

Autodesk® Robot[™] Structural Analysis: Steel and RC Design

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In this class we will cover the workflow for design of steel and RC structures starting with building the best possible model for a task followed by assigning correct design parameters and finding the optimal steel section sizes or reinforcement arrangement.

Learning Objectives

At the end of this class, you will be able to:

- Create a model of a structure that matches needs of the Steel and RC design modules of Autodesk Robot Structural Analysis Professional
- Define loads and load combinations to be correctly recognized in the design modules
- Apply principles of steel and concrete design modules and understand the influence of defined parameters on the design process
- Run concrete design of elements of a model

About the Speaker

Artur is a Structural Engineer. He graduated from Cracow's University of Technology. He has been working as a Support Specialist since 1996 at Robobat and since 2008 at Autodesk supporting Robot's users worldwide.

Introduction

Regardless of what kind of a structure you are about to design it is extremely important that you create its model in the manner that allows you to assign the correct design parameters to each of its elements. This document will not be a step by step guideline to follow but it will show you the ways for having models which are coherent with the design modules of RSA as well as indicate the rules that govern both steel and RC design in the program.

The topics discussed in this presentation are based both on my own experience as well as threads from Robot forum which I would like to encourage you to use as a platform to discuss them further or the place where you can both find help for your challenging issues and help others solve theirs.

1. Building a model

a) For Steel design

- Define bar elements in such a way it is easy to assign design parameters. Consider their role in a structure and design criteria
- Create multi span beams as single elements among supports (columns) rather than single elements and cantilevers as separate bars so that it is easy to define SLS (deflection) limits



• Enter columns as single elements instead of being defined through the entire height of a structure which allows for both defining their displacement limits as well assigning them to the stories (seismic analysis)



• Use "superbars" in case there is a need to split columns and beams between supports e.g. to define a connection or to change its section size (e.g. increase thickness of flanges of I section) on a part of its length



Mind that the local X axes of components of a "superbar" should point in the same direction.



Mind that the orientation of a "superbar" doesn't follow the direction of the local coordinate systems of its components. It is governed by the number of its origin and end node instead (lower node number is assumed as the start whereas the higher one as the end). To replace the origin with the end it is necessary to renumber the nodes which can be done using the numbering option.

L. Numbering			~
Nodes			
Node number:	1		
Step:	1		
Selection:			
			*
Bars/panels/objects:			
Object number:	1		
Step:	1		
Selection:			
			<u>^</u>
Standard numberir	ng		
Geometrical numb	ering	Paramet	ers
Confirmation of changes in numbering			
Apply	Cancel	Help	

• Use offsets (bar shortening) to generate additional bending moments on columns which originate from pinned connections of beams to their flanges



The relative definition of the offset for a member length automatically adjusts its value to a change in the size of a column.

• Trusses from library structures – to avoid instabilities it is recommended to create continuous chords and use releases or truss bar definitions on posts and diagonals only. It should be remembered to delete side posts which for typical situations overlap with already defined columns



• To define partial releases which represent real stiffness of connections you can use elastic release definition



A similar approach (partial releases) may be used to obtain additional bending in pinned connections among elements of a model for having safety margin.

New Release Definition							
Bars	Elastic	Dam	ping	Unidirec	tiona	al Gap 🚺	
Labe	el:						
Rele	eased dii	rection	1S				
© E	Elastic co	eff.					
	فندر استعرد	()	kN/m);	; (kN*m/	rad)		
	rartial stil	mess	coeff.			End	
Deg	jinning					Eliu	
0.00)		Ux			0,00	
0.00)		Uy			0,00	
0.00)		Uz			0.00	
0.00)		Rx			0.00	
0,01	1	v	Ry		1	0,01	
0,01	1	-	Rz		1	0,01	
Add Close Help							
	Auu			Close		Telp	

