

Steel Structure

Bolting and Welding Connection

ئاماده کردنی
ئهندازیاری شارستانی
کیا عباس صدیقی

ژماره‌ی پیناس: ۳۵ کاتی

Steel Structure

Bolting and Welding Connection

With more than two years of active presence in Kurdistan Regional Government and my complete proficiency with construction conditions of this region, it came to my attention that steel frames have the lowest (near to zero) share in planning and execution of projects.

With more than 15 years of experience, I realized that an article about steel frames and properties of their connections (according to my own experience) is sorely needed.

While total expense of steel frames is higher than concrete, its properties provide more advantages in comparison. Significant advances in designing and execution of steel frames and modern systems replacing traditional ones have prompted large projects to use steel frames according to the following considerations:

- Quicker implementation compared to concrete frame
- Lower structure weight due to fewer material
- Smaller scale elements and lower deposit area preferred by architecture engineers and mechanical and electrical installations
- More comprehensive monitoring of manufacture in workshop or factory by contractor's engineers and supervising body resulting in correction of defects and confirmation of quality before implementation
- Coordination between architecture and structure designers allows addition of new structures (for architectural change purposes) during implementation.
- Required flexibly against powerful earthquakes for maximum deformation and minimum demolition.

I hope this article can provide my colleagues insights about steel frame execution method so that in addition to obtaining the know-how they can utilize this technique as with advanced regions in the world.

This article provides important execution notes (with photos) about welding and bolting connections and then proceeds to provide personal experience of the author in comparison of these two types of connections.

Bolting



Structural Bolting



- During hoisting, connectors will install a minimum of two bolts per connection
- The rest of the bolts are installed and tightened after the structure is plumbed
- A systematic pattern must be followed when tightening bolts so that a joint is drawn together and all fasteners are properly installed

Bolt Types



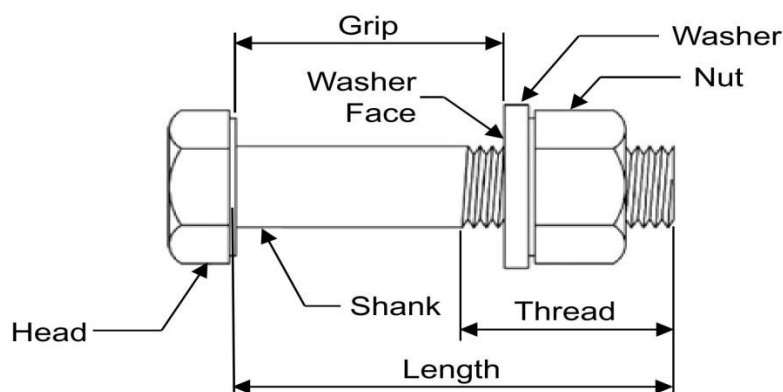
- A307 – Low carbon steel
 - Not commonly used
 - Only used for secondary members
- A325 – High-strength medium carbon steel (above left)
 - Most common bolts used in building construction
- A490 – High-strength heat treated steel (above right)
 - Cost more than A325's, but are stronger so fewer bolts may be necessary
- Note that the ASTM designation is indicated on the head of the bolts above

Washers



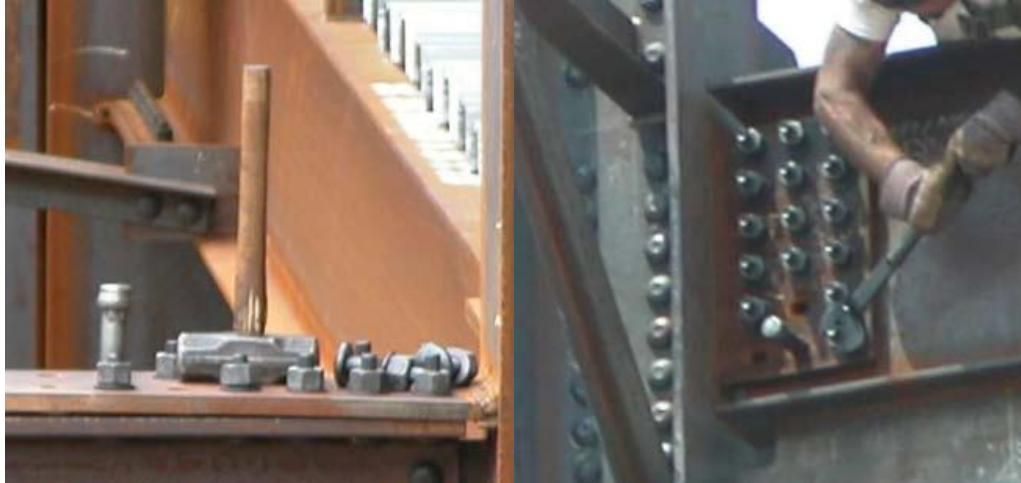
- Hardened steel washers are used in many structural connections to spread pressure from the bolt tightening process over a larger area
- Washers may also be used to cover an oversized or slotted hole
- Flat washers are most commonly used
- Tapered washers (above left) are used when the surface being bolted has a sloped surface, such as the flange of a channel or an S shape
- A325 bolts require a washer under the element (head or nut) being turned to tighten the bolt (shown under the nut, above right)
- A490 bolts require a washer under both the head and nut

Parts of the Bolt Assembly



- Grip is the distance from behind the bolt head to the back of the nut or washer
 - It is the sum of the thicknesses of all the parts being joined exclusive of washers
- Thread length is the threaded portion of the bolt
- Bolt length is the distance from behind the bolt head to the end of the bolt

Bolted Joint Types



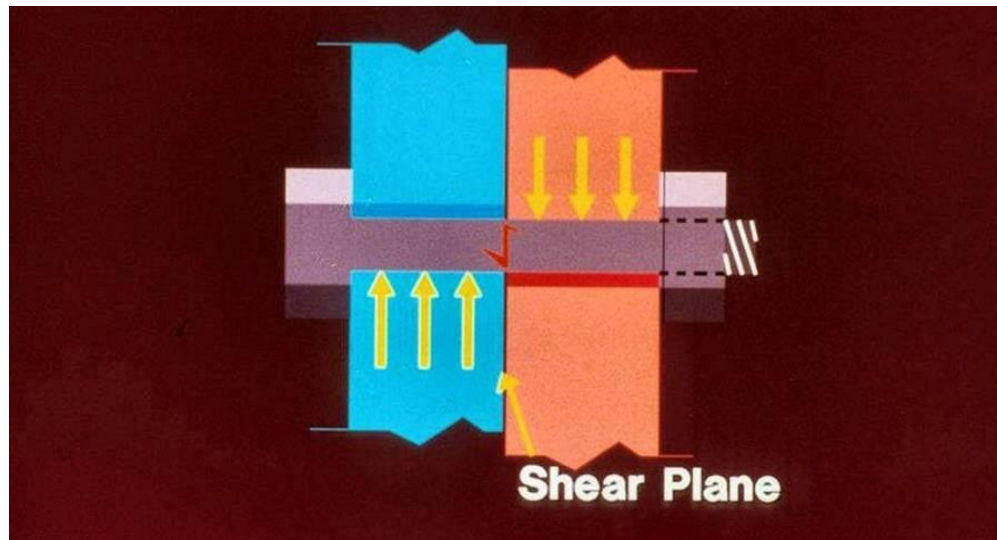
- There two basic bolted joint types:
 - Bearing
 - The load is transferred between members by bearing on the bolts
 - Slip-critical
 - The load is transferred between members by friction in the joint

Bolted Joint Failure Modes



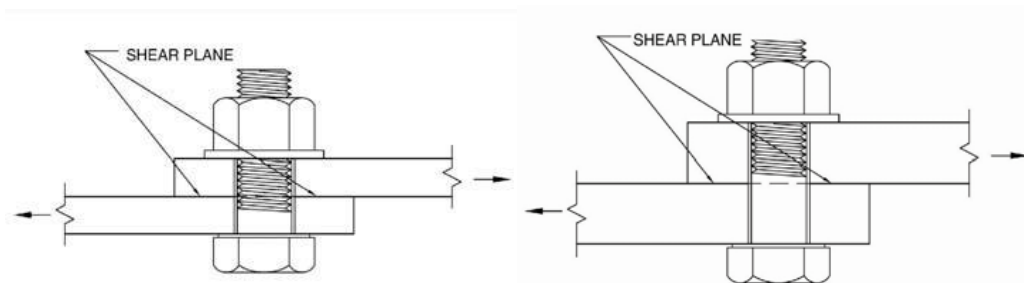
- Bolts in bearing joints are designed to meet two limit states:
 1. Yielding, which is an inelastic deformation (above left)
 2. Fracture, which is a failure of the joint (above left)
- The material the bolt bears against is also subject to yielding or fracture if it is undersized for the load (above right)
- Tension connections act similarly to bearing connections
 - Many times, connections in direct tension are reconfigured so that the bolts act in shear

Bearing Joints



- In a bearing joint the connected elements are assumed to slip into bearing against the body of the bolt
- If the joint is designed as a bearing joint the load is transferred through bearing whether the bolt is installed snug-tight or pretensioned

Threads in the Shear Plane

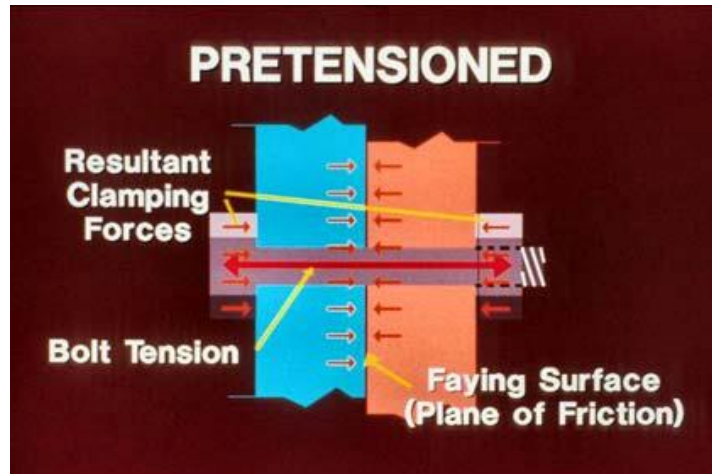


Threads Included In The Shear Plane

Threads Excluded From The Shear Plane

- The shear plane is the plane between two or more pieces under load where the pieces tend to move parallel from each other, but in opposite directions
- The threads of a bolt may either be included in the shear plane or excluded from the shear plane
- The capacity of a bolt is greater with the threads excluded from the shear plane
- The most commonly used bolt is an A325 3/4" bolt with the threads included in the shear plane

Slip-Critical Joints



- In a slip-critical joint the bolts must be fully pretensioned to cause a clamping force between the connected elements
- This force develops frictional resistance between the connected elements
- The frictional resistance allows the joint to withstand loading without slipping into bearing against the body of the bolt, although the bolts must still be designed for bearing
- The faying surfaces in slip-critical joints require special preparation

When to Use Slip-Critical Joints



Slip-critical joints are only required in the following applications involving shear or combined shear and tension:

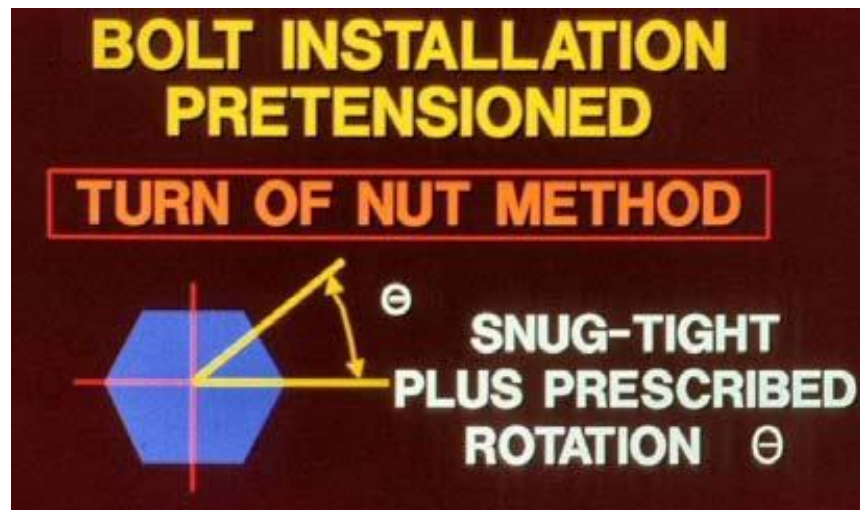
1. Joints that are subject to fatigue load with reversal of the loading direction (not applicable to wind bracing)
2. Joints that utilize oversized holes
3. Joints that utilize slotted holes, except those with applied load approximately perpendicular to the direction of the long dimension of the slot
4. Joints in which slip at the faying surfaces would be detrimental to the performance of the structure

Snug-tight Installation



Snug-tight is the tightness attained with a few hits of an impact wrench or the full effort of an ironworker using an ordinary spud wrench to bring the connected plies into firm contact

Turn-of-Nut Installatio



- Installation beyond snug-tight is called pretensioning
- Turn-of-nut pretensioning involves several steps:
 1. The bolt is snug-tightened
 2. Matchmarks are placed on each nut, bolt, and steel surface in a straight line
 3. The part not turned by the wrench is prevented from turning
 4. The bolt is tightened with a prescribed rotation past the snug-tight condition
- The specified rotation varies by diameter and length (between 1/3 and 1 turn)

Introduction of Fasteners

- When high-strength bolts are to be tensioned, minimum limits are set on the bolt tension. See Table J3.1
- Tension equal to **70% of the minimum tensile strength** of the bolt
- Purpose of tensioning is to achieve the clamping force between connected parts.

Bolt Size, in.	A325 Bolts	A490 Bolts
½	12	15
¾	19	24
¾	28	35
¾	39	49
1	51	64
1½	56	80
1¾	71	102
1¾	85	121
1¾	103	148

*Equal to 0.70 of minimum tensile strength of bolts, rounded off to nearest kip, as specified in ASTM specifications for A325 and A490 bolts with UNC threads.

Calibrated Wrench Installation



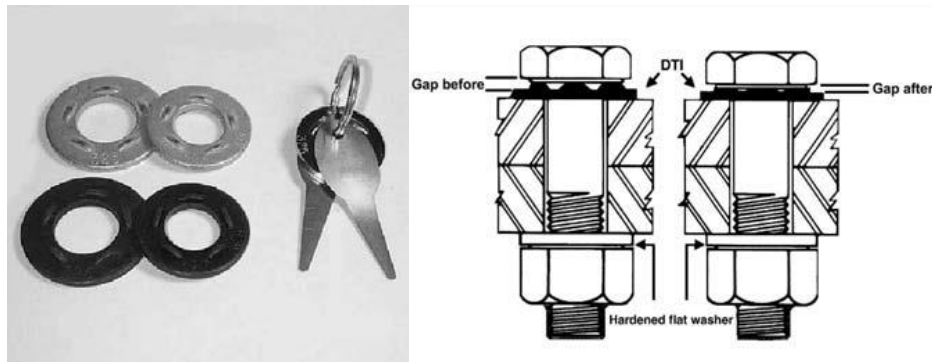
- Calibrated Wrench pretensioning uses an impact wrench (above left) to tighten the bolt to a specified tension
- A Skidmore-Wilhelm calibration device (above right) is used to calibrate the impact wrench to the torque level which will achieve the specified tension
- A sample of bolts representative of those to be used in the connections are tested to verify that the correct tension will be achieved

F1852 Installation



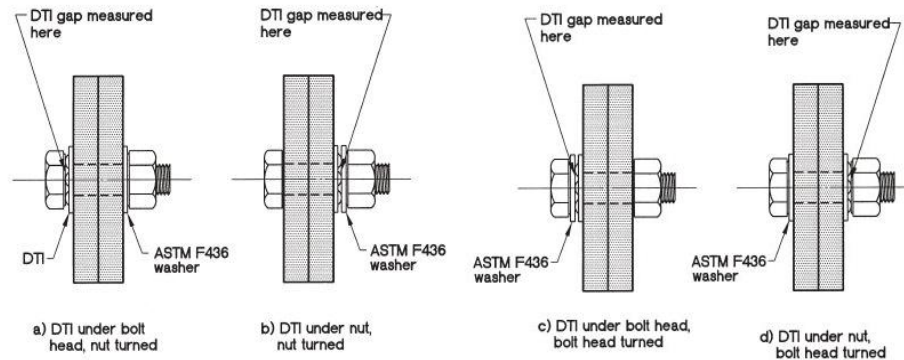
- F1852 bolts are twist-off-type tension-control bolts
- These bolts must be pretensioned with a twist-off-type tension-control bolt installation wrench that has two coaxial chucks
- The inner chuck engages the splined end of the bolt
- The outer chuck engages the nut
- The two chucks turn opposite to one another to tighten the bolt
- The splined end of the F1852 bolt shears off at a specified tension

F959 Direct Tension Indicators



- Another way to try to ensure proper pretensioning of a bolt is through the use of direct tension indicators (DTIs)
- These washers have protrusions that must bear against the unturned element
- As the bolt is tightened the clamping force flattens the protrusions and reduces the gap
- The gap is measured with a feeler gage
- When the gap reaches the specified size the bolt is properly pretensioned

Installation of DTIs



(Adapted from Figure C-8.1 RCSC 2000)

It is essential that direct tension indicators be properly oriented in the assembly

- The bolt head is stationary while the nut is turned – DTI under bolt head
- The bolt head is stationary while the nut is turned – DTI under nut (washer required)
- The nut is stationary while the bolt head is turned – DTI under bolt head (washer required)
- The nut is stationary while the bolt head is turned – DTI under nut

Nominal Bolt Hole Dimensions

Nominal Bolt Diameter, d_b in.	Nominal Bolt Hole Dimensions ^{a,b} , in.			
	Standard (diameter)	Oversized (diameter)	Short-slotted (width × length)	Long-slotted (width × length)
$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{9}{16} \times \frac{11}{16}$	$\frac{9}{16} \times 1\frac{1}{4}$
$\frac{5}{8}$	$\frac{11}{16}$	$\frac{13}{16}$	$\frac{11}{16} \times \frac{7}{8}$	$\frac{11}{16} \times 1\frac{9}{16}$
$\frac{3}{4}$	$\frac{13}{16}$	$\frac{15}{16}$	$\frac{13}{16} \times 1$	$\frac{13}{16} \times 1\frac{7}{8}$
$\frac{7}{8}$	$\frac{15}{16}$	$1\frac{1}{16}$	$\frac{15}{16} \times 1\frac{1}{8}$	$\frac{15}{16} \times 2\frac{3}{16}$
1	$1\frac{1}{16}$	$1\frac{1}{4}$	$1\frac{1}{16} \times 1\frac{5}{16}$	$1\frac{1}{16} \times 2\frac{1}{2}$
$\geq 1\frac{1}{8}$	$d_b + \frac{1}{16}$	$d_b + \frac{5}{16}$	$(d_b + \frac{1}{16}) \times (d_b + \frac{3}{8})$	$(d_b + \frac{1}{16}) \times (2.5d_b)$

^a The upper tolerance on the tabulated nominal dimensions shall not exceed $\frac{1}{32}$ -in. Exception: In the width of slotted holes, gouges not more than $\frac{1}{16}$ -in. deep are permitted.

