi-inc.com or by contacting us at info@jvi-inc.com.

THE SHOOTER
Introduction



Keywords

Invisible Connection, Gravity Support, Embedded Steel Section, Double Tee, Strut-And-Tie Model, Corbel, Haunch, Dap, Precast, Prestressed, Concrete

Introduction

The Shooter is an invisible, gravity connection designed to eliminate the need for aesthetically undesirable corbels, haunches, or daps when building a precast/prestressed concrete structure incorporating double tees.

More specifically, it is a tube within a tube which is cast into the ends of the double tee stems at their widest point. The inner tube is recessed during casting and extended at erection into a receiving pocket in a spandrel, wall, or beam. To prevent the inner tube from recessing back into the double tee, a pin is installed through the projected inner tube after the double tee is set in its final position.

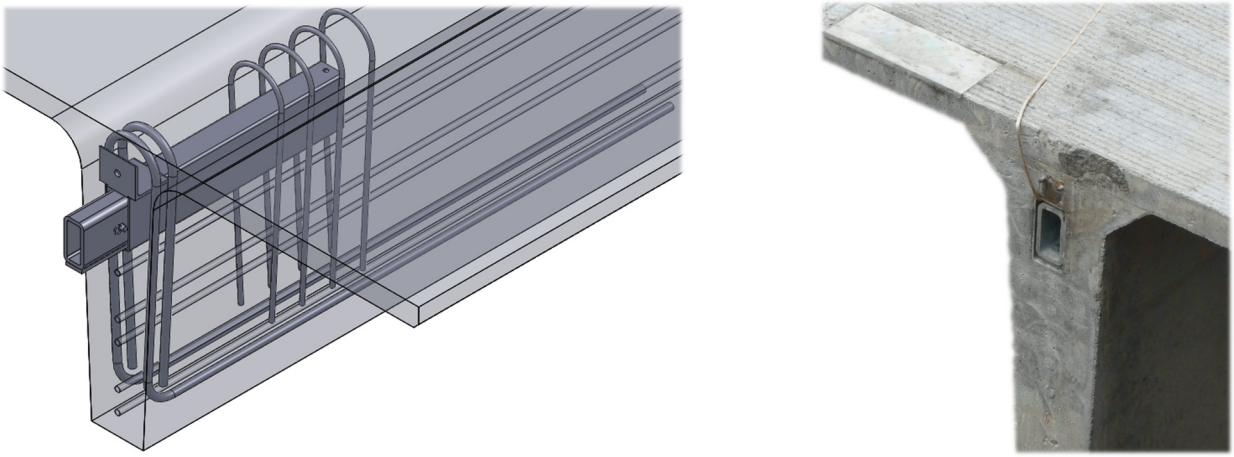
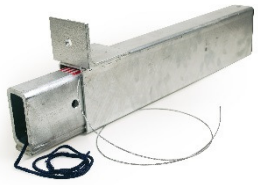


Figure 1.1 Shooter at end of Double tee leg

Practical Advantages

The Shooter connection system is a simple, efficient connection that creates clean, elegant lines. Beyond aesthetics, some benefits are:

- Eliminates weld on corbels and ledges
- Reduces torsion on supporting members
- Reduces the size of the pocket in the spandrel
- Eliminates dap forming, bearing plate, and reinforcing
- Simplified erection does not require “diving” of double tees into pockets
- Allows for axial volume movements due to creep, shrinkage and temperature change
- Can increase ceiling height or reduce overall height of the structure
- Full-scale tested solution to verify design methodology