Additional references to the discussions on these topics on the Robot Forum:

http://forums.autodesk.com/t5/robot-structural-analysis/member-consisting-of-multiple-barsfor-design/td-p/3467536

http://forums.autodesk.com/t5/robot-structural-analysis/steel-design-divided-bar-2-identicalstructures-one-pass-and-one/td-p/3535282

http://forums.autodesk.com/t5/robot-structural-analysis/dimensionnement-des-barres-acier/tdp/3750349

http://forums.autodesk.com/t5/robot-structural-analysis/lateral-buckling-parameters/tdp/3536254

http://forums.autodesk.com/t5/robot-structural-analysis/minimum-eccentricity-for-steel-simplecolumns/td-p/3657566

http://forums.autodesk.com/t5/robot-structural-analysis/beam-offsets/td-p/4344866

http://forums.autodesk.com/t5/robot-structural-analysis/truss-design/td-p/3596600

http://forums.autodesk.com/t5/robot-structural-analysis/steel-design/td-p/3573540

b) For RC design

• Define bar elements with section types supported in design modules (neither use an RC Beam section for or an RC Column definition and vice versa nor use steel ones for either of them)

T New Section	New Section
General Parameters Label: Color Auto Image: Color Basic dimensions (cm) Reduction of mom. of inertia Use tapered section	General Parameters
Gamma angle: 0 ▼ (Deg) Section type: RC beam Add Close Help C12/15	Gamma angle: 0 ▼ (Deg) Section type: RC column Add Close Help C12/15

- Define bar elements and surfaces in such a way it is easy to assign design parameters. Consider their role in a structure and design criteria.
- You can create multi span beams as single elements among supports (columns) or as a single bar between the outside ones when you want to design them in the RC Beam Design module as it automatically detects spans but define spans of beams as separate bars if you intend to calculate required area of reinforcement inside the RC Member Required reinforcement module to be able to correctly define deflection limits

Member Type Definition - EN 1992-1	-1:2004 AC:2008
Beam Column	
Member: RC Beam	▼
Span length Support at support faces in axes coefficient *Lo ✓ Admissible deflection ✓ Relative f=L/ Z50	twidth ing 0.40 m end 0.40 m cording to structure geometry Absolute f= cm
 T-beam (slab considered) Maximum slab widths: b1= (m) b2= (m) b1.2= * slab thickness Simple bending. N=0 	Calculations for forces: Fx My/Fz My/Fz Mz/Fy Mx Additional parameters
Note	Close Help

• Enter columns as single elements instead of being defined through the entire height of a structure which allows for both defining their buckling parameters as well assigning them to the stories (seismic analysis). In addition you may find the access to their results easier especially in the Forces table.

Member Type Definition - EN 1992-1-1:2004 AC:2008						
Beam Column	1					
Member: RC Column	▼					
Buckling with respect to Y axis Member length ly at support faces real coeff. Buckling length coefficient	Buckling with respect to Z axis Member length Iz at support faces real coeff. m buckling length coefficient					
Ky: 1,00 Kz: 1,00 Maximum node displacement						

- Do not divide columns and beams between supports or stories (levels of beams) into smaller parts as such chains of elements are not supported correctly in the RC design module (with the exception of RC Beam Design one)
- To define RC Columns of different sizes at top of each other you can use offsets or (recommended) rigid links. If there is a slab "between" them you can define them in their real positions as they (top node of a bottom one and bottom node of a top one) will be connected by mesh elements of the slab.



• I shape RC Beams can only be designed in the RC Member Required reinforcement module.