^b The slightly conical hole that naturally results from punching operations with properly matched punches and dies is acceptable.

(Table 3.1 RCSC 2000)

- Bolts are installed in one of four types of holes (see table above)
- Standard holes can be used anywhere
- Oversized holes may only be used in slip-critical connections
- Short-slotted holes are used with the slot perpendicular to the direction of stress
- Long-slotted holes are primarily used when connecting to existing structures

Inspections for the Construction Manager



There are several bolted connection inspections a construction manager can perform:

- Look at the bolt stick-out (above)
 - Stick-out is the amount the bolt extends beyond the outside surface of the nut
 - Positive or zero stick-out is acceptable
 - Negative stick-out, where the end of the bolt is inside the nut, is not acceptable

Inspections for the Construction Manager



- Inspect the turn-of-nut matchmarks to ensure the bolts have been pretensioned
- If F1852 bolts are used, make sure the ends have been snapped off all bolts (above)
 - In some cases, due to insufficient clearance for the installation wrench, F1852 bolts will be tightened by alternative methods so the ends will not be snapped off

Bolting Cost Considerations



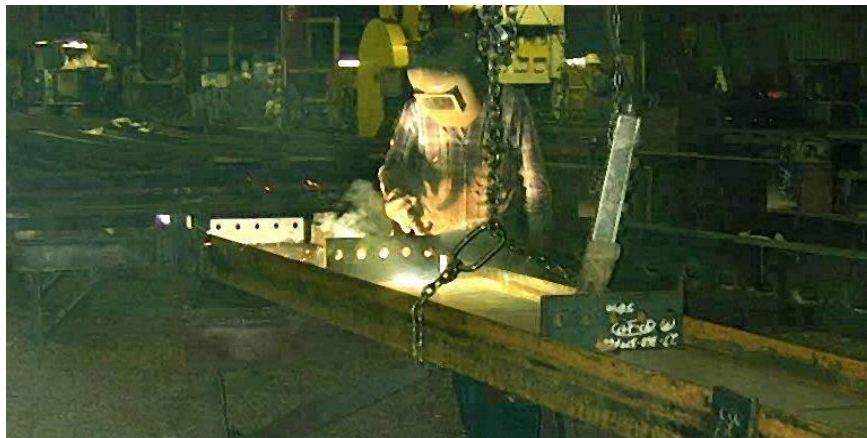
The types of joints used in a structure are somewhat dependent on the overall design of the structure, but these are some points to consider:

- The erector may prefer certain bolt and joint types over others due to equipment requirements, experience, and installation times
- Snug-tightened joints are normally the most economical bolted joints
- For pretensioned joints, F1852's and DTI's are popular and can be economical
- Slip-critical joints are the most costly joints, and should only be specified when necessary

Welding



Structural Welding



- Another common method for connecting structural steel is welding
- Welding can be performed in the shop or in the field
- Many fabrication shops prefer to weld rather than bolt
- Welding in the field is avoided if possible due to welding condition requirements
- There are several welding processes, types, and positions to be considered in building construction



- Welding is the process of fusing multiple pieces of metal together by heating the filler metal to a liquid state
- A properly welded joint is stronger than the base metal

Strength of Structural Welds

Available Strength of Welded Joints

Load Type and Direction Relative to Weld Axis	Pertinent Metal	Φ and Ω	Nominal Strength (F_{bm} or F_w)	Effective Area (A_{BM} or A_W)	Required <i>Filler metal</i> Strength Level ^{(a)(b)}
COMPLETE-JOINT-PENETRATION GROOVE WELDS					
Tension Normal to weld axis	Strength of the joint is controlled by the base metal			Matching <i>filler metal</i> shall be used. For T and corner <i>joints</i> with backing left in place, notch tough <i>filler metal</i> is required. See Section J2.6	
Compression Normal to weld axis	Strength of the joint is controlled by the base metal			<i>Filler metal</i> with a strength level equal to or one strength level less than matching <i>filler metal</i> is permitted.	
Tension or Compression Parallel to weld axis	Tension or compression in parts joined parallel to a weld need not be considered in design of welds joining the parts.			<i>Filler metal</i> with a strength level equal to or less than matching <i>filler metal</i> is permitted	
Shear	Strength of the joint is controlled by the base metal			Matching <i>filler metal</i> shall be used. ^(c)	

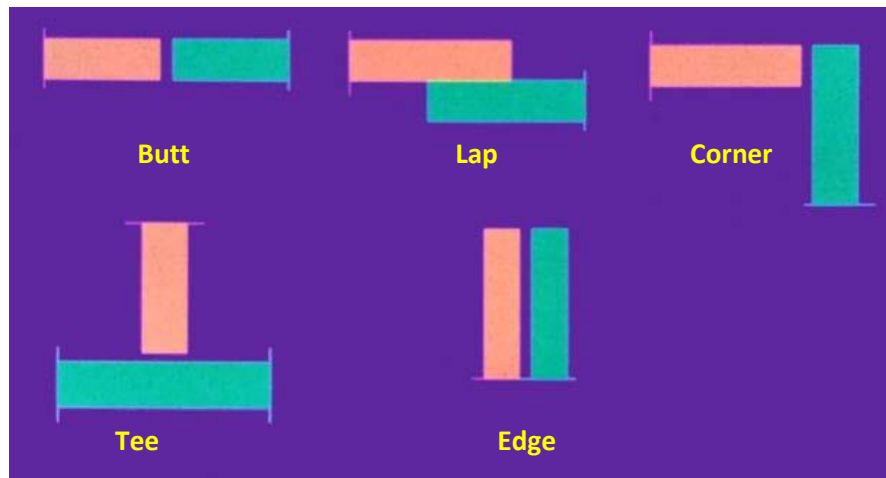
(Part of Table J2.5)

- Welds may be loaded in shear, tension, compression, or a combination of these
- Capacities for welds are given in the AISC Specification Section J2
- The strength of a weld is dependent on multiple factors, including: base metal, filler metal, type of weld, throat and weld size

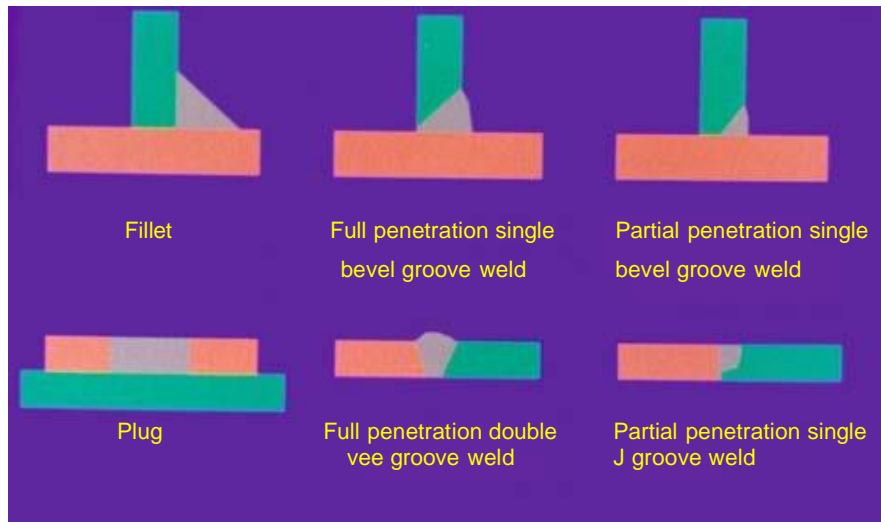
Welding Terminology



- Tack Weld (above left)
 - A temporary weld used to hold parts in place while more extensive, final welds are made
- Continuous Weld
 - A weld which extends continuously from one end of a joint to the other
- Stitch Weld (above right)
 - A series of welds of a specified length that are spaced a specified distance from each other

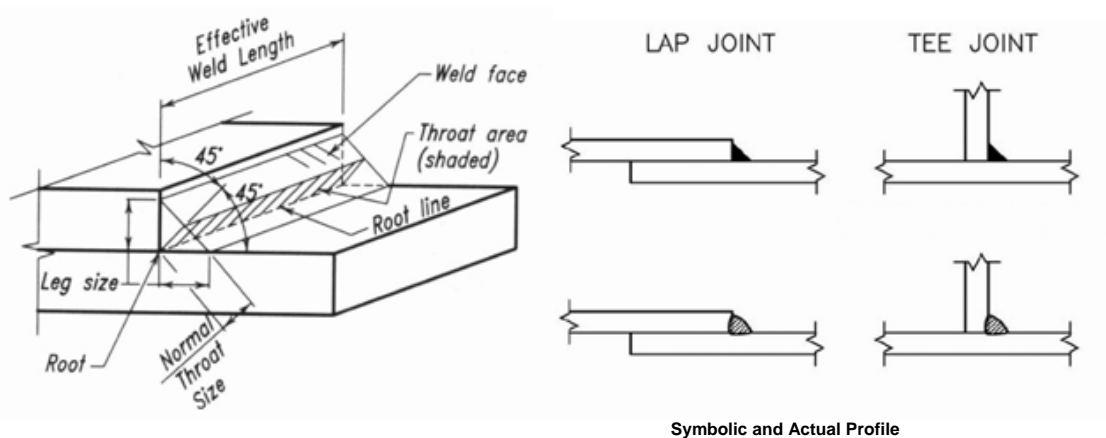


- Shown above are types of structural joints which are established by positions of the connected material relative to one another
 - Lap, tee, and butt joints are most common



- Weld types define the configuration of the weld and its underlying design approach
- Fillet welds and groove welds are most common
- Groove welds fall into two categories
 - Full penetration – the entire member cross-section is welded
 - Partial penetration – just part of the member cross-section is welded

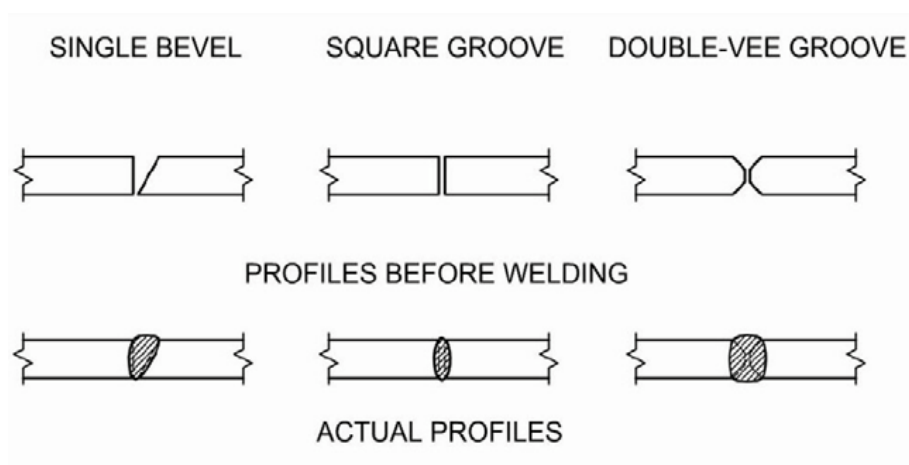
Fillet Welds



Symbolic and Actual Profile

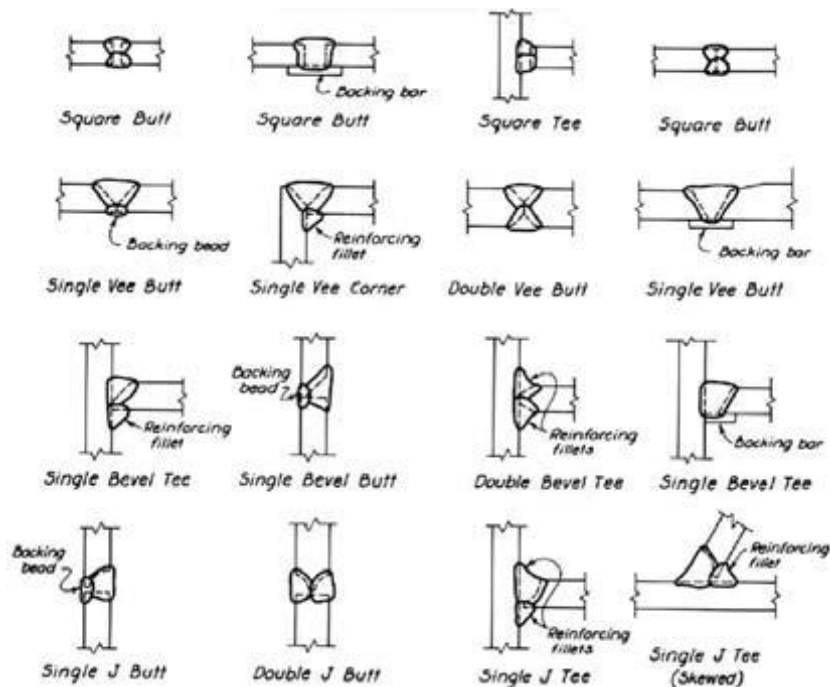
- The most commonly used weld is the fillet weld
- Fillet welds are theoretically triangular in cross-section
- Fillet welds join two surfaces at approximately right angles to each other in lap, tee, and corner joints

Groove Welds



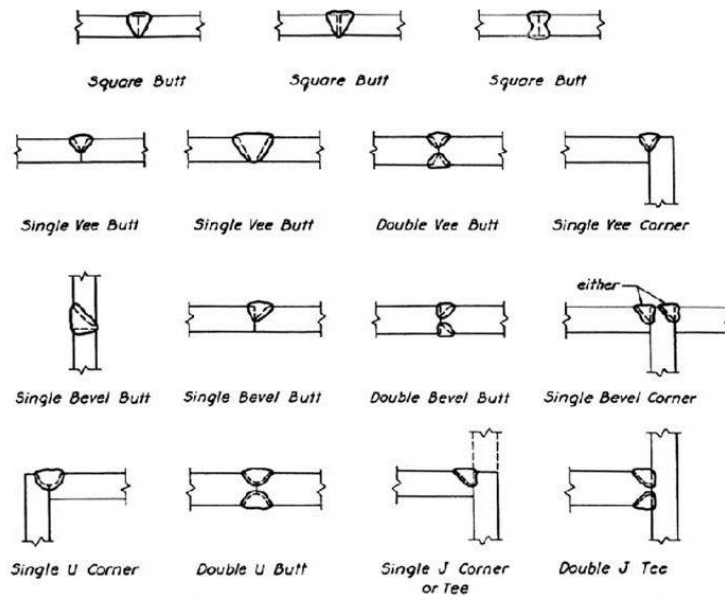
- Groove welds are specified when a fillet weld is not appropriate for the job
 - The configuration of the pieces may not permit fillet welding
 - A strength greater than that provided by a fillet weld is required
- Groove welds are made in the space or groove between the two pieces being welded

Full Penetration Groove Welds



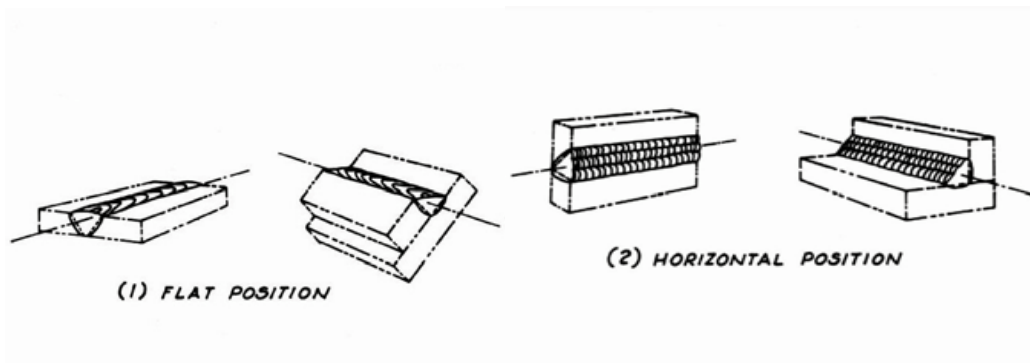
- The bevel or "J" preparation extends over most of or the entire face of the material being joined
- Complete fusion takes place
- In some types of full penetration groove welds the material will be beveled from one side of the plate with a separate plate on the opposite side – called backing or a backing bar

Partial Penetration Groove Welds



Partial joint penetration welds are used when it is not necessary for the strength of the joint to develop the full cross section of the members being joined

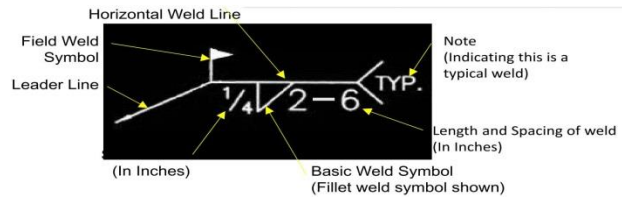
Welding Positions



- There are four recognized welding positions:
 - Flat – The face of the weld is approximately horizontal and welding is performed from above the joint
 - Horizontal – The axis of the weld is horizontal
 - Vertical – The axis is approximately vertical or in the upright position
 - Overhead – Welding is performed from below the joint
- The flat position is preferred because it is easier and more efficient to weld in this position.