Product Dimensions

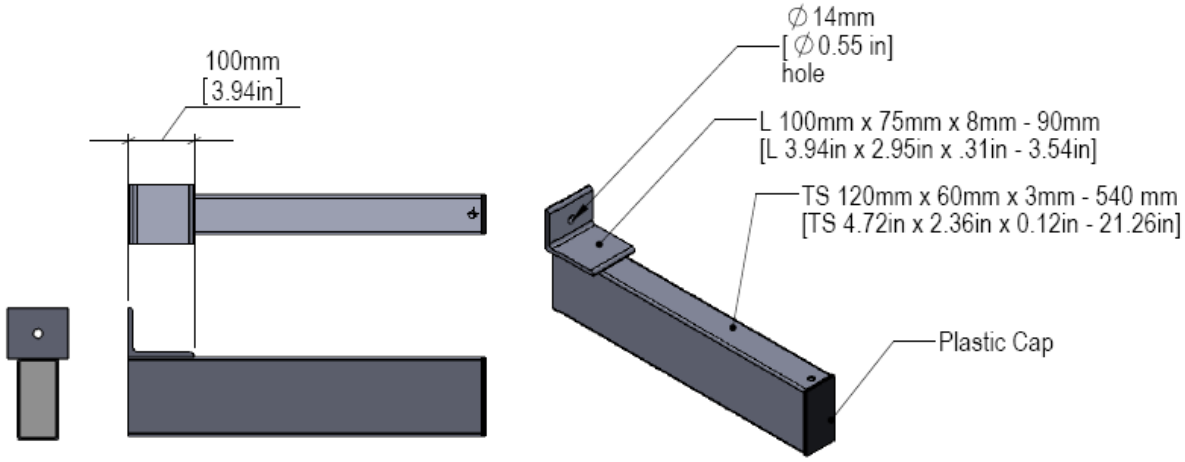


Figure 1.2 Outer Tube Dimension

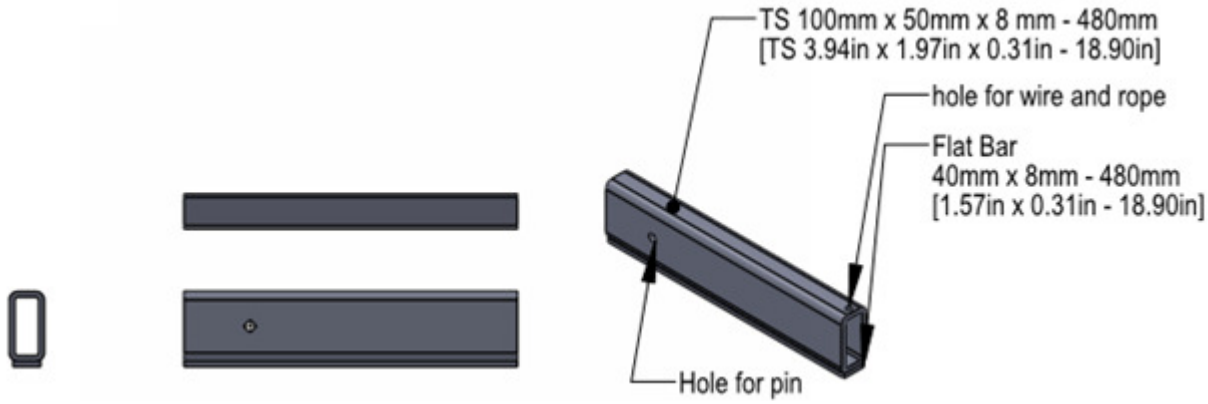


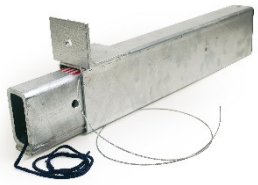
Figure 1.3 Inner Tube Dimensions

Material

The Shooter is composed of steel meeting the requirements of the European Standard EN 10025. The European grade of material provided is S355, where the S denotes the fact that it is structural steel and the 355 is related to the minimum yield strength of the steel in MPa. The US equivalent grade of S355 is A572, Gr50[1] for flat bar and ASTM A500 Gr C for rectangular HSS. The material properties for both S355, A572 and A500 are shown in table 1.1.

Material Property	ASTM A572, GR. 50/A500 GR. C	S355
F_y Minimum Yield Stress, ksi	50/50	50
F_u Tensile Strength, ksi	65/62	68-91
Modulus of Elasticity, ksi	29,000	29,000

Table 1.1 Equivalent Material Properties

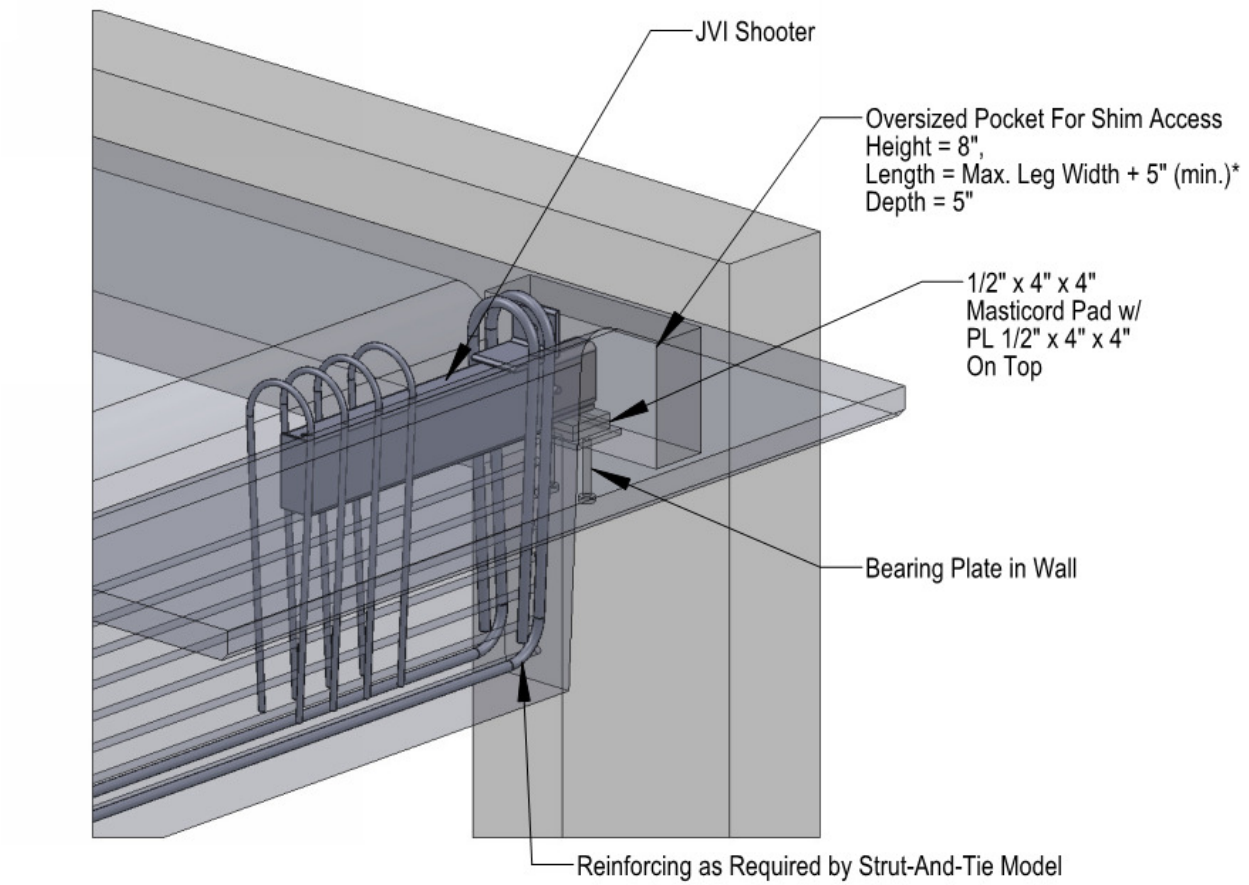


The Shooter is provided with a hot dipped galvanized finish according to the European specification NS-EN ISO 1461. ISO 1461 is essentially equivalent to ASTM A123[2].

Mechanical Design Strength

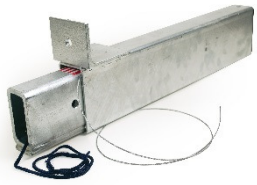
Full scale test results[3] have indicated that the Shooter has a mechanical design Strength in excess of 40,000 lbs. The testing also indicated that a strut-and-tie model can be used to design any member using the shooter as a connection. To achieve the mechanical design capacity of the Shooter sufficient concrete must surround the shooter to develop the required compression strut capacity and reinforcing must be supplied to develop the required tension strut capacity.