• It is not recommended to use vertical offsets for RC Beams you want to design reinforcement for as they influence values of internal forces causing large increase of the axial force (tension) and significant reduction of the bending moment



- To design a T shape beam under a slab (panel) without using the offsets (for the reasons explained above) you may follow these steps:
- define a beam with a rectangular cross section that represents T shape "web" with no offset
- increase its IY moment of inertia so that it is the same as the T shape it "replaces"

T New Section	I New Section
General Parameters	General Parameters Label: B R20x50 Color Auto
Basic dimensions (cm) Basic dimensions (cm) b 20 bf 80 h 50 hf 15 Use tapered section	Reduction of mom. of inertia 1,00 * b 1,78 * Iy 1,00 * Iz b 20,0 Use tapered section b 50,0 b 50,0
Gamma angle: 0	Gamma angle: 0 (Deg) Section type: RC beam Add Close Help C12/15

- replace the rectangular section with the "original' T one after exporting a beam from a model to the RC Beam Design module

General parame	ters	
Label:	B T20x60	
Start:	0,00 🔻] <mark> +</mark> " h
End:	3,50 🔻	
		Basic dimensions (cm)
Adv	vanced	b 20 bf 80
Use tapered	section	n 00,0 nr 15
Apply	<<	>> Close Help

• In order to model curved RC beams you need to approximate them with number of smaller straight elements.



Then you can calculate required area of reinforcement in the RC Member Required reinforcement module.

- In order to correctly export a bar element from a model that represent a strap footing to the RC Continuous Footing (rather than to RC Beam) design module you should:
 - Define elastic soil as its attribute
 - Set it Structure object as Bar
 - In case of a T shape cross section assign it 180° (Gamma) rotation angle



• To obtain correct values of "cracked" deflection of a multi span slab with use of the equivalent stiffness method you should create number of smaller panel among the support lines rather than a single one "covering" the entire shape of the floor.



There are two main reasons for such way of creating a model:

- Equivalent stiffness of RC plate (see: <u>Help</u>) is calculated for each of the "spans" (panels) separately which is important for different geometries and loads on each of panels
- Scaling of elastic displacements is done for load which causes maximal deformation for given panel rather than for the load which causes maximal displacements from the point found in the entire floor.





Otherwise the stiffness update method should be used instead.

• To obtain unidirectional behavior of a slab in a model you may use the orthotropic thickness definition instead of the homogenous one and reduce value of Young modulus in the direction the slab is not supposed to "work"



- To define raft foundation you should you should define elastic soil as either:
- parameter of its thickness (recommended for it allows for display of stress in soil as a map)

I INCAN I	nickness		
Homoge	eneous Orthotropic		
t t			
l abel:	TH30_CONCF Color	Auto 👻	
© Cor	nstant Th =	30,0 (cm)	
🔘 Var	iable along a line		
🔘 Var	riable on a plane		Definition - Elastic
	Point coordinates	Thicknesses	Foundation elasticity
	(m)	(cm)	Elastic foundation coefficient
P1:	0,00; 0,00; 0,00	0,0	Ka = 50000 (kN/m3)
P2 :	0,00; 0,00; 0,00	0.0	
P3:	0,00; 0,00; 0,00	0.0	Uplift: None 🔻
R_	duction of the memory		Tangent elasticity
ofi	nertia	00 *1g >>	Automatic direction
	Parameters of foundati	on elasticity	Kx = 0,00 (kN/m3)
Matoria		2/15	Ky = 0,00 (kN/m3)
materia		2/13	
	Add Close	e Help	Add Close Help

- or elastic planar (surface) elastic support. Mind not to mark the Constant coefficient check box to allow the stiffness of each support generated in panel's node to be automatically calculated based on tributary area of elements of a mesh.

☆ Supports	Support Definition
	Rigid Elastic Friction Gap Nonlinear
Nodal Linear Pidiar X Delete % Fixed	Label: Support_2 Constant elastic coef. at support nodes
→ v _i <u>Finned</u> - Support_1 v _k wall	Fixed Elastic Unit directions: coefficients: 1/m2
	V UX KX = 0.00 kN/m
Current selection	UZ KZ = 50000 kN/m
Apply Close Help	RY HY = 0.00 kN*m/Deg RZ HZ = 0.00 kN*m/Deg
L	Angle Support