Weld Symbol

Basic Weld Symbols									
Back	Fillet	Plug or Slot	Groove or Butt						
			Square	V	Bevel	U	J	Flare V	Flare Bevel
Supplementary Weld Symbols									
Backing	Spacer	Weld All Around	Field Weld	Contour		For other basic and supplementary weld symbols, see AWS A2.4			
				Flush	Convex				



38

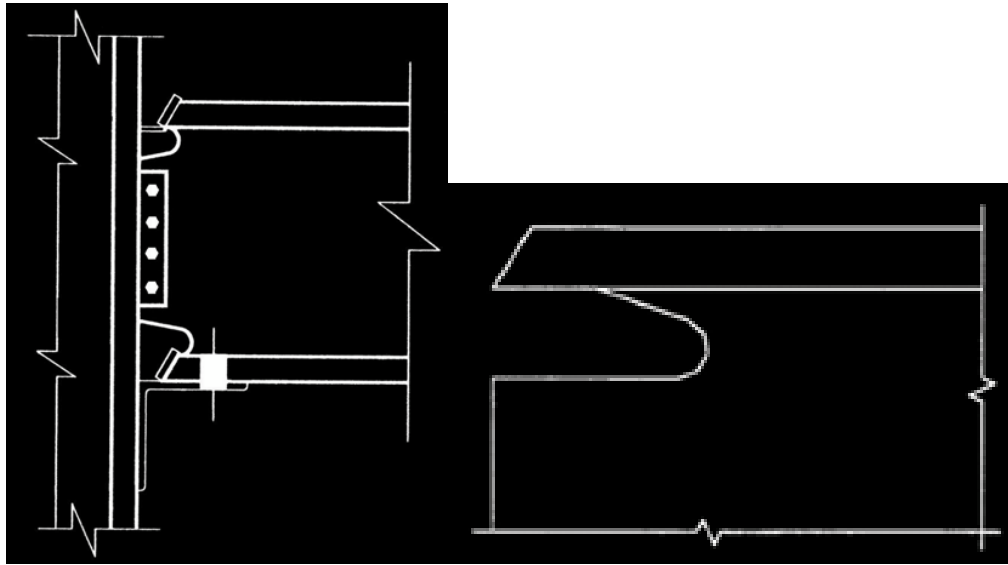
- Weld symbols are used to communicate the specific details and requirements of each weld to the welder
- Weld symbols are included on fabrication and erection drawings

Weld Size



- The size of a weld must match the size specified on the drawings
- Some welds may meet the required size after a single pass of the welder
- Larger weld sizes may require multiple passes to meet the size requirement
- Common single pass welds include fillet welds up to and including 5/16 inch and thin plate butt welds with no preparation
- Common multiple pass welds include single bevel full penetration groove welds, single bevel partial penetration groove welds, and fillet welds over 5/16 inch
- The weld in the above picture is a multiple pass fillet weld

Weld Accessibility



Adapted from AISC 2001

Adapted from AISC 2002a

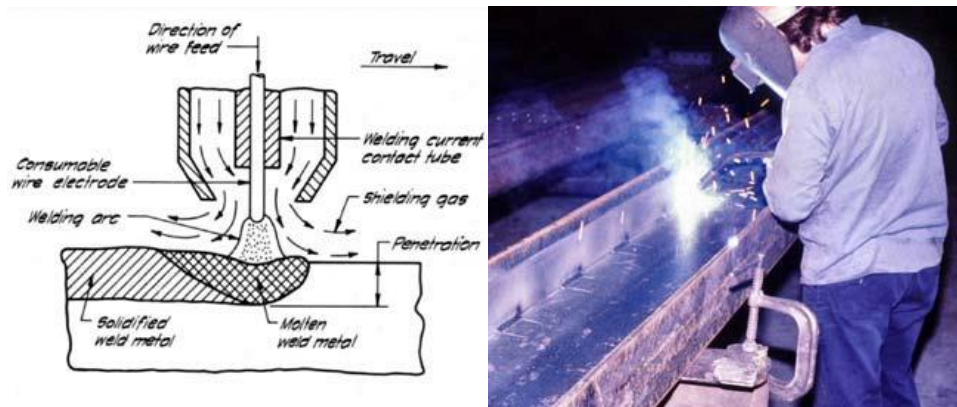
- Access holes are required for some welds, such as the welded flange connection shown to the right
 - The top access hole allows for a continuous backing bar to be placed under the top flange
 - The bottom access hole allows for complete access to weld the entire width of the bottom flange
- A detail of a weld access hole for a welded flange connection is shown below

SMAW Welding



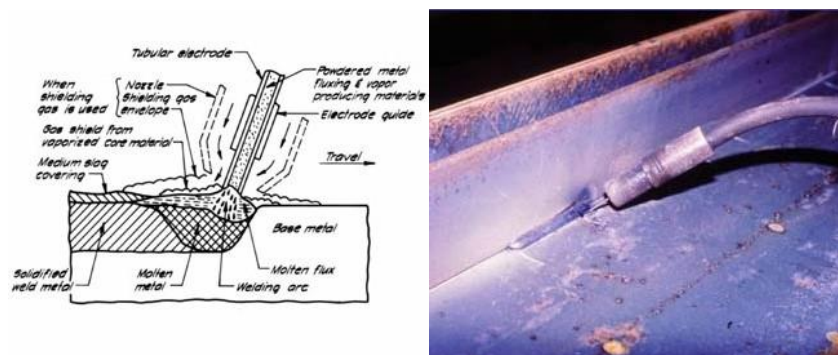
- Shielded Metal Arc Welding (SMAW) is also known as manual, stick, or hand welding
- An electric arc is produced between the end of a coated metal electrode and the steel components to be welded
- The electrode is a filler metal covered with a coating
- The electrode's coating has two purposes:
 - It forms a gas shield to prevent impurities in the atmosphere from getting into the weld
 - It contains a flux that purifies the molten metal

GMAW Welding



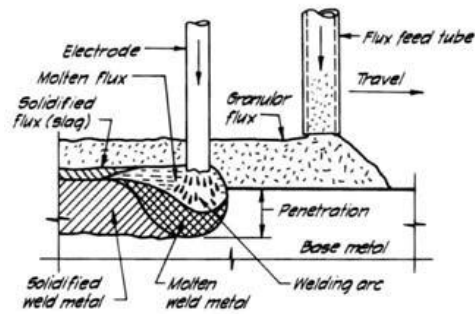
- Gas Metal Arc Welding (GMAW) is also known as MIG welding
- It is fast and economical
- A continuous wire is fed into the welding gun
- The wire melts and combines with the base metal to form the weld
- The molten metal is protected from the atmosphere by a gas shield which is fed through a conduit to the tip of the welding gun
- This process may be automated

FCAW Welding



- Flux Cored Arc Welding (FCAW) is similar to the GMAW process
- The difference is that the filler wire has a center core which contains flux
- With this process it is possible to weld with or without a shielding gas
 - This makes it useful for exposed conditions where a shielding gas may be affected by the wind

SAW Welding



- Submerged Arc Welding (SAW) is only performed by automatic or semiautomatic methods
- Uses a continuously fed filler metal electrode
- The weld pool is protected from the surrounding atmosphere by a blanket of granular flux fed at the welding gun
- Results in a deeper weld penetration than the other process
 - Only flat or horizontal positions may be used

Weld Inspections



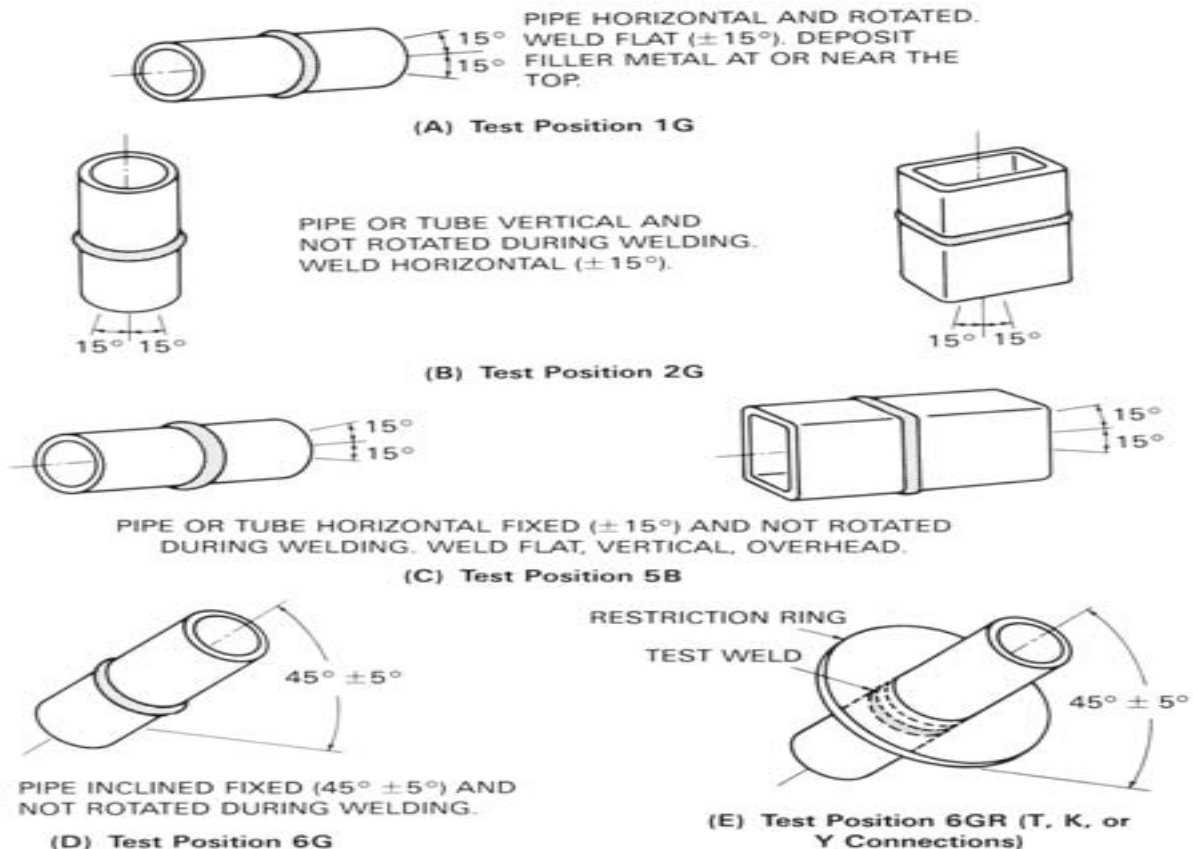
- In addition to the erector's quality control program, tests and inspections are specified by the Engineer of Record and/or the local building authority
- A local building inspector may request that tests in addition to those specified by the Engineer of Record be performed
- Some problems that can be found in welds include:
 - Lack of fusion
 - Cracks
 - Wrong size
 - Porosity
 - Insufficient penetration
 - Poor workmanship

Visual Inspection



- Visual inspection is the most frequently used inspection and is the only inspection required unless the specification calls for a more stringent inspection method
- Inspection is done by the welder before, during, and after welding
- When outside inspection is required it should also be done before, during, and after welding
- Minor problems can be identified and corrected before the weld is complete

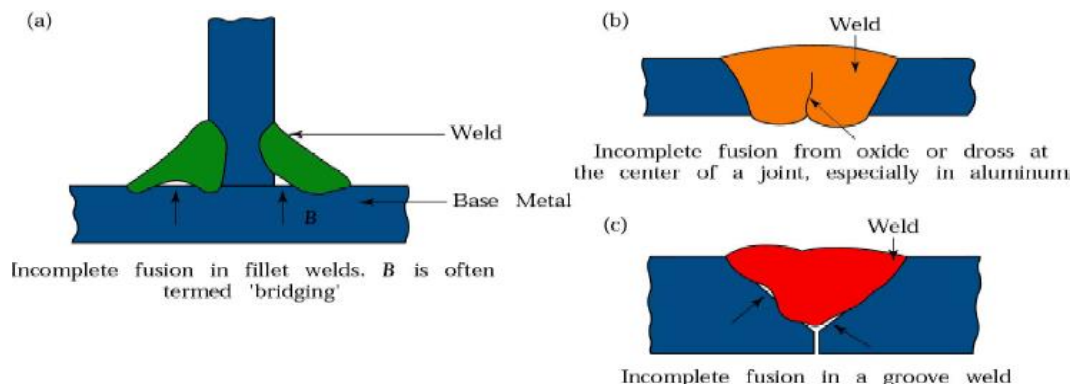
Welding of Tubular Structures



Weld Quality

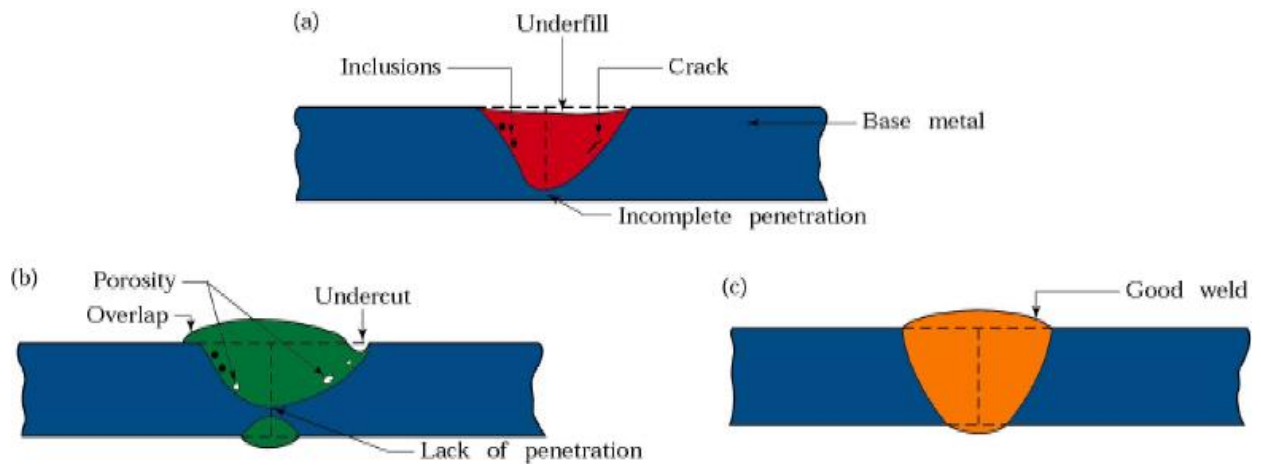
- **Welding discontinuities can be caused by inadequate or careless application**
- **The major discontinuities that affect weld quality are**
 - Porosity
 - Slag Inclusions
 - Incomplete fusion and penetration
 - Weld profile
 - Cracks
 - Lamellar tears
 - Surface damage
 - Residual stresses