Example Detailing

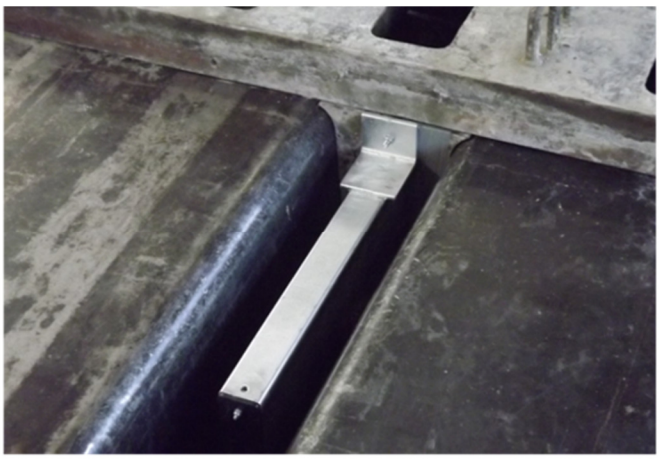


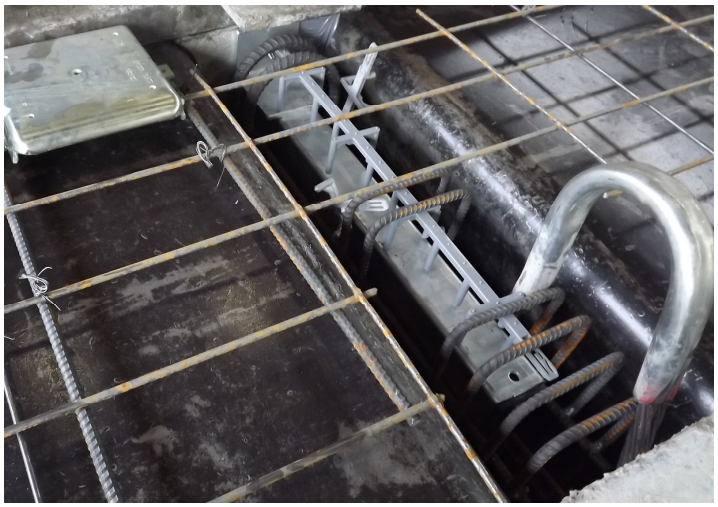
* For a pocket with pin access on both sides of the DT leg, the pocket width should increase to Max. Leg Width + 10" min.

Figure 1.4 Example Detailing

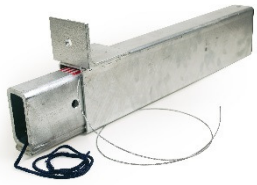


In Production





In the Field



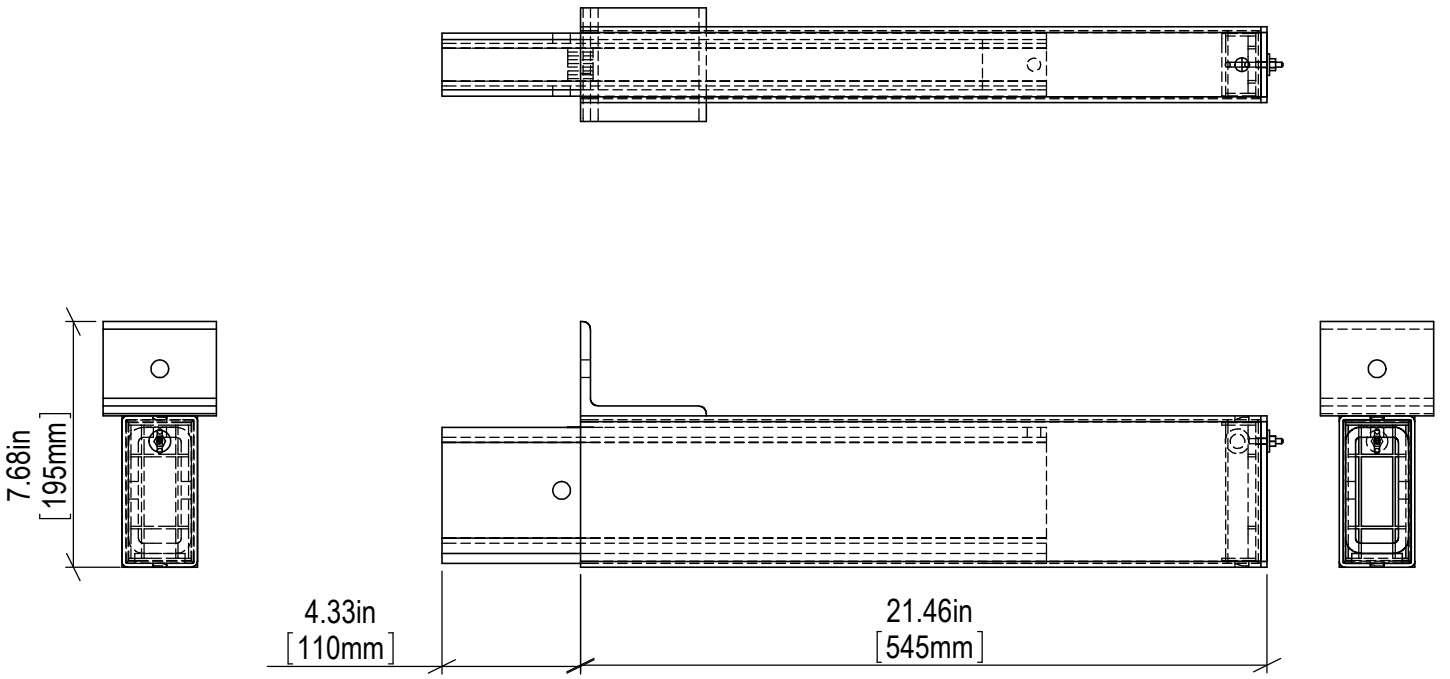
In the Field-Continued

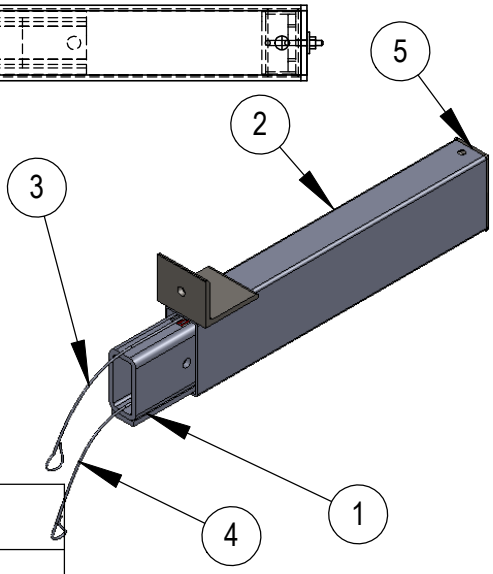
References

[1] Gilbert, Nick (2012). Structural Steel - S235, S275, S355 Chemical Composition, Mechanical Properties and Common Applications. http://www.azom.com/article.aspx?ArticleID=6022

[2] Langill, Tom, (2002). ISO 1461 and ASTM A123. http://www.galvanizeit.org/education-and-resources/resources/technical-faq-dr-galv/iso-1461-and-astm-a-123

[3] Poore, Lois E (2009). The Development of a Steel Embedded Connection for Double-Tee Beams. Department of Civil and Environmental Engineering, Virginia Polytechnic Institute and State University, Blacksburg, VA.