Penetration



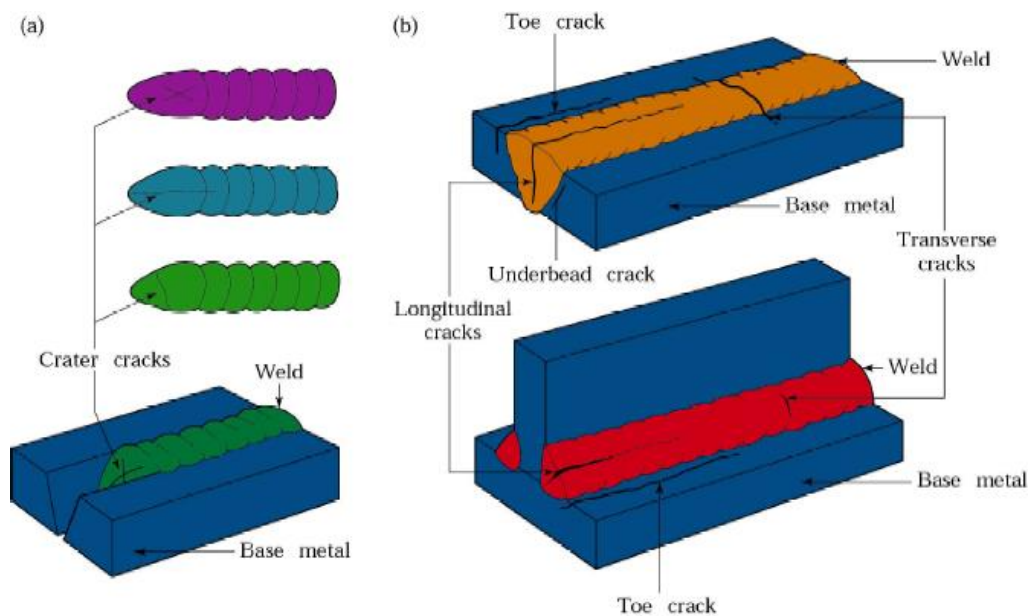
- **Incomplete penetration** occurs when the depth of the welded joint is insufficient
- **Penetration can be improved by the following practices :**
 - **Increasing the heat input**
 - **Reducing the travel speed during the welding**
 - **Changing the joint design**
 - **Ensuring the surfaces to be joined fit properly**

Discontinuities in Fusion Welds



Schematic illustration of various discontinuities in fusion welds

Cracks

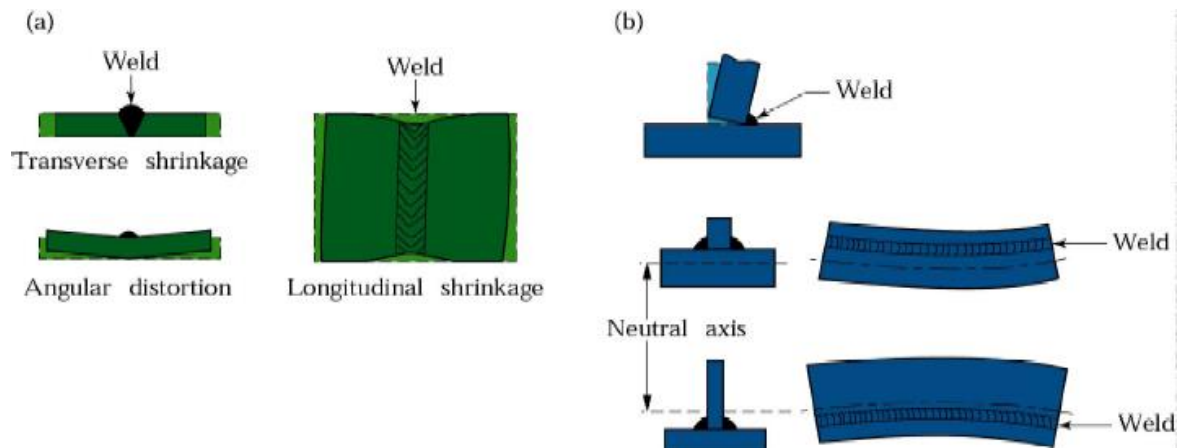


Types of cracks (in welded joints) caused by thermal stresses that develop during solidification and contraction of the weld bead and the surrounding structure.

(a) Crater cracks

(b) Various types of cracks in butt and T joints

Distortion after Welding

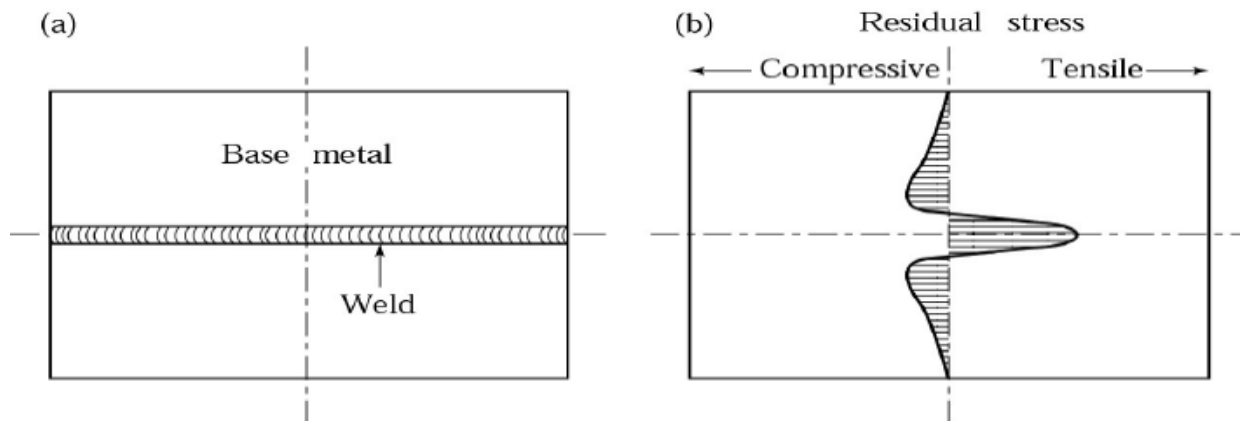


Distortion of parts after welding :

- (a) butt joints;
- (b) fillet welds.

Distortion is caused by differential thermal expansion and contraction of different parts of the welded assembly

Residual Stresses developed during welding



Residual stresses developed during welding of a butt joint

Stress relieving of welds :

- Preheating reduces reduces problems caused by preheating the base metal or the parts to be welded
- Heating can be done electrically, in furnace, for thin surfaces radiant lamp or hot air blast
- Some other methods of stress relieving : Peening, hammering or surface rolling

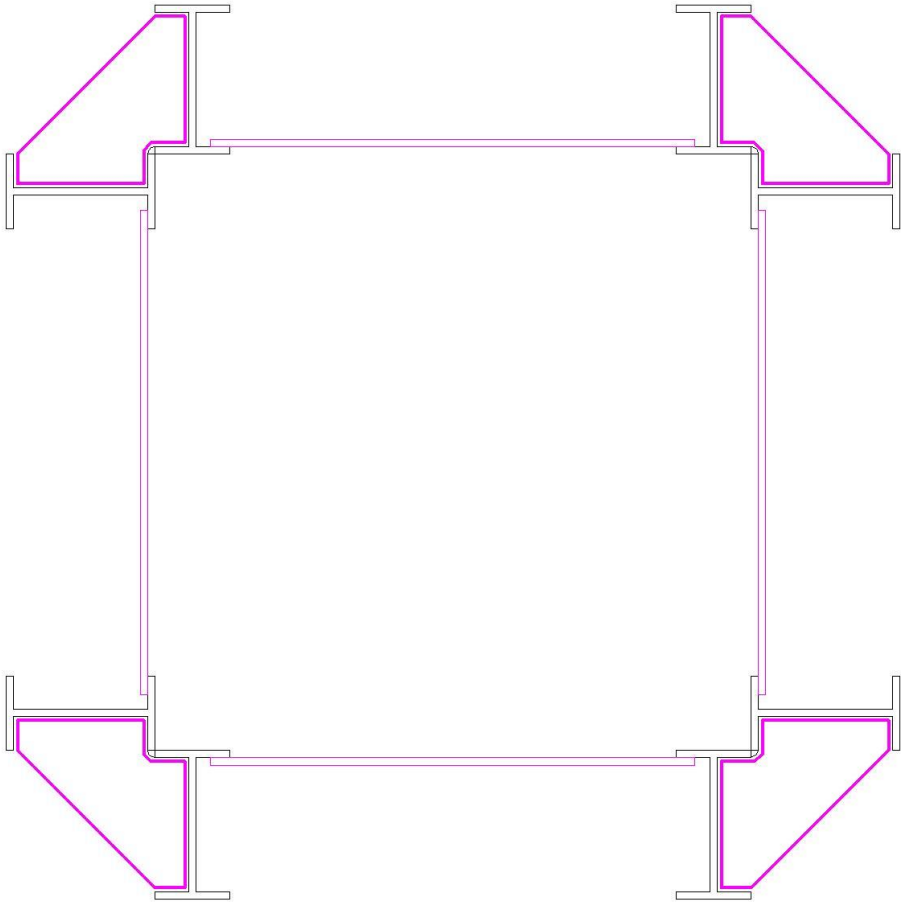
During my 13 years of civil engineering activity in Iran as a member of Iran Ramp Company, I've been involved in projects executed by concrete and steel frames methods (or a combination of both) in industrial projects. I provide a brief description of two steel frame projects I've worked on early in my career and a more detailed description of two other projects and two special frame in my recent years in Iran (with shopdrawing and picture):

1) Karaj Permanent Agriculture Machinery Exhibition



This project was designed with single foundation in four concentric circles with specific segments in columns and beams and profile rolling and was considered a special steel structure. Unfortunately this project was scrapped in middle of execution due to lack of budget from the employer.

Columns Section:



2) Shiraz Mabas Residential Complex



A project with steel frame and executed traditionally (all connections were welded)

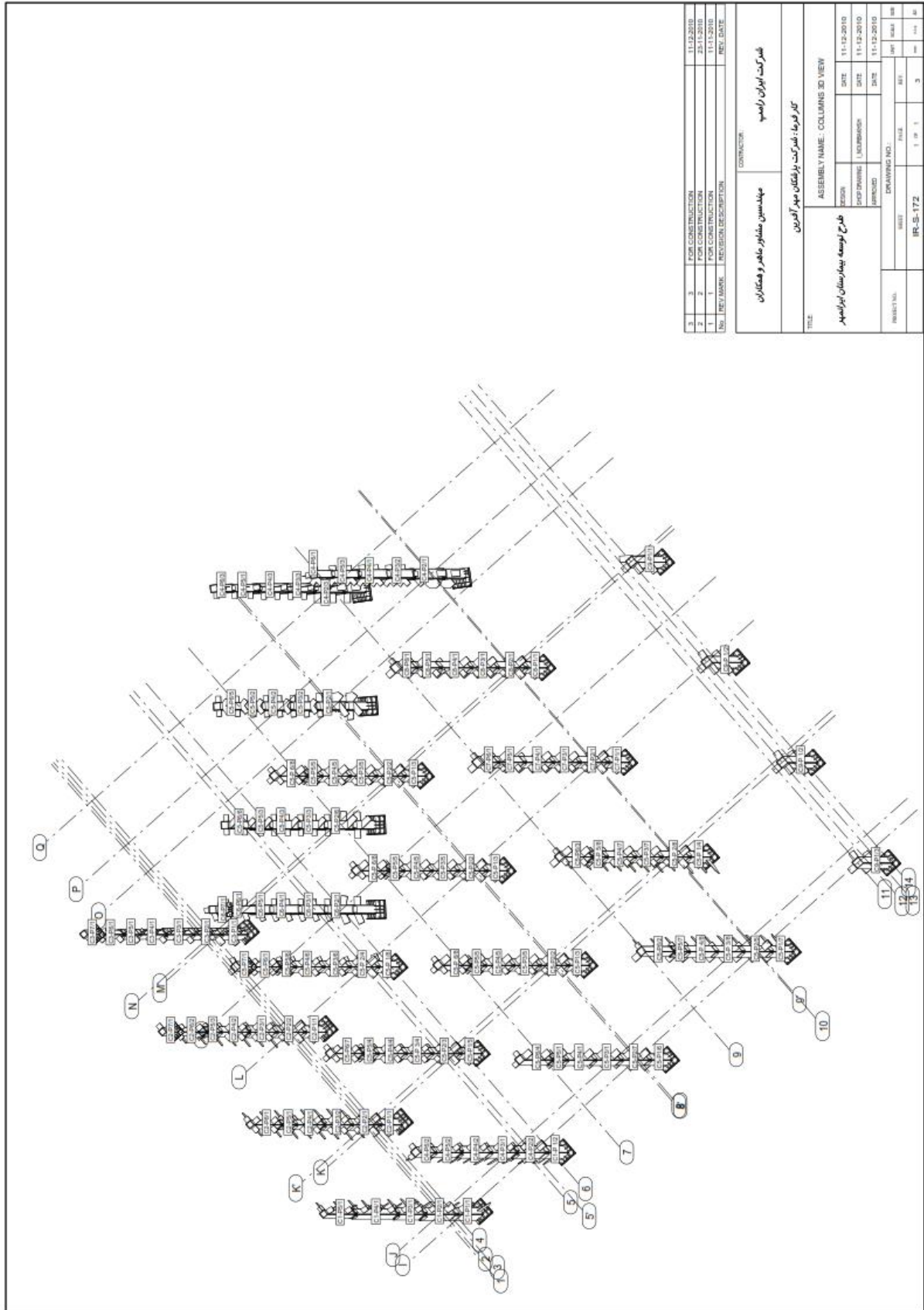


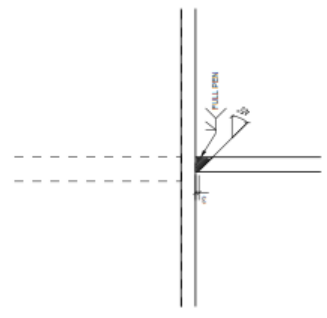
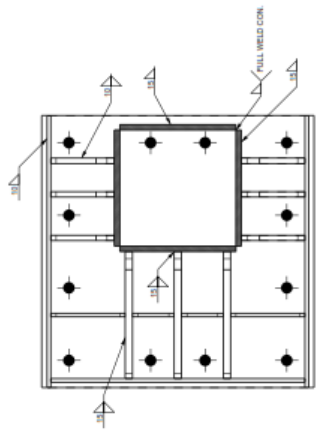
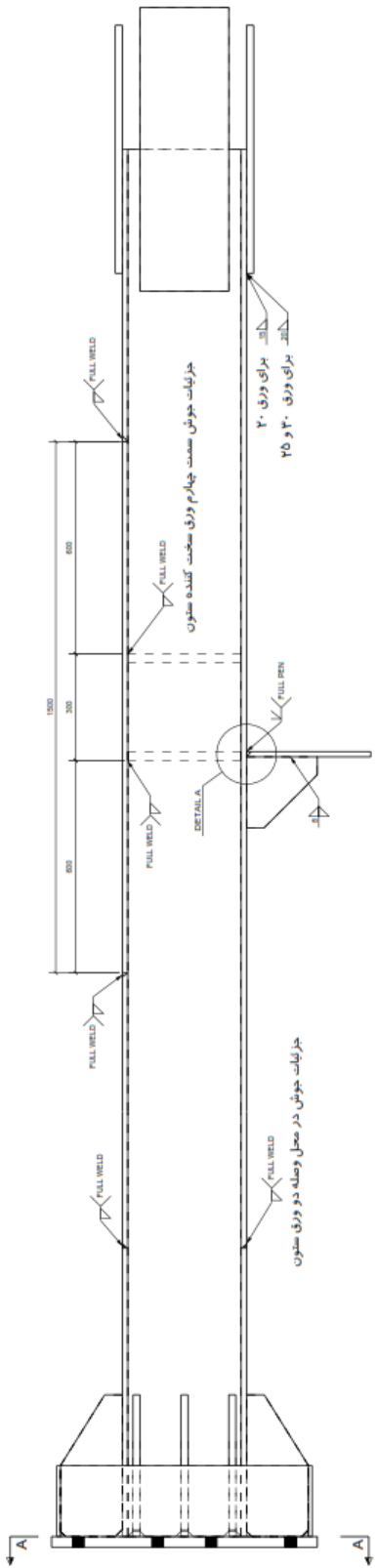
3) Tehran Iranmehr Hospital Development Project



3rd Phase of Iranmehr Hospital was designed & executed in 12 floors as plate beam and plate column with welding connections. Construction and implementation stages of the main building, supporting structure and welding connections are provided in photos and workshop plans.