NOTES:
1. ALL STEEL IS GALVANIZED ACCORDING TO NS-EN ISO 1461
2. SECURE AND SEAL PLASTIC END CAP WITH CONTRACTOR GRADE DUCT TAPE AFTER INSTALLLNG ROPES

PART LIST

ITEM	DESCRIPTION	MATERIAL	CUTTING LENGTH	QTY	WT. LBS
1	INNER TUBE			1	19.6
2	OUTER TUBE			1	11.7
3	WIRE ROPE W/ LOOPED ENDS	STEEL CABLE	1500	1	
4	BLUE ROPE W/ LOOPED ENDS	NYLON	1500	1	
5	TAPE	SEE NOTE 2		1	

TOTAL WEIGHT : 31.3 LBS

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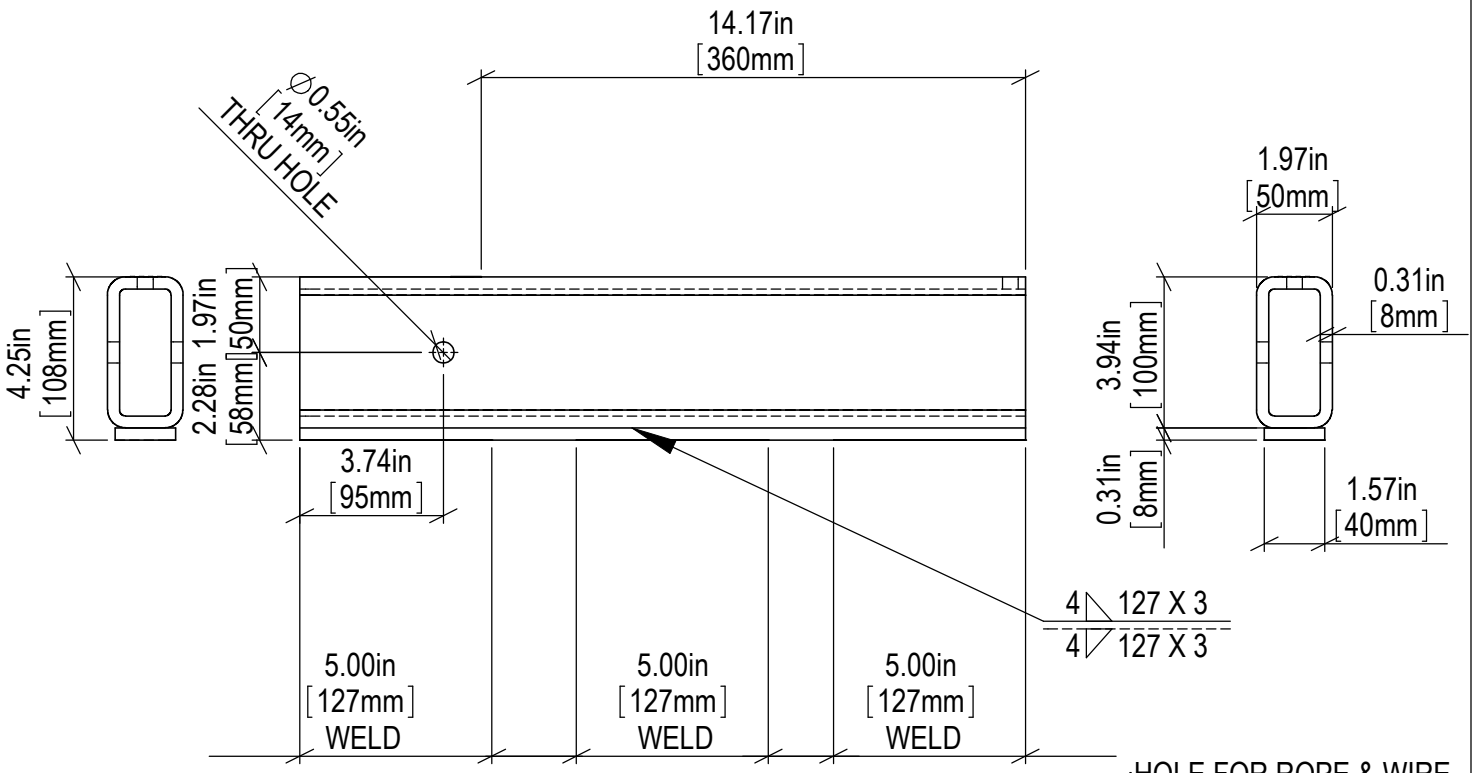
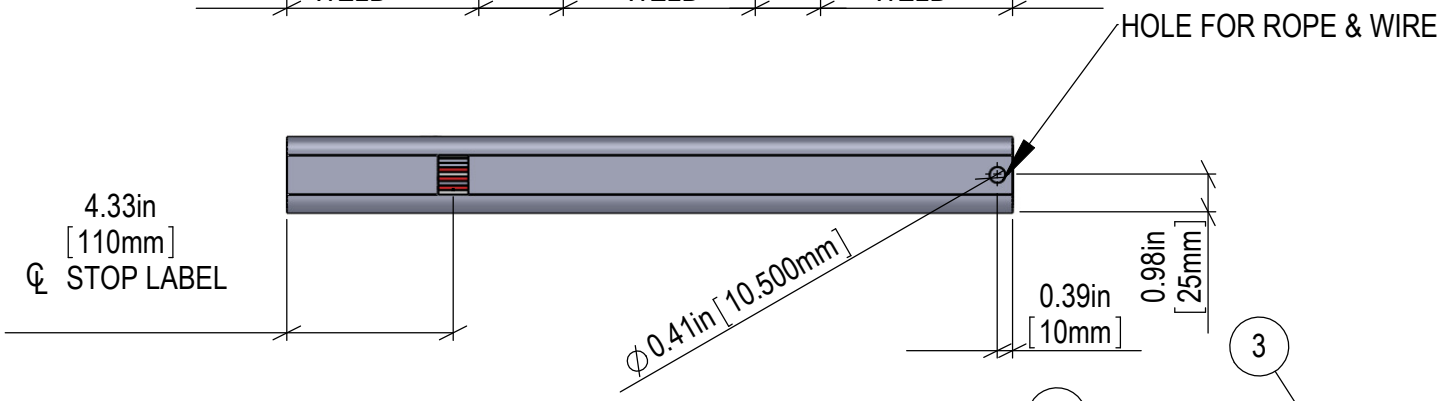
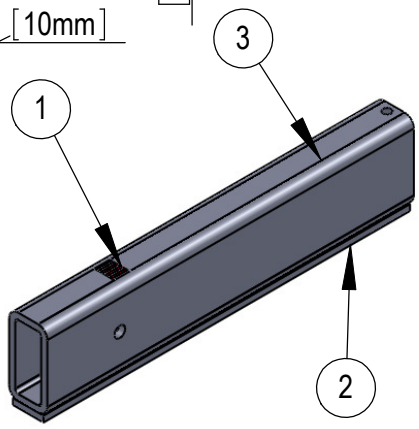
INNER AND OUTER TUBE ASSEMBLED WITH WIRE AND ROPE