Column:



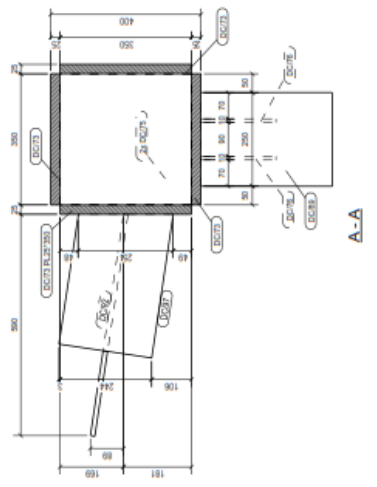
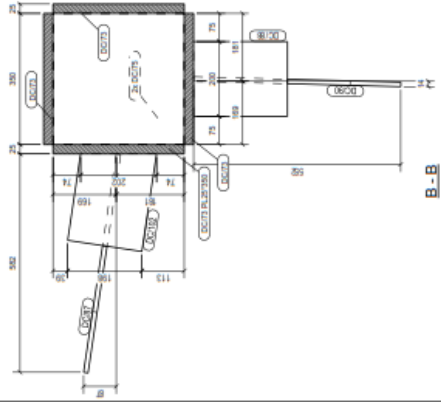
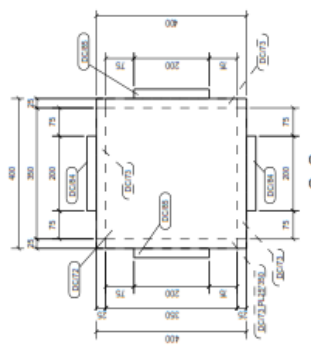
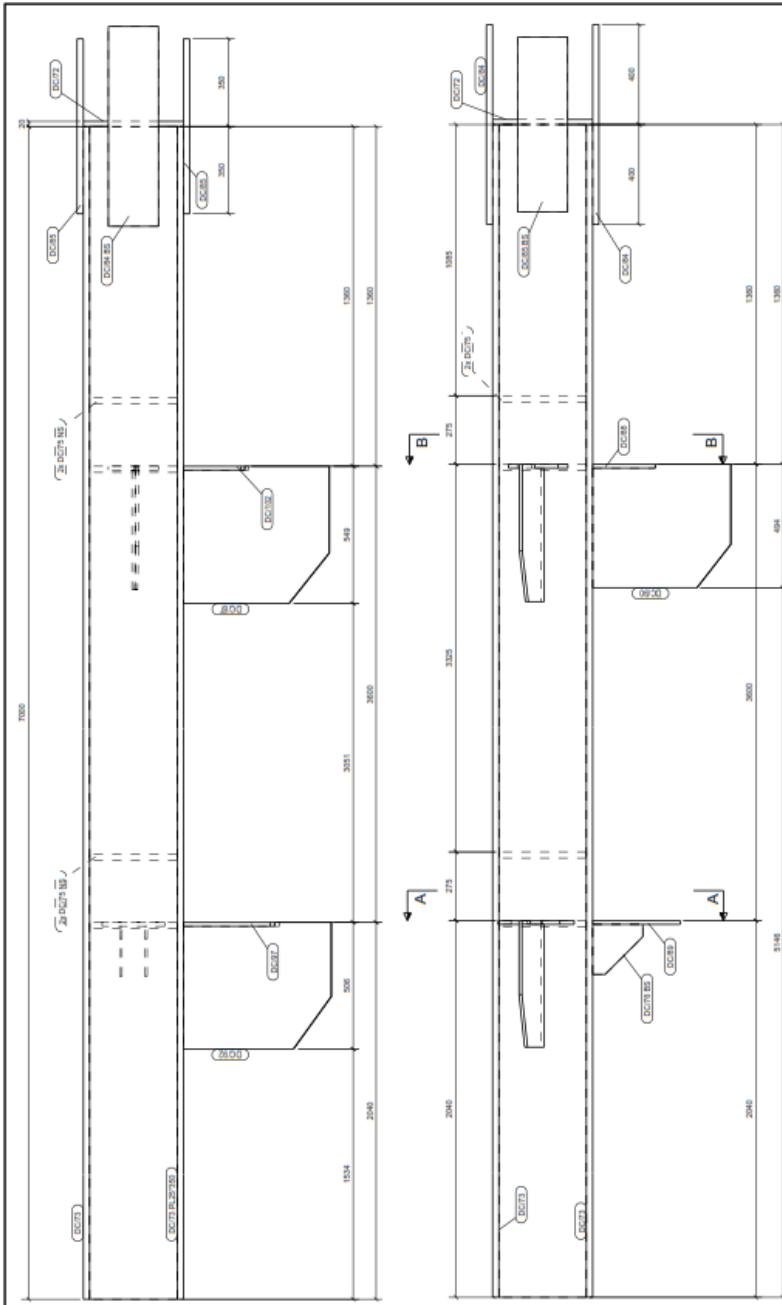


SECTION A-A

DETAIL A

NO.	REV. MARK.	REVISION DESCRIPTION	REV. DATE
2		FOR CONSTRUCTION	02-09-2010
2			

CONTRACTOR		مهندس مشاور ماهر و همکاران	
CONTRACT NAME		شرکت ایران راسپ	
ASSEMBLY NAME		تیر فولد - شرکت پارسگان مهر آفرین	
DESIGN	DATE	02-09-2010	
DRAWING	DATE	02-09-2010	
PROJECT NO.	DRAWING NO.	IR-S-103	1 of 1
SHEET	FILE		
DATE	REV.		
02-09-2010	001		



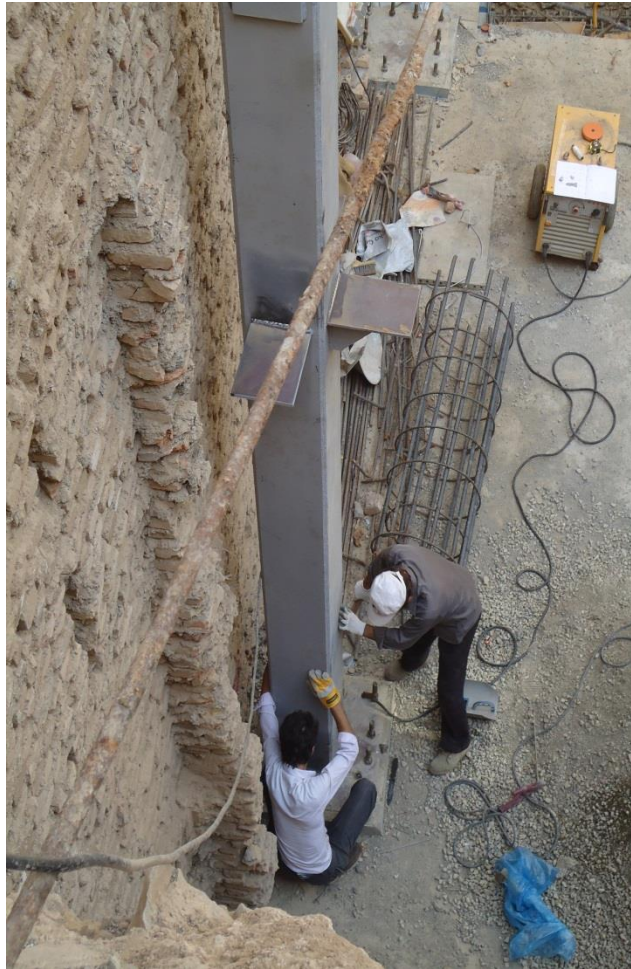
PART NAME : C1-P2/1 **QTY : 1**

Mark	Size	Length	QTY	material
DC/72	FL100*20	400	1	ST-37
DC/73	FL20*300	7000	4	ST-37
DC/75	FL20*300	300	4	ST-37
DC/76	FL10*200	200	2	ST-37
DC/84	FL200*25	800	2	ST-37
DC/85	FL200*25	700	2	ST-37
DC/87	FL12*48	508	1	ST-37
DC/88	FL19*200	200	1	ST-37
DC/89	FL19*200	300	1	ST-37
DC/90	FL12*48	592	1	ST-37
DC/92	FL12*106	596	1	ST-37
DC/97	FL10*200	307	1	ST-37
DC/102	FL19*200	203	1	ST-37

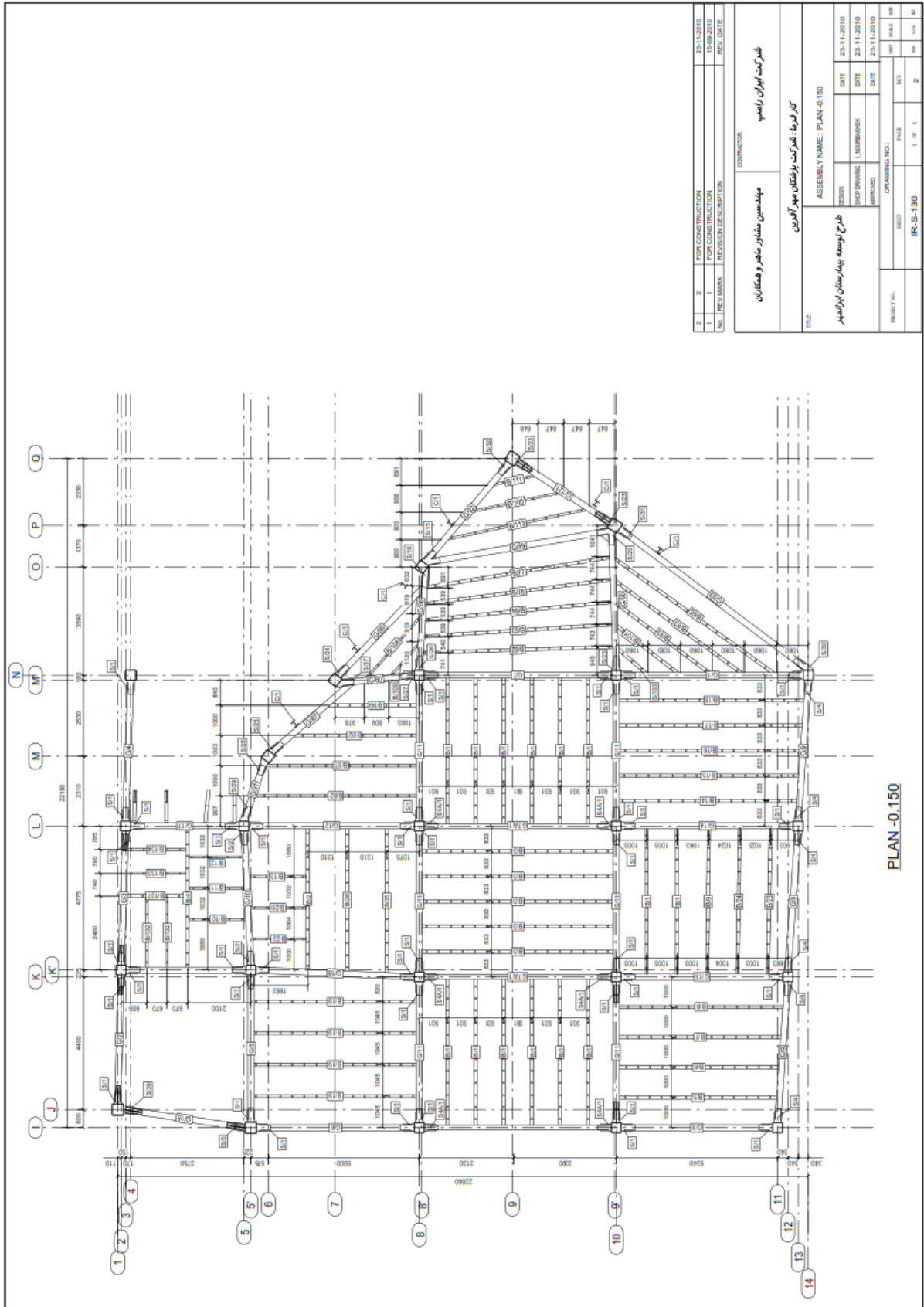
1	1	FOR CONSTRUCTION	03-10-2010
No	REV	REVISION DESCRIPTION	REV DATE

CONTRACTOR: مهندس مشاور ماکرو ساختمان شرکت ایران راسپ کارفرما: شرکت بازنگار مهر آذین	
ASSEMBLY NAME: C1-P2/1	
DRAWING NO: IR-S-100	SHEET NO: 1
DATE: 03-10-2010	DATE: 03-10-2010
APPROVED: طرح توسعه بندر اسکان ایرانراسپ	DATE: 03-10-2010

PROJECT NO:	DRAWING NO:	SHEET:	FILE:	REV:	DATE:
	IR-S-100	1	1	1	03-10-2010



Beam:



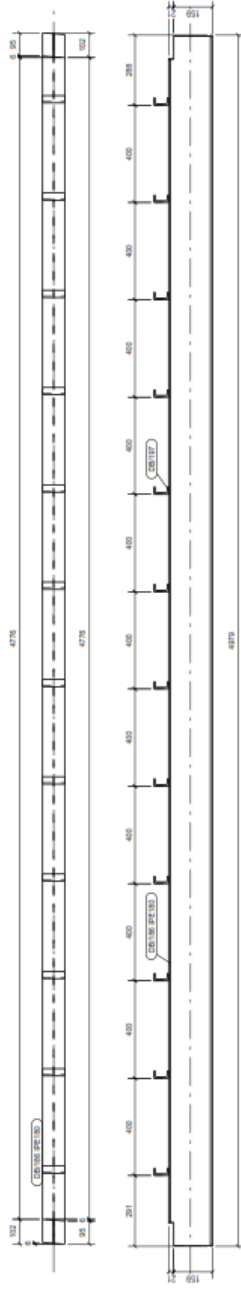
2	2	23-11-2010	23-11-2010
1	1	12-05-2010	12-05-2010
No	REV	REVISION DESCRIPTION	REV DATE
CONTRACTOR شرکت ایران راسب مهندس مشاور ماهر و همکاران کارفرما: شرکت پارسگان مهر آفرین			
ASSEMBLY NAME: PLAN-0.150 DESIGN DATE: 23-11-2010 SUPERVISION DATE: 23-11-2010 APPROVAL DATE: 23-11-2010			
PROJECT NO.	DRAWING NO.	SHEET	FILE
	IR-S-130	1 of 1	2



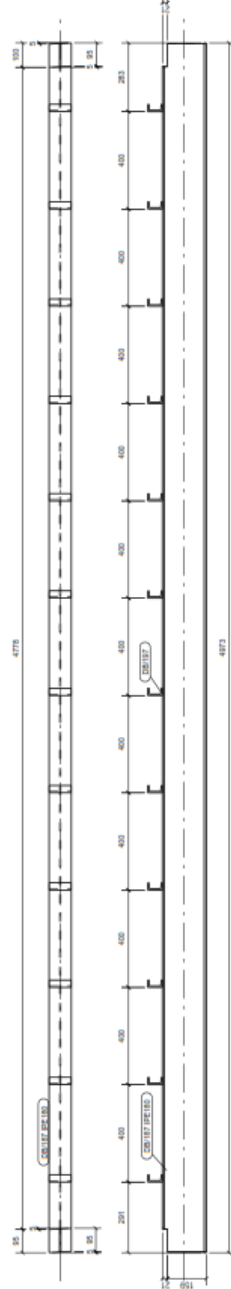
No. 2, Marked G/15

PART NAME : G/13				QTY : 2				
MATERIAL LIST FOR ASSEMBLY								
Mark	Size	Length(mm)	QTY.	Material	Mark	Size	Length(mm)	
DG/7	PL30*200	5295	4	ST-37	DG/25	PL10*210	5295	2
PART NAME : G/14								
MATERIAL LIST FOR ASSEMBLY								
Mark	Size	Length(mm)	QTY.	Material	Mark	Size	Length(mm)	
DG/6	PL30*200	5830	4	ST-37	DG/26	PL10*210	5830	2
PART NAME : G/15								
MATERIAL LIST FOR ASSEMBLY								
Mark	Size	Length(mm)	QTY.	Material	Mark	Size	Length(mm)	
DG/21	PL10*210	4006	2	ST-37	DG/31	PL30*200	4009	4

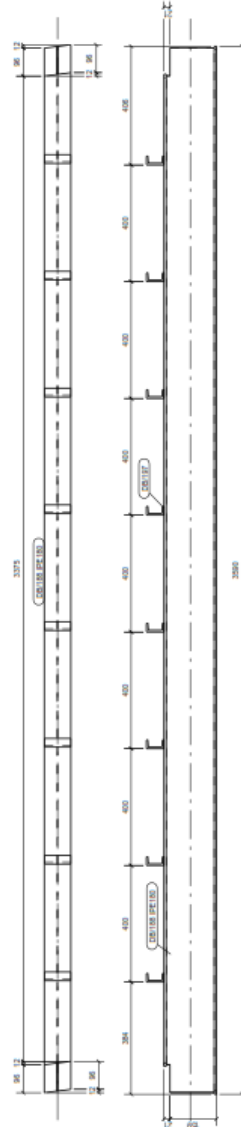
NO. 1		FOR CONSTRUCTION		14-08-2010	
NO.	REV. MARK.	REVISION DESCRIPTION	REV. DATE	NO.	REV. DATE
<p>مهندس مشاور ماهر و همکاران</p> <p>شرکت ایران راسپ</p> <p>کابل فولاد - شرکت پارسکاب مین گرون</p>					
<p>ASSEMBLY NAME : G/13 TO G/15</p>					
DESIGN		DATE		15-08-2010	
DRAWING		DATE		15-08-2010	
CHECK		DATE		15-08-2010	
DRAWING NO.		FILE		REV.	
SHEET		1 OF 1		REV.	
PROJECT NO.		IR-S-135		REV.	



No. 4, Marked B/121



No. 4, Marked B/122



No. 4, Marked B/123

PART NAME : B/121				QTY.-4			
MATERIAL LIST FOR ASSEMBLY				MATERIAL LIST FOR ASSEMBLY			
Mark	Size	Length(mm)	QTY.	Mark	Size	Length(mm)	QTY.
DB/100	IPE100	4879	4	ST-37			
DB/197	UNP90	91	40	ST-37			

PART NAME : B/122				QTY.-4			
MATERIAL LIST FOR ASSEMBLY				MATERIAL LIST FOR ASSEMBLY			
Mark	Size	Length(mm)	QTY.	Mark	Size	Length(mm)	QTY.
DB/100	IPE100	4873	4	ST-37			
DB/197	UNP90	91	40	ST-37			

PART NAME : B/123				QTY.-4			
MATERIAL LIST FOR ASSEMBLY				MATERIAL LIST FOR ASSEMBLY			
Mark	Size	Length(mm)	QTY.	Mark	Size	Length(mm)	QTY.
DB/100	IPE100	3590	4	ST-37			
DB/197	UNP90	91	32	ST-37			

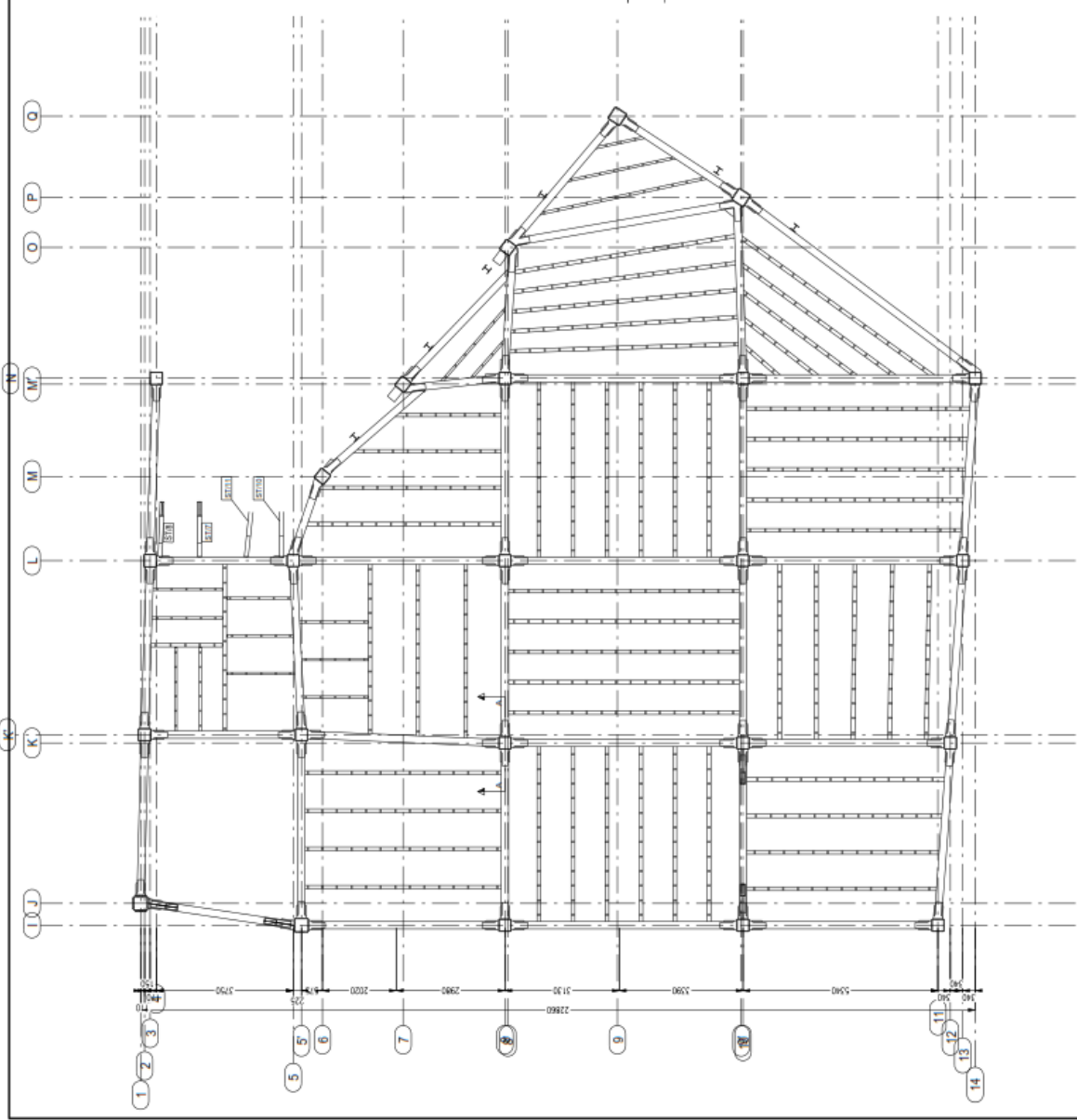
No.	REV.	MARK	REVISION DESCRIPTION	DATE
1	1		FOR CONSTRUCTION	11-12-2010
2	1		FOR CONSTRUCTION	23-12-2010

CONTRACTOR	
مهندسین مشاور ماهر و همکاران	شرکت ایران رانسیب

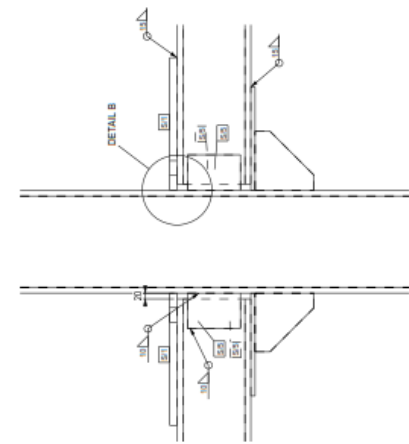
ASSEMBLY NAME: B/121 TO B/123	
REGION	DATE
DRAWING NUMBER	DATE
ISSUED	DATE

PROJECT NO.	SHEET	TITLE	DATE
IR-S-301	1	1	2

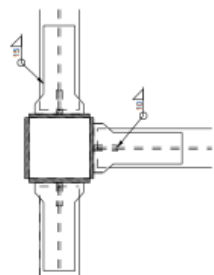




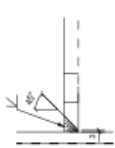
PLAN -3.39 & -0.15



SECTION A-A
1/10

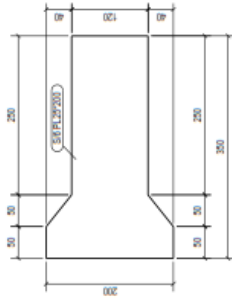


CONNECTION DETAIL
1/10

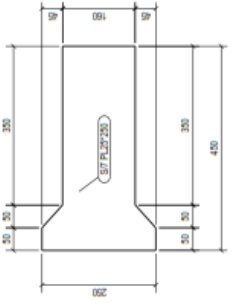


DETAIL B
1/10

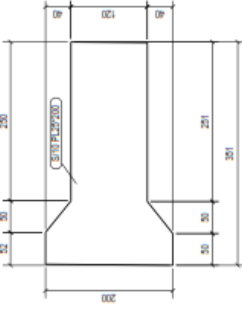
1	FOR CONSTRUCTION	27-09-2010
2	REV. MARK	REV. DATE
CONTRACTOR:		
مهندسان مشاور ماسرو و همکاران		
CONTRACTOR:		
شرکت ایران راسپ		
ASSEMBLY NAME: CONNECTION PLATE		
کارفرمای: شرکت پارتیکان مهر گرون		
TITLE:		
طرح توسعه بیمارستان آبراهیم		
SECTION	DATE	27-09-2010
DRAWING NUMBER	DATE	27-09-2010
APPROVED	DATE	27-09-2010
DRAWING NO.:	FILE	REV. DATE
SHEET	1 OF 1	REV. DATE
PROJECT NO.	IR-S-143	REV. DATE



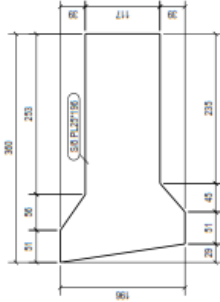
No. 251, Marked S/6



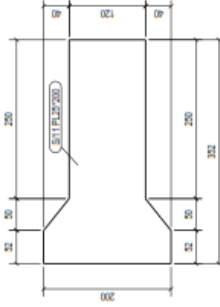
No. 82, Marked S/7



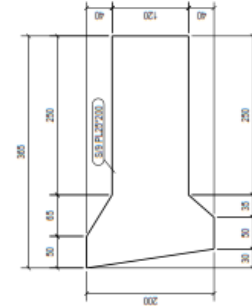
No. 4, Marked S/10



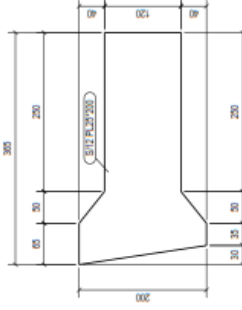
No. 7, Marked S/8



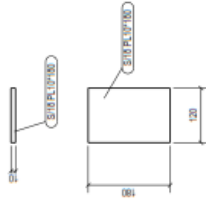
No. 1, Marked S/11



No. 2, Marked S/9



No. 7, Marked S/12



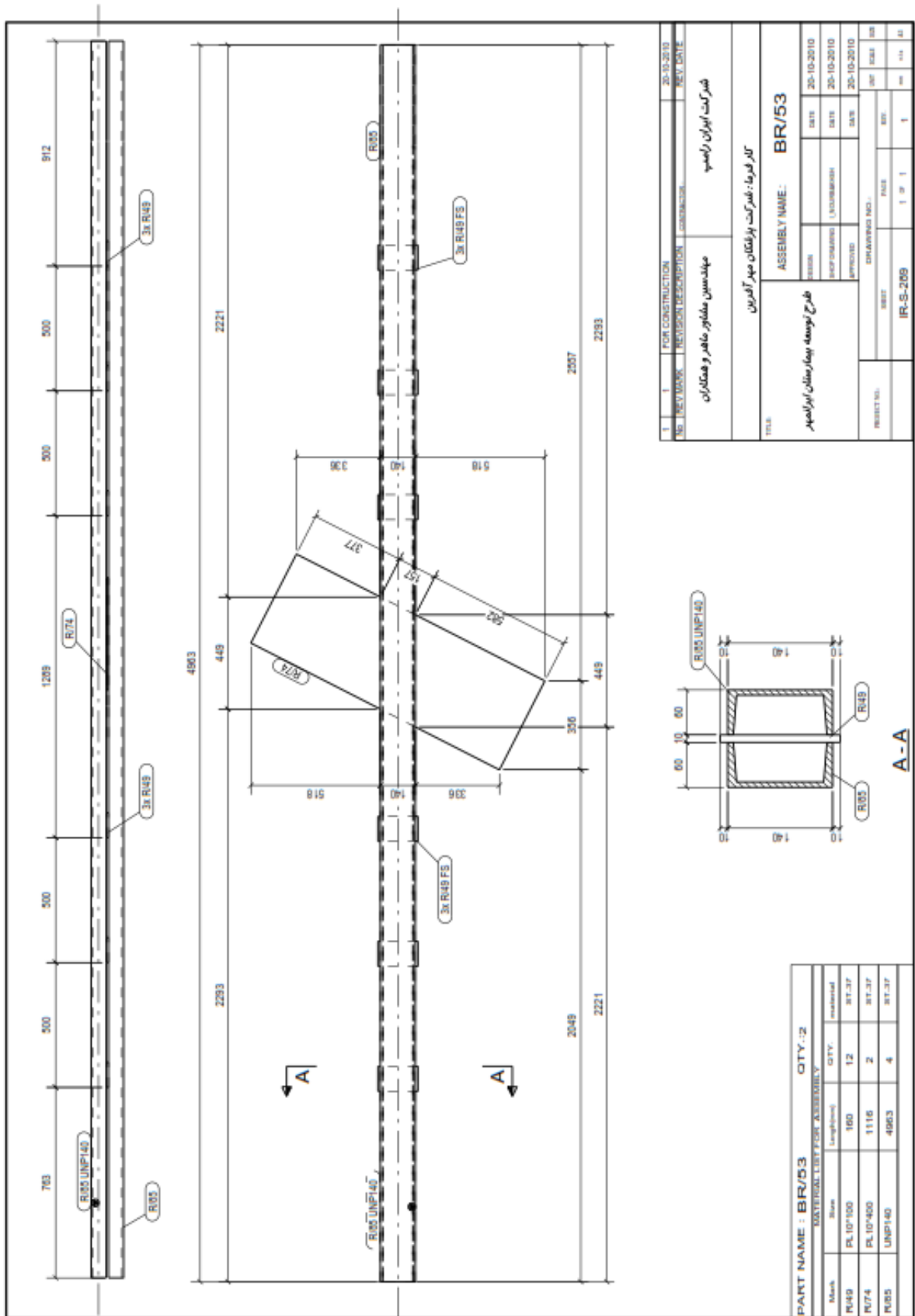
No. 1007, Marked S/14

PART NAME : S/6				QTY.:251			
MATERIAL LIST FOR ASSEMBLY							
Mark	Size	Length(mm)	QTY.	material	Mark	Size	Length(mm)
S/6	PL20*200	350	251	ST-37			
PART NAME : S/7							
MATERIAL LIST FOR ASSEMBLY							
Mark	Size	Length(mm)	QTY.	material	Mark	Size	Length(mm)
S/7	PL20*200	450	82	ST-37			
PART NAME : S/8							
MATERIAL LIST FOR ASSEMBLY							
Mark	Size	Length(mm)	QTY.	material	Mark	Size	Length(mm)
S/8	PL20*196	360	7	ST-37			
PART NAME : S/9							
MATERIAL LIST FOR ASSEMBLY							
Mark	Size	Length(mm)	QTY.	material	Mark	Size	Length(mm)
S/9	PL20*200	365	2	ST-37			
PART NAME : S/10							
MATERIAL LIST FOR ASSEMBLY							
Mark	Size	Length(mm)	QTY.	material	Mark	Size	Length(mm)
S/10	PL20*200	351	4	ST-37			
PART NAME : S/11							
MATERIAL LIST FOR ASSEMBLY							
Mark	Size	Length(mm)	QTY.	material	Mark	Size	Length(mm)
S/11	PL20*200	352	1	ST-37			
PART NAME : S/12							
MATERIAL LIST FOR ASSEMBLY							
Mark	Size	Length(mm)	QTY.	material	Mark	Size	Length(mm)
S/12	PL20*200	365	7	ST-37			
PART NAME : S/14							
MATERIAL LIST FOR ASSEMBLY							
Mark	Size	Length(mm)	QTY.	material	Mark	Size	Length(mm)
S/14	PL10*100	120	100	ST-37			

2	FOR CONSTRUCTION	11-12-2010
1	FOR CONSTRUCTION	20-10-2010
1	REV. MARK	REVL. DATE
CONTRACTOR:		
مهندسين مشاور مهر آرمين		
شرکت ايران رامپ		
کتر گيرما: شرکت دانشان مهر آرمين		
ASSEMBLY NAME: S/6 TO S/14		
DESIGN	DATE	11-12-2010
PROF. DRAWING	DATE	11-12-2010
APPROVED	DATE	11-12-2010
DRAWING NO.:	SHEET	REV. NO.
IR-S-220	1	2
SCALE	mm	mm
1	1	2



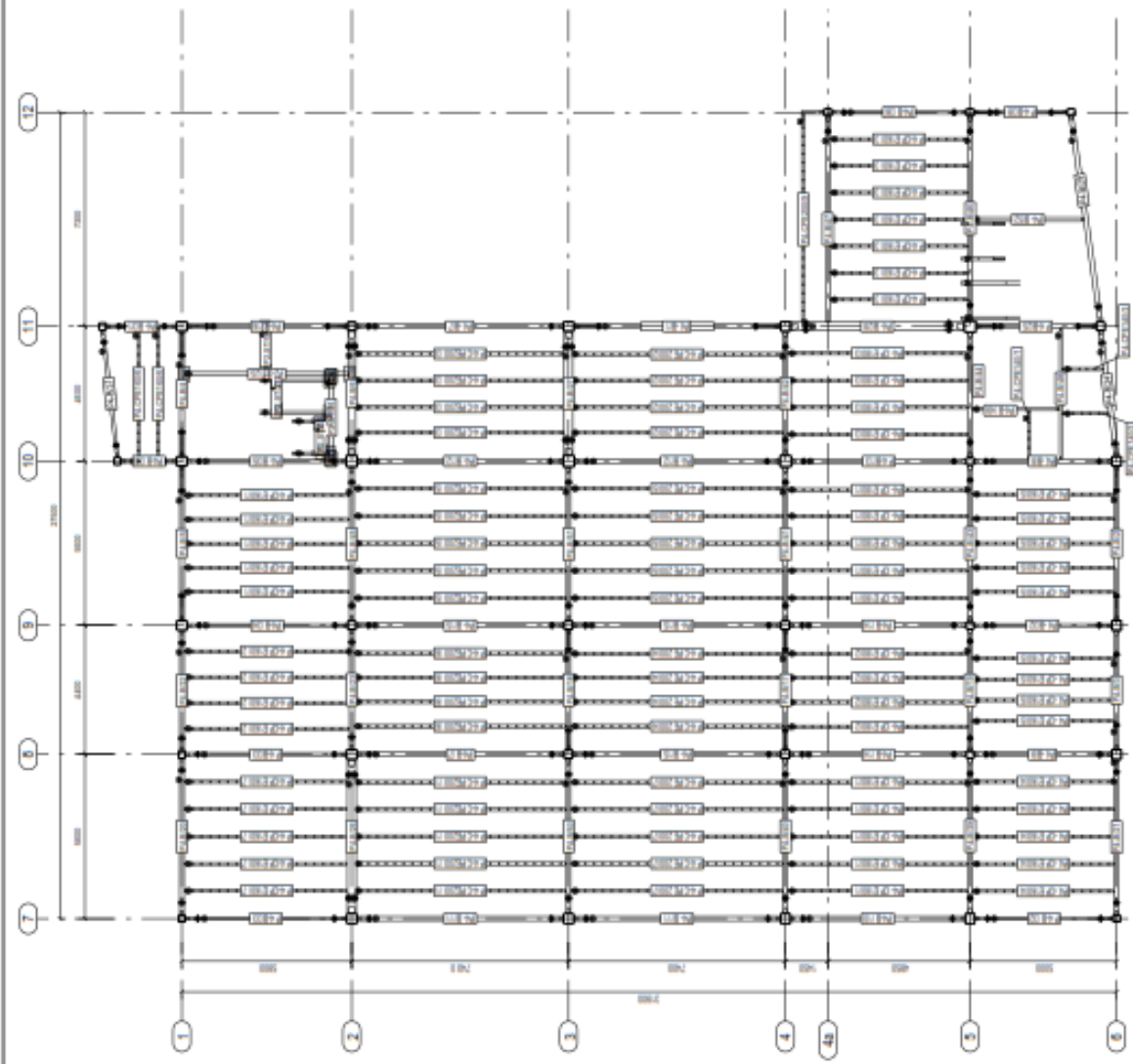
Bracing:





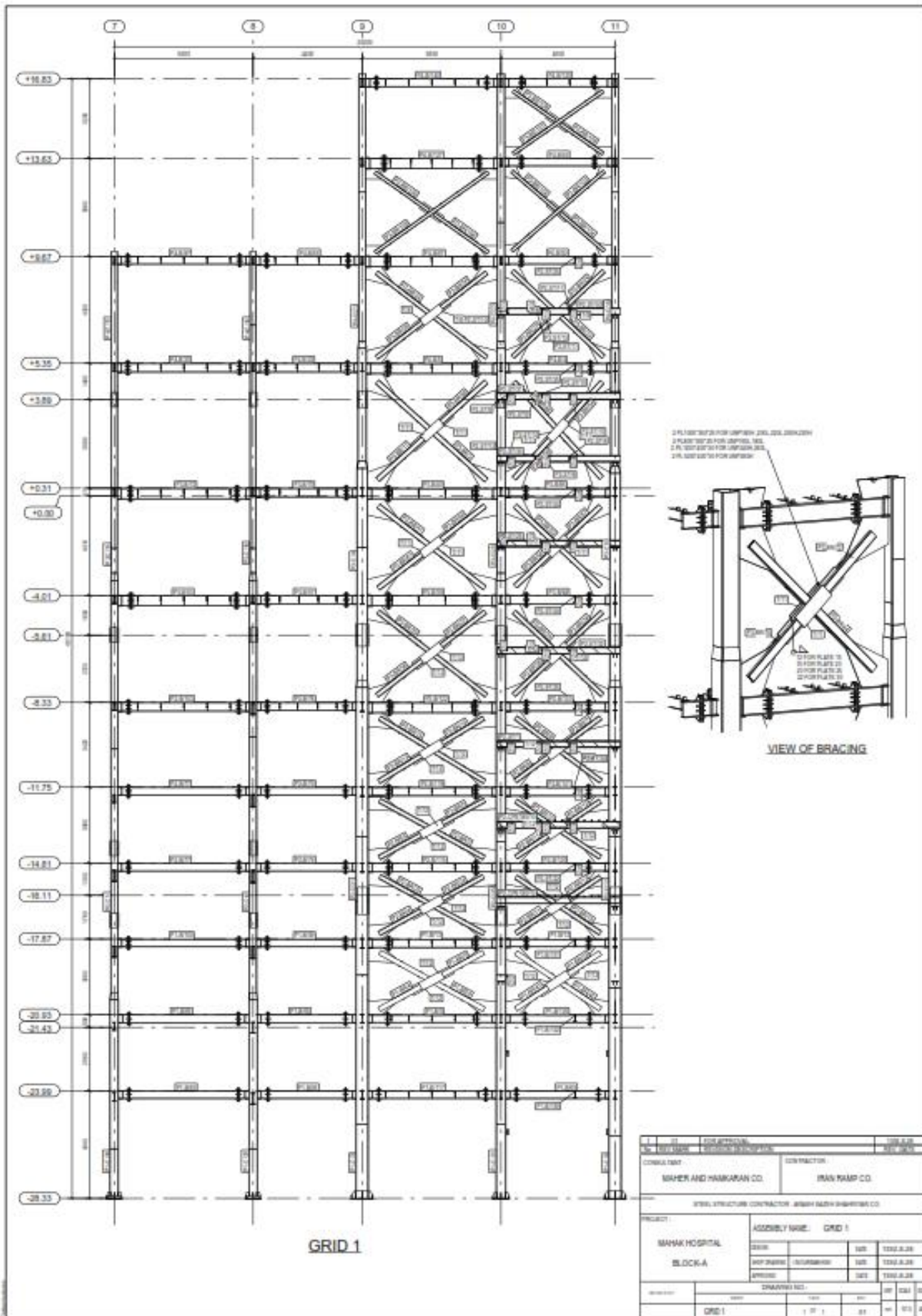
4) Tehran Mahak Hospital Development Project





PLAN +5.35

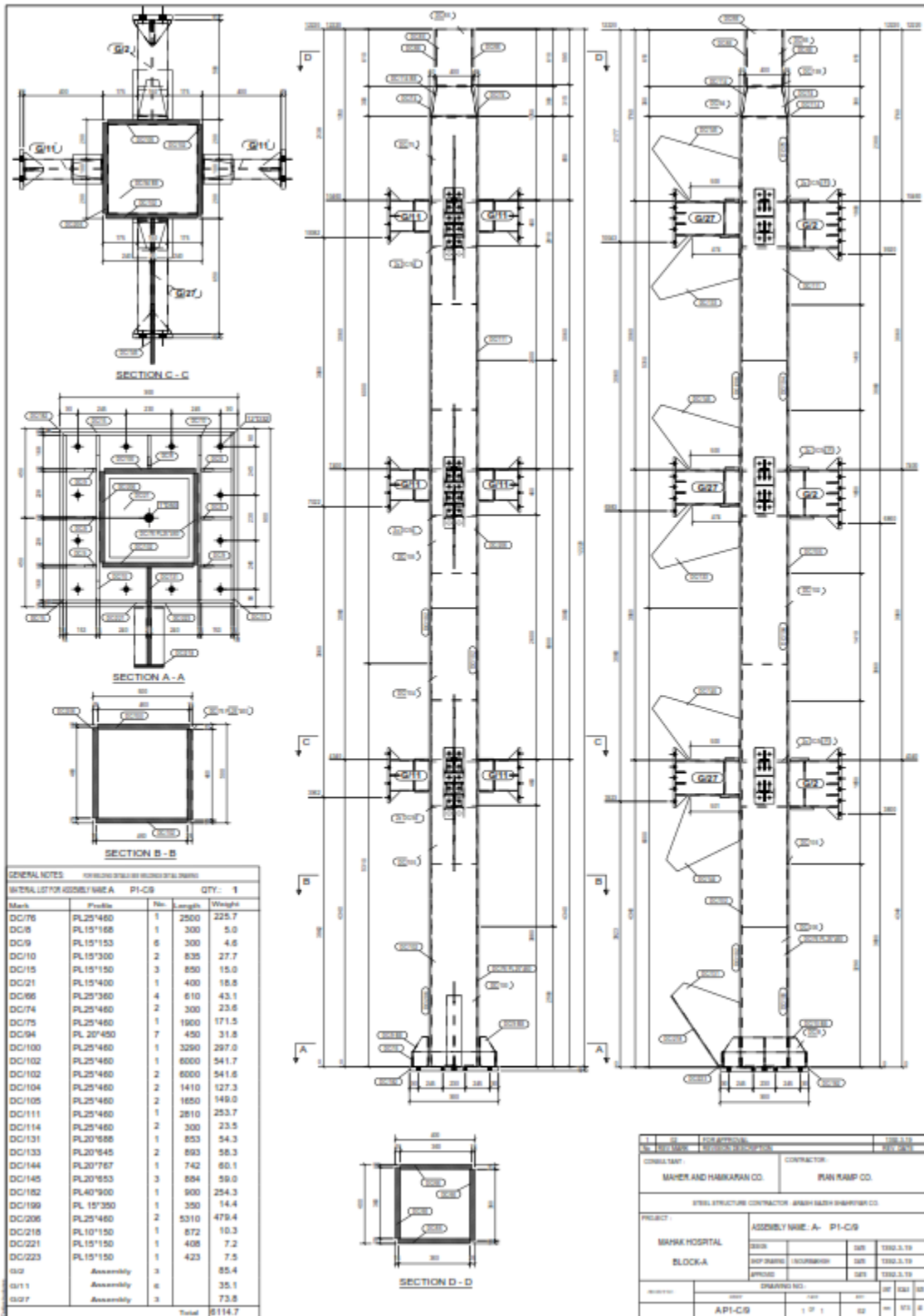
1	FOR APPROVAL	DATE: 13.07.17
2	BY: ENGINEER	REVISION:
CONSULTANT:		CONTRACTOR:
MAHEM AND HAKKARI CO.		IRAN KAMP CO.
PROJECT:		
STEEL STRUCTURE CONTRACTOR: ARUP SAZID SHARIFI CO.		
ASSEMBLY NAME: PLAN +5.35		
DATE:	13.07.17	
APP. NAME:	INCUMBENT	DATE:
APPROVED:	DATE:	13.07.17
DRAWING NO.:		
PROJECT NO.:	100	
SCALE:	1:50	1:50
PLAN +5.35		





Tehran Mahak Hospital Development project was designed and executed in 13 floors as plate beam and plate column with bolting connections. Construction and implementation stages of the main building, supporting structure and welding connections are provided in photos and workshop plans.

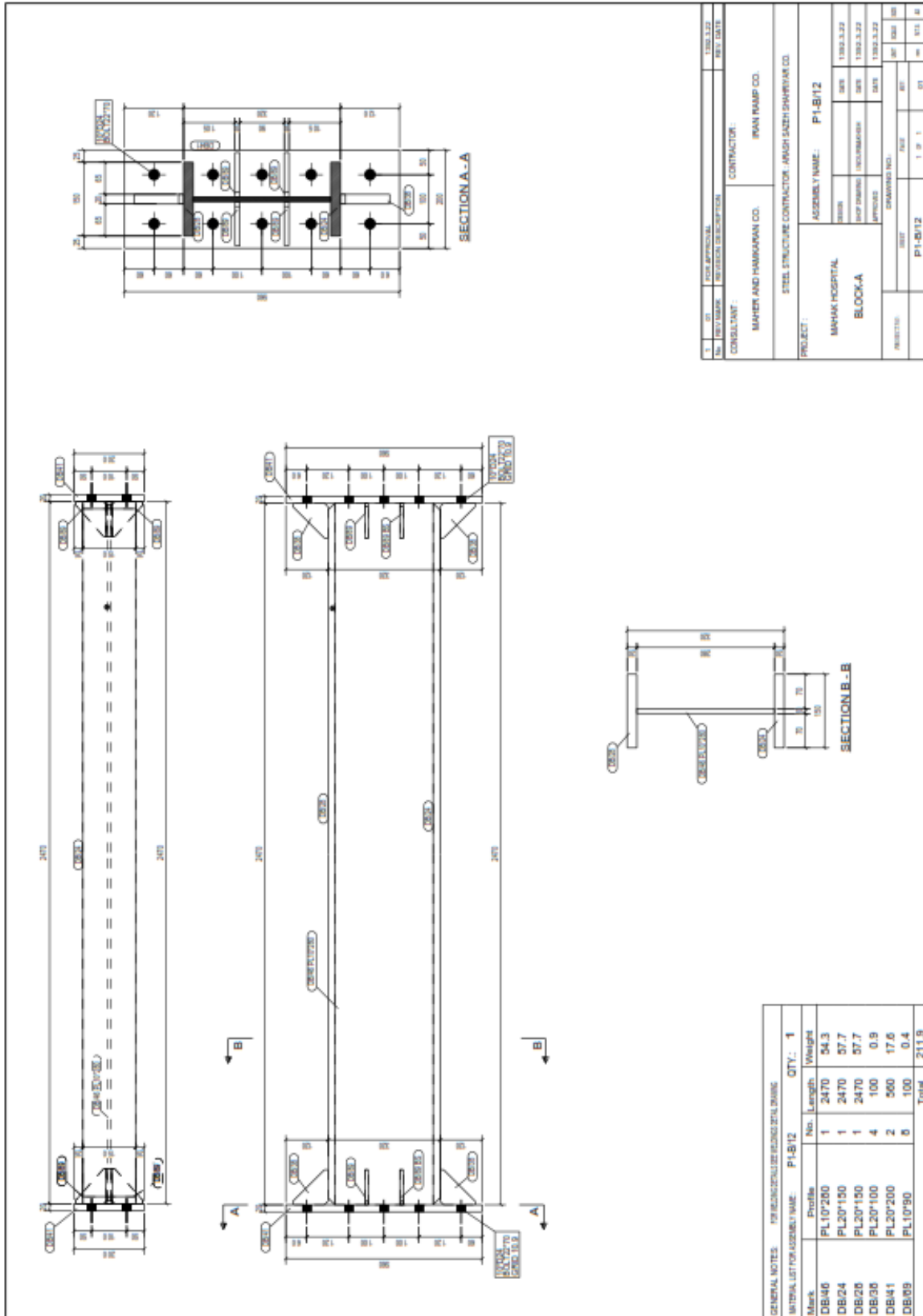
Column:



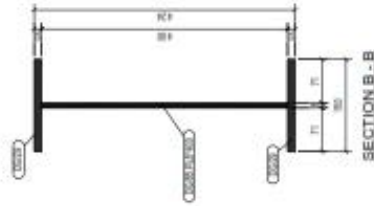
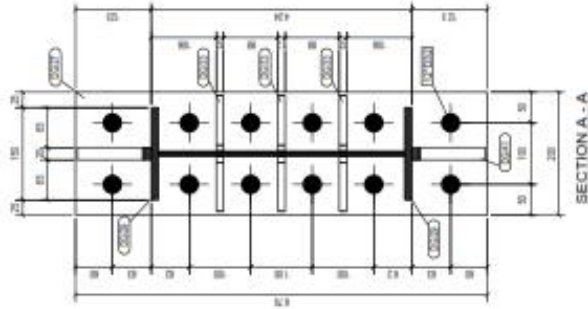
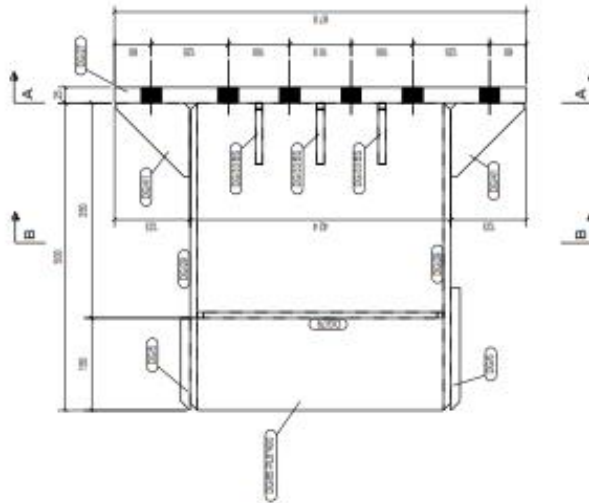
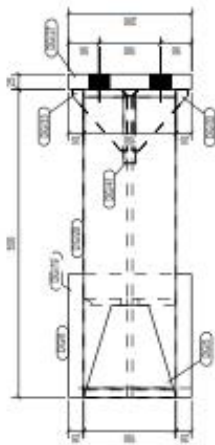




Main Beam:



NO.	DATE APPROVAL	1393.3.22
NO.	REV. / MARK	REVISION DESCRIPTION
CONSULTANT:		CONTRACTOR:
MAHER AND HAJARANI CO.		IRAN KAMP CO.
PROJECT:		
STEEL STRUCTURE CONTRACTOR: ARSH SEZEH SHIRVAN CO.		
ASSEMBLY NAME: P1-B12		
DATE:	SER:	1393.3.22
NOF DRAWING:	NOF DRAWING:	203
APPROVED:	NOF:	1393.3.22
PROJECT:	DRAWING NO:	P1-B12
	NOF:	01
	NOF:	01
	NOF:	01



GENERAL NOTES: FOR REFERENCE SEE DRAWING SET IN DRAWING

Mark	Profile	Qty	Length	Weight
DG/05	PL8*400	1	500	12.6
DG/06	PL15*144	1	174	1.7
DG/07	PL15*200	1	200	4.5
DG/27	PL25*200	1	670	26.3
DG/29	PL12*130	2	500	6.9
DG/33	PL12*90	6	100	0.5
DG/41	PL20*120	2	120	1.3
DG/79	PL10*71	2	400	2.2
Total				69.0