DATE	DRAWN	CHECKED	SCALE
09.07.2017	JVI	— — —	— — —







PART LIST					
ITEM	DESCRIPTION	MATERIAL	CUTTING L	QTY	WT. LBS
1	TS 100X50X8 L=480	S355	480	1	16.9
2	FLAT BAR 40X8 L=480	S355	480	1	2.7
3	STOP LABEL			1	

TOTAL WEIGHT : 19.6 LBS

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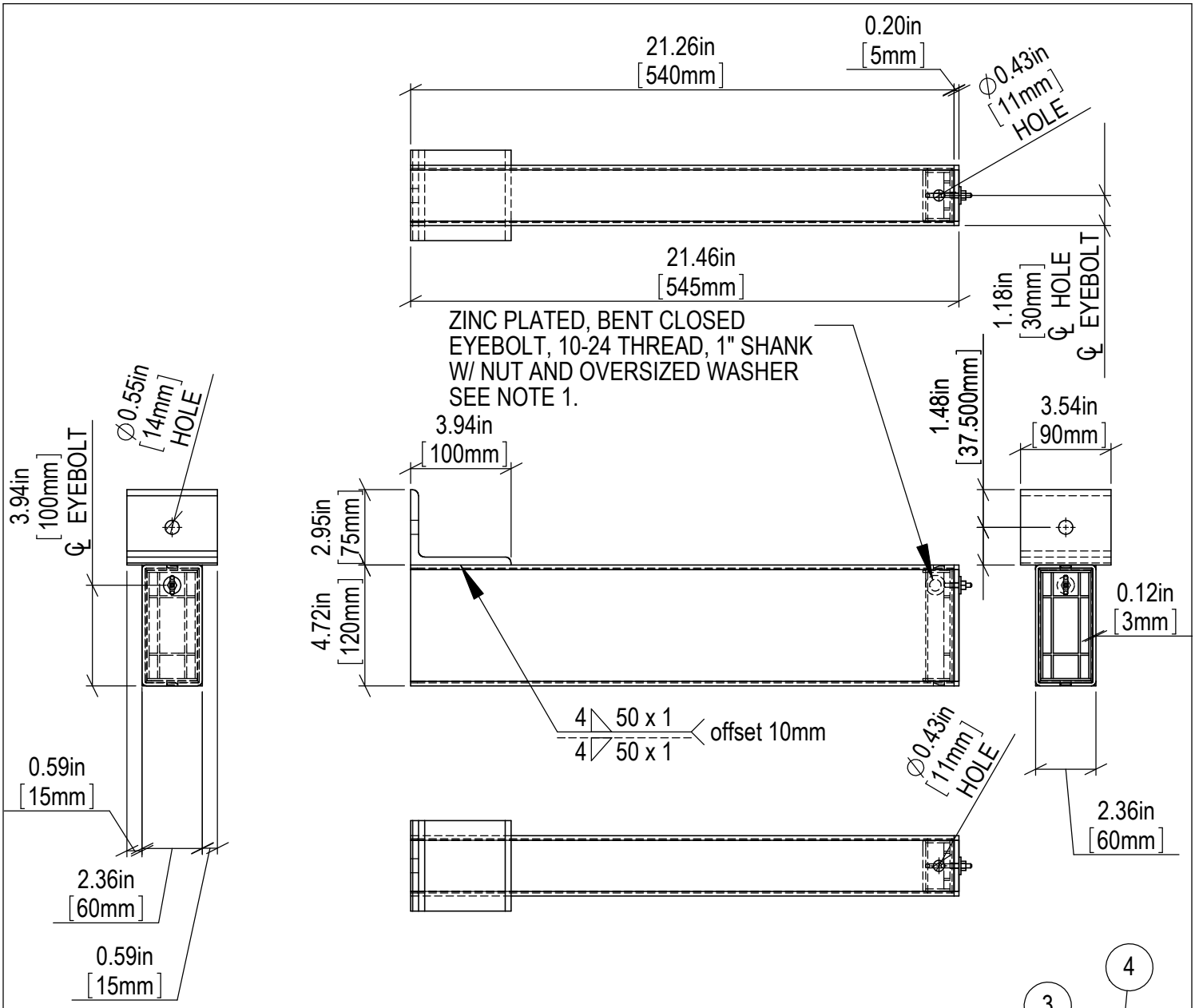
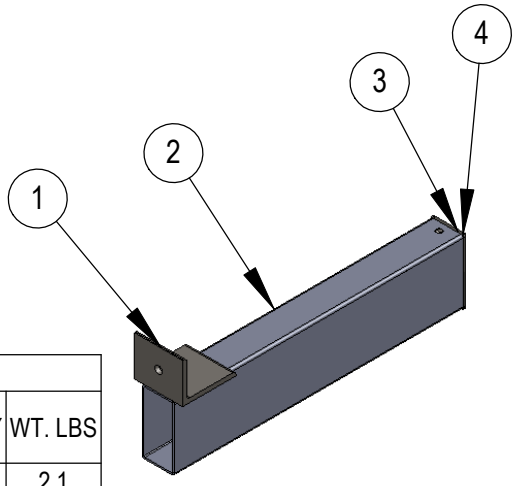
JVI DT SHOOTER

INNER TUBE

DATE	DRAWN	CHECKED	SCALE
09.07.2017	JVI	— — —	— — —





NOTES:
1. PLASTIC LID REQUIRES EYEBOLT, NUT AND WASHER FOR STRING ATTACHMENT

PART LIST					
ITEM	DESCRIPTION	MATERIAL	CUTTING LENGTH	QTY	WT. LBS
1	L 100X75X8 L=90	S355	90	1	2.1
2	TS 120X60X3 L=540	S355	540	1	9.6
3	PLASTIC TOP (SEE NOTE 1)			1	
4	EYEBOLT, 10-24 THREAD, 1" SHANK W/ NUT AND WASHER	ZINC PLATED STEEL		1	

TOTAL WEIGHT : 11.7 LBS

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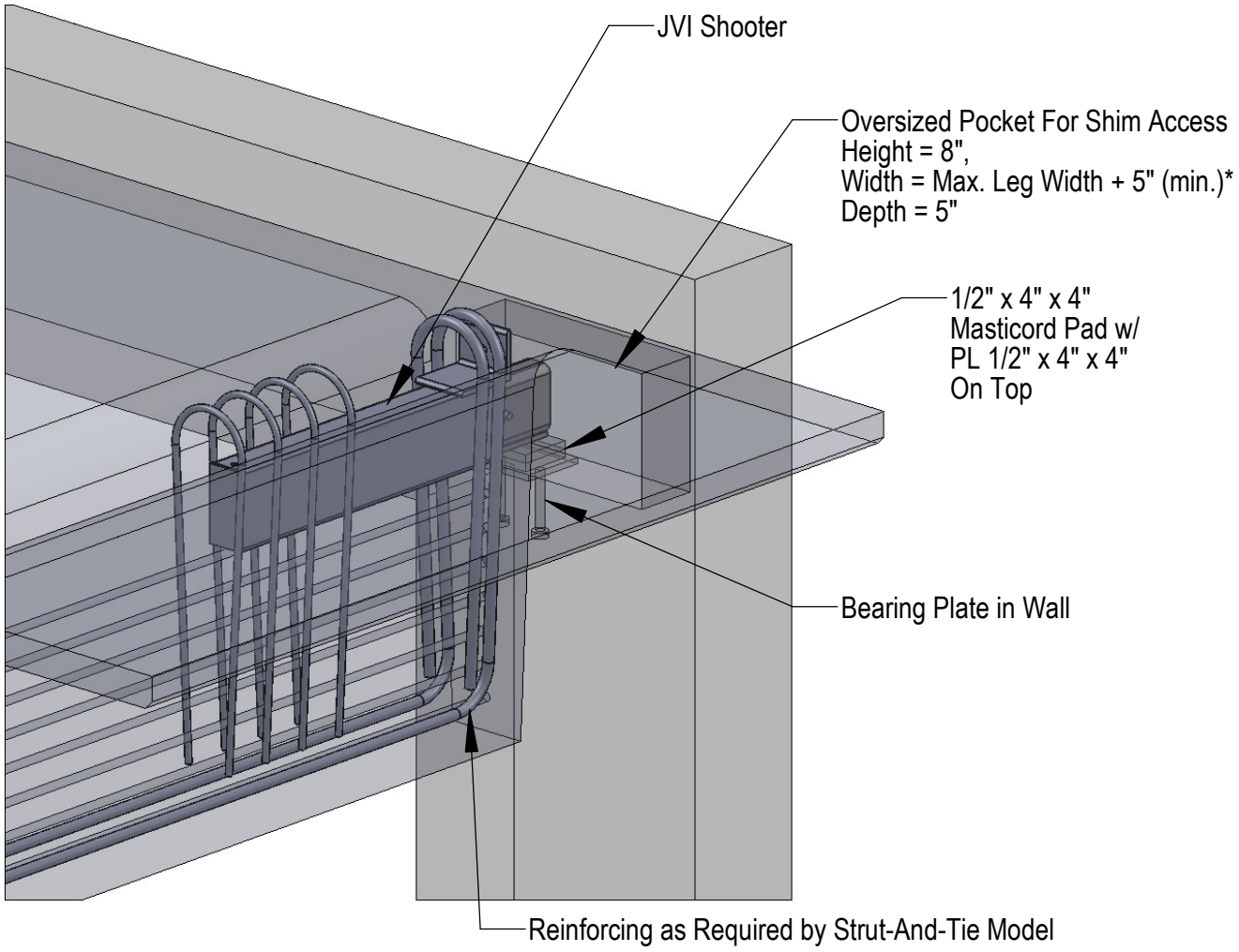
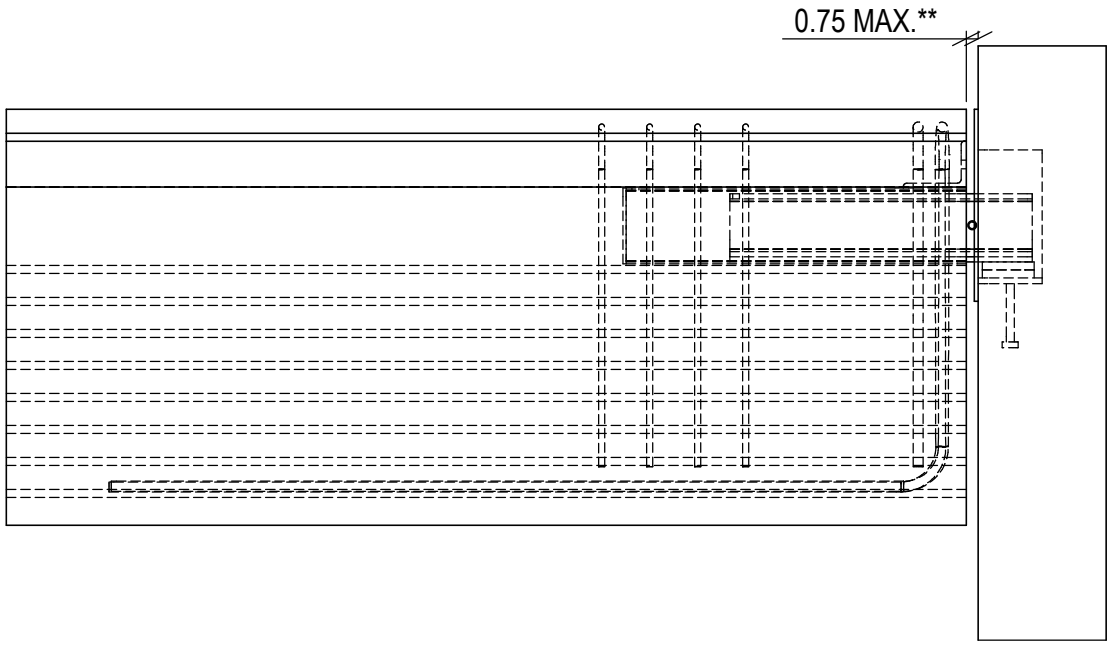
OUTER TUBE

DATE	DRAWN	CHECKED	SCALE
09.07.2017	JVI	— — —	— — —



* For a pocket with pin access on both sides of the DT leg, the pocket width should increase to Max. Leg Width + 10" min.



** To ensure adequate bearing length, the joint between the face of the double tee and the supporting vertical surface should be minimized as much a feasible for tolerances. 3/4" is a recommended maximum detailed joint size.

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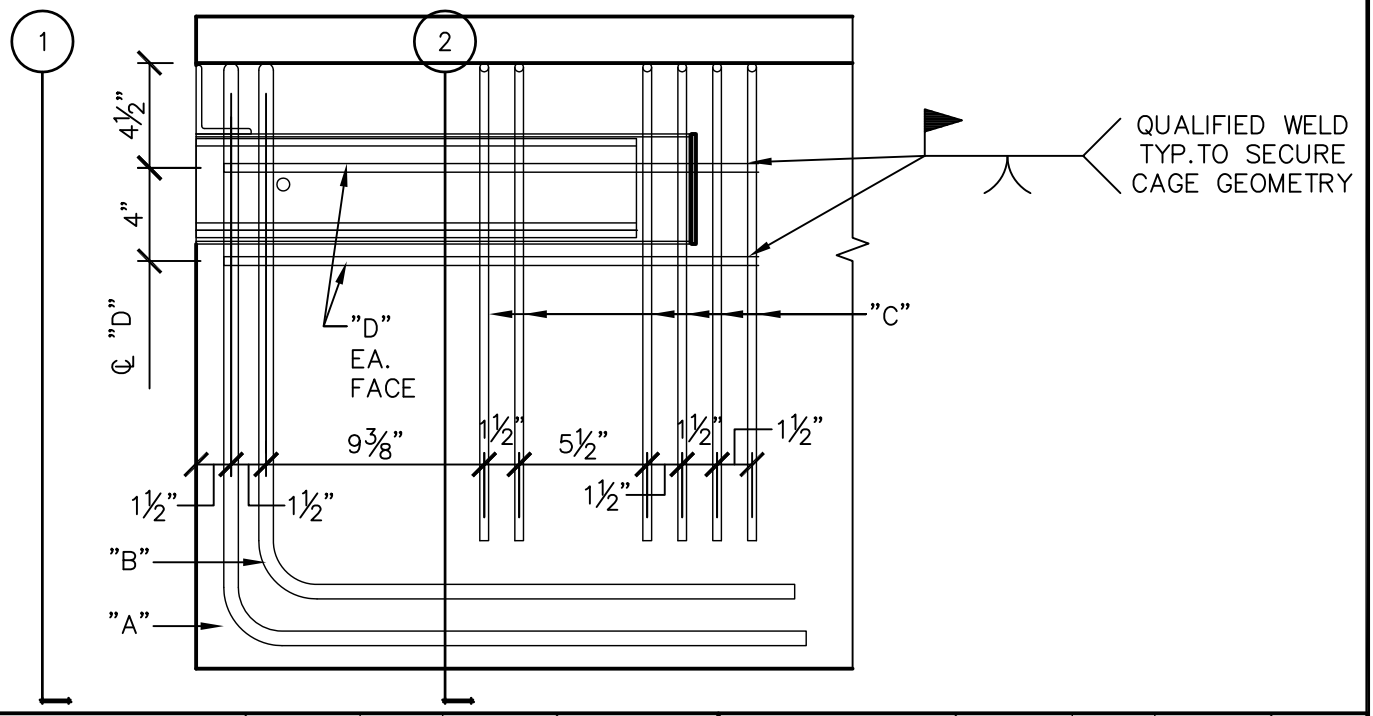
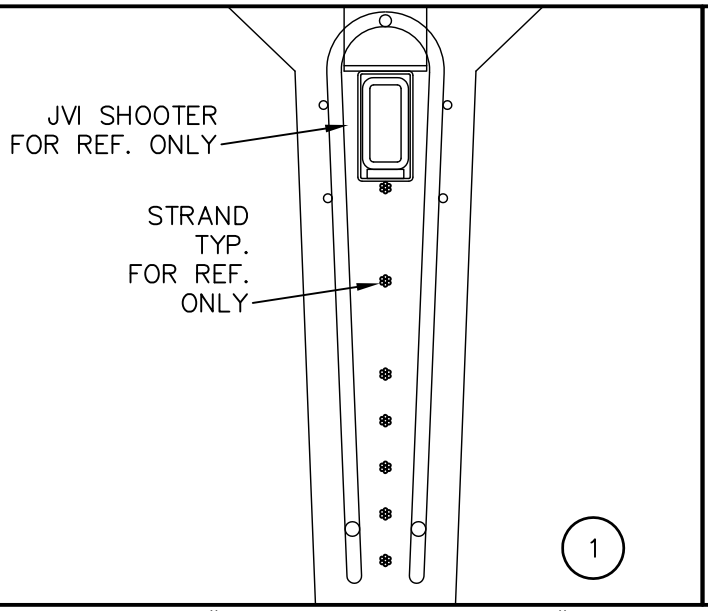
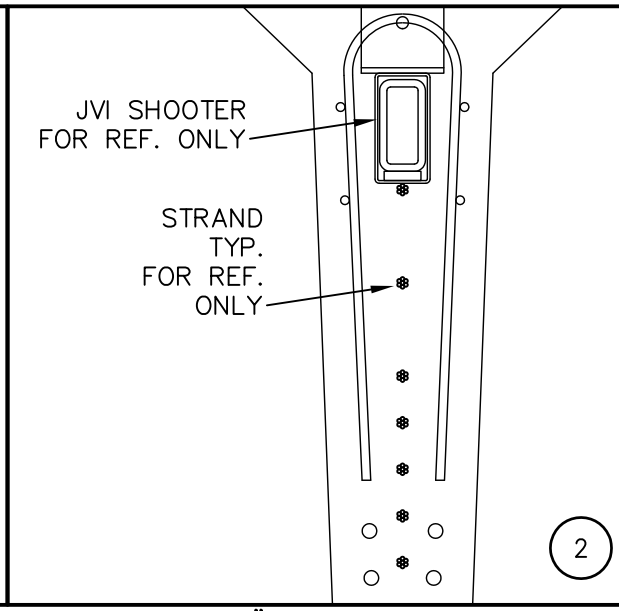
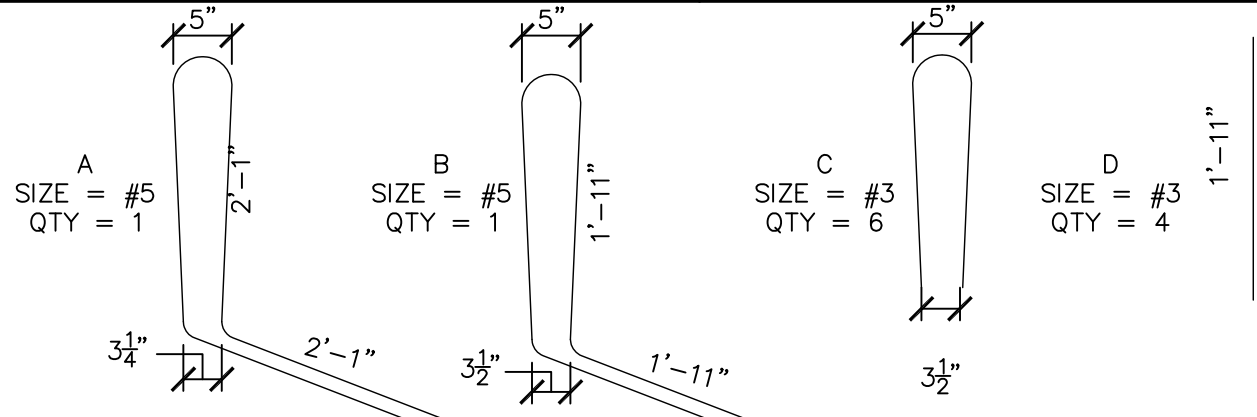
DOUBLE TEE BEARING ON WALL

DATE	DRAWN	CHECKED	SCALE
07.24.2014	JVI	__ __ __	N/A









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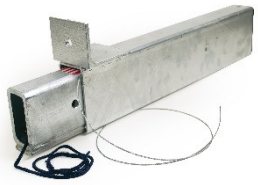
JVI SHOOTER REINFORCING

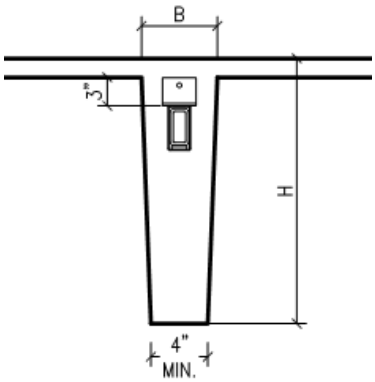
DT28 EXAMPLE SHOOTER REINFORCING

DATE	DRAWN	CHECKED	SCALE
07.24.2014	JVI		1½"=1'



Recommended Design Strengths based on Strut-An-Tie Model

Using the strut-and-tie model described above, assuming the simplified double tee geometry shown in figure 2.8, and assigning *d' =4in*, *S= H-d' -2.5in*, and *Strut Width Vertical = Strut Width Horizontal = 5.5in* the following recommendations for design strength are presented.



Values in table 2.1 should be considered estimates and not for construction values. For actual design strength of member, the correct geometry and concrete strengths should be applied by a qualified engineer. The table does not take into consideration of the required reinforcing at the tension struts and whether or not adequate room would be available within the concrete section.

Recommended Design Strength Based on f'_c = 5000 psi			
H (in)	**B (in)**	**ϕV_n (kip)**	**Controlling Factor**
24	6	24.25	Compression Stress at Resultant Concrete Strut @ Shooter (CFR) Eq. 2-29
	8	30.25	Compression Stress at Resultant Concrete Strut @ Node (CFR) Eq. 2-29*
	10	30.5	Compression Stress at Resultant Concrete Strut @ Node (CFR) Eq. 2-29
28	6	27.0	Compression Stress at Resultant Concrete Strut @ Shooter (CFR) Eq. 2-29
	8	33.0	Compression Stress at Resultant Concrete Strut @ Node (CFR) Eq. 2-29 *
	10	33.25	Compression Stress at Resultant Concrete Strut @ Node (CFR) Eq. 2-29*
32	6	29.0	Compression Stress at Resultant Concrete Strut @ Shooter (CFR) Eq. 2-29
	8	35.0	Compression Stress at Resultant Concrete Strut @ Node (CFR) Eq. 2-29*
	10	35.5	Compression Stress at Resultant Concrete Strut @ Node (CFR) Eq. 2-29*
Recommended Design Strength Based on f'_c = 6000 psi			
24	6	27.5	Vertical Shear Along Resultant Concrete Strut @ Shooter (CFR) Eq. 2.21
	8	36.25	Vertical Shear Along Resultant Concrete Strut @ Node (CFR) Eq. 2.21*
	10	40.0	Mechanical Design Strength of the Shooter
28	6	32.5	Compression Stress at Resultant Concrete Strut @ Shooter (CFR) Eq. 2-29
	8	39.75	Compression Stress at Resultant Concrete Strut @ Node (CFR) Eq. 2-29 *
	10	40.0	Mechanical Design Strength of the Shooter
32	6	35.0	Compression Stress at Resultant Concrete Strut @ Shooter (CFR) Eq. 2-29
	8	40.0	Mechanical Design Strength of the Shooter
	10	40.0	Mechanical Design Strength of the Shooter

* *Failure modes "@ Node" are governed by 4" minimum bottom of leg dimension. If the bottom of the leg is wider than the 4" additional capacity is available beyond that reported.*