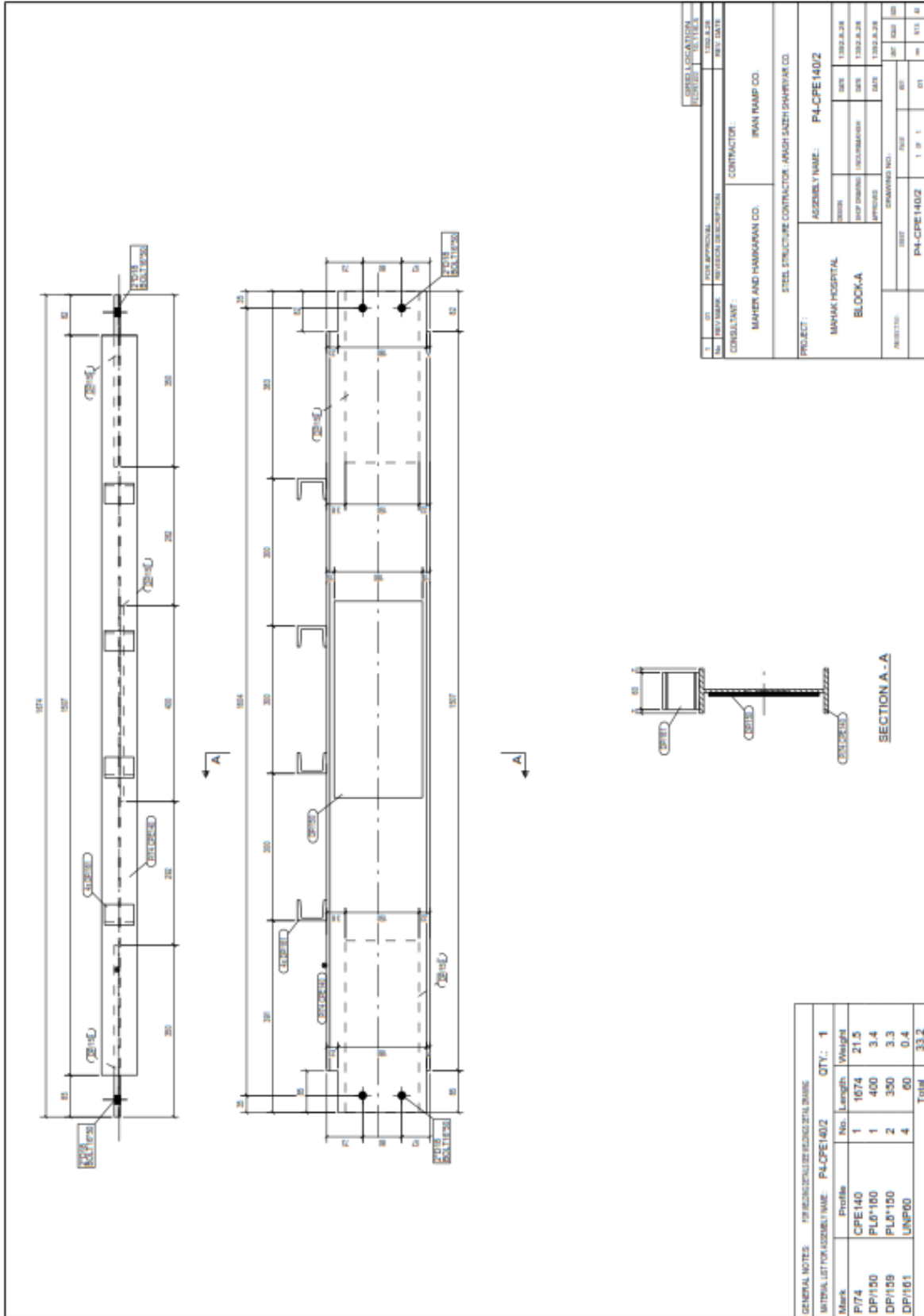
NO.	REV.	DATE	BY	CHKD.
CONTRACTOR:		IRVAN RAMP CO.		
CONSULTANT:		MAHYEN AND HANIKAWAN CO.		
PROJECT:				
STEEL STRUCTURE CONTRACTOR: JAHRI SAZEN SHIRVAT CO.				
ASSEMBLY NAME: G/25				
BLOCK-A				
SHEET: 01				
DRAWING NO.: G/25				
SCALE: 1/3" = 1'-0"				
DATE: 01/11/2020				







Connection (secondary Beam – Main Beam):



GENERAL NOTES: FOR CONNECTION OF SECONDARY BEAMS

Mark	Profile	No.	Length	Weight	QTY. : 1
P/74	CPE140	1	1074	21.5	
DP/100	PL/100	1	400	3.4	
DP/109	PL/100	2	300	3.3	
DP/101	UNF/60	4	60	0.4	
Total				33.2	

NO.	REV.	DATE	DESCRIPTION	BY	CHKD.

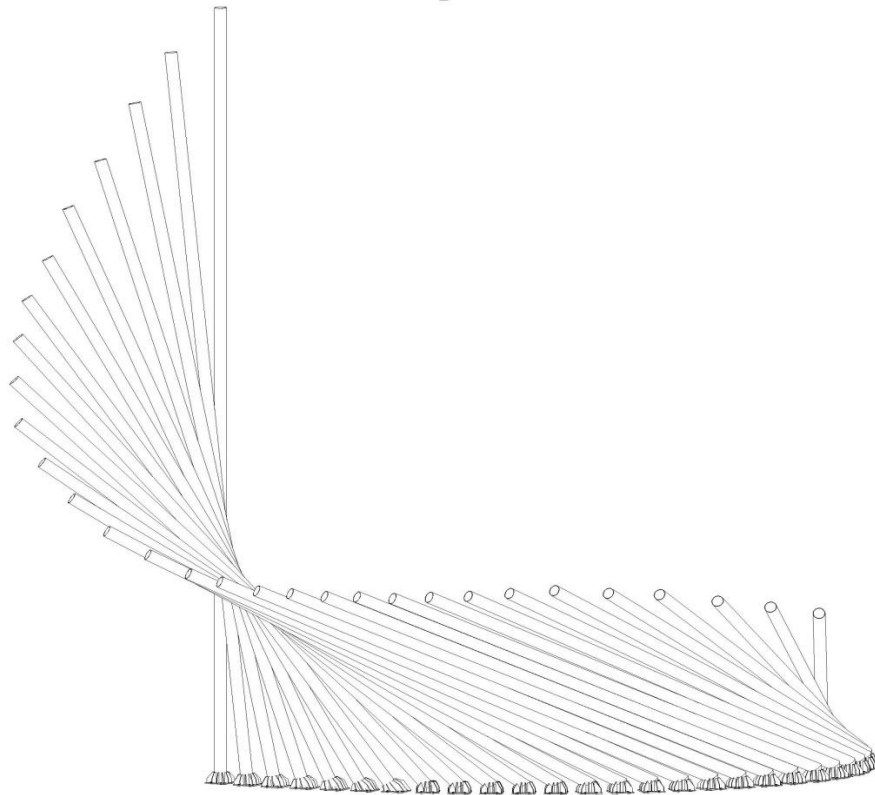
CONSULTANT:	BAHAR AND HANISMAN CO.	CONTRACTOR:	IRAN RAMP CO.
PROJECT:	STEEL STRUCTURE CONTRACTOR: ARASH SAZEH SHIRAZI CO.		
ASSEMBLY NAME:	P4-CPE140/2		
DATE:	1393.A.28	DATE:	1393.A.28
APP. ENGINEER:		DATE:	1393.A.28
PROJECT NO.:		DATE:	
DRAWING NO.:	P4-CPE140/2	1 OF 1	01

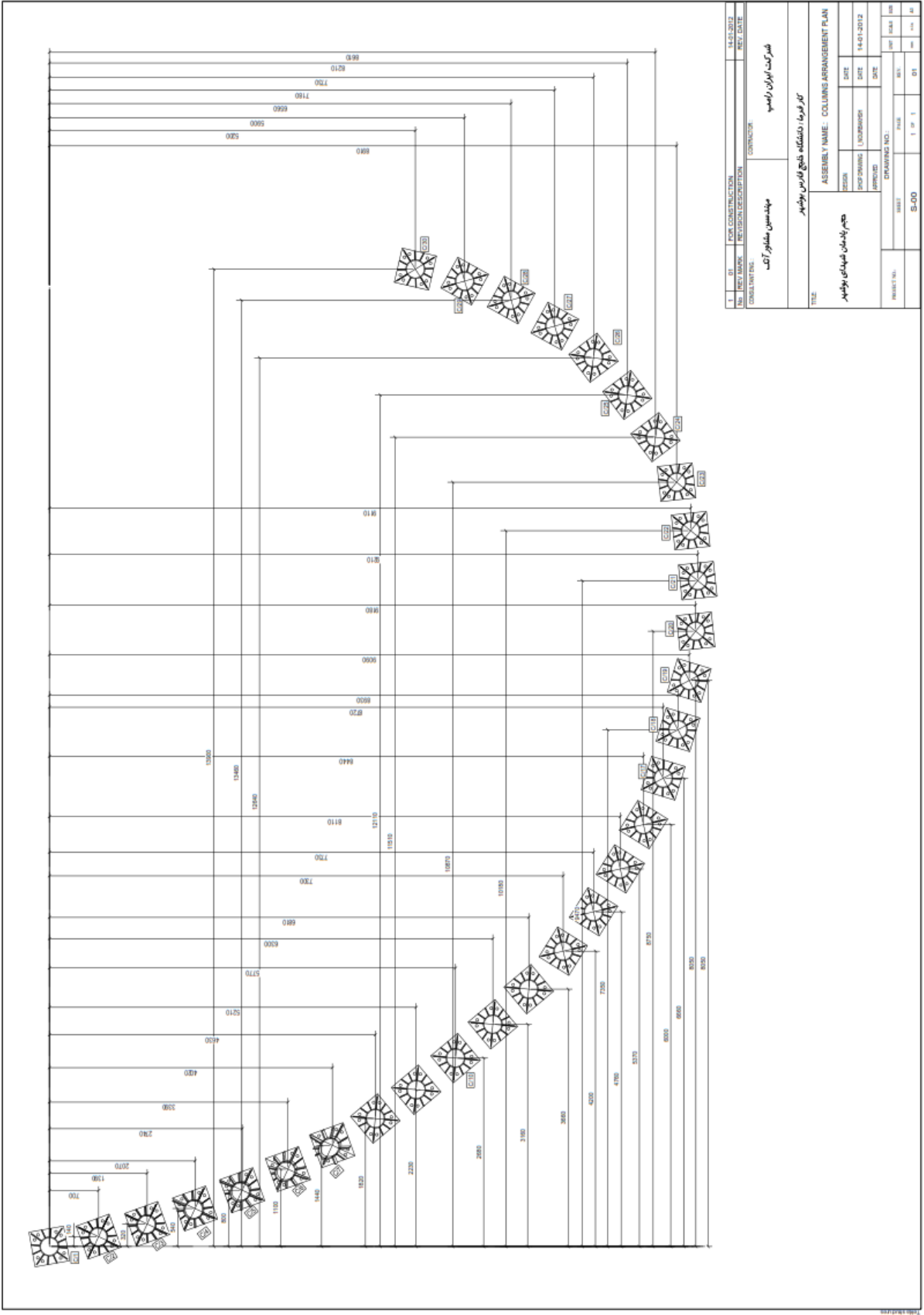






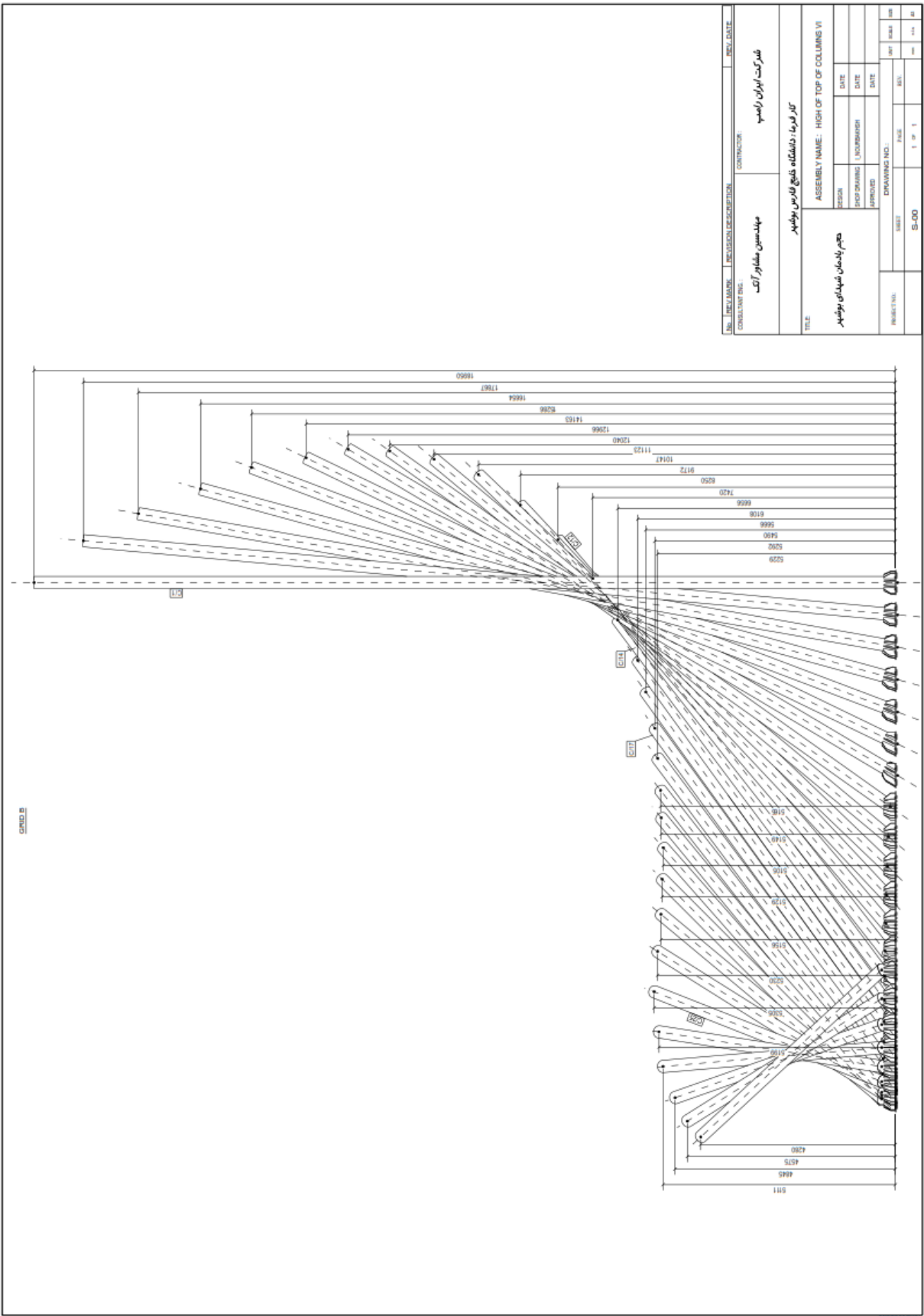
5) Yademan Shohadayeh Khalij Fars University (Special Frame With Welding Connection)





1	DT	FOR CONSTRUCTION	14-01-2012
2	REV	REVISION DESCRIPTION	REV DATE
GENERAL INFO:			
CONSULTANT:		SOURCE:	
مهندس مشاور آگ		مهرکت ایران راسب	
ASSEMBLY NAME: COLUMNS ARRANGEMENT PLAN			
تکر فرما دانشگاه صنعتی ارس و شهر			
PROJECT NO:		S-00	
SHEET NO:		1 OF 1	
DATE:		14-01-2012	
DRAWN BY:		S.M.	
CHECKED BY:		S.M.	
SCALE:		1:1	

1/16/1391



REV. NO.	REVISION DESCRIPTION	CONTRACTOR	ISSUE DATE
1	مهندسين مشاور آژاک	شرکت ایران رالساپ	
ASSEMBLY NAME : HIGH OF TOP OF COLUMNS VI			
DESIGN	DATE	DATE	DATE
CHECK DRAWING	REVISION	DATE	DATE
APPROVED	DATE	DATE	DATE
PROJECT NO.	DRAWING NO.	SHEET	PAGE
	S-00	1 OF 1	1 OF 1





5) Yademan Shohadayeh Olum-Tahghighat University (Special Frame With Welding and Bolting Connection)



As evident in the construction process of structures, new advancements in designing and execution of steel structures have ushered this industry into a new era and as more automatic steel frame factories are constructed, its share of construction works increases.

These methods not only reduced the load on structure, but also increase the quality of execution and safety, resulting in less consumption of iron and lower overall costs.

All manufacturing stages of a steel structure with bolting connections are conducted at the factory with appropriate machineries, resulting in omission of human factor errors and quicker manufacturing and installation. Considering adequate time and facilities in this method, there is an opportunity for more comprehensive and easier quality control by engineers. They can control the frame and examine welding points inside factory using special tools and control during installation is limited to correct bolting of connections and adherence of the structure dimensions to the guidelines.

Manufacturing (Site):









Manufacturing (Factory):







The aforesaid reasons and also the invention of the very useful Composite Steel Deck roofs (low thickness, high speed, low iron consumption and etc) increases has increased inclination of employers towards this type of structures. I hope that Kurdistan Regional Government would soon follow lead in this trend.

Composite Steel Deck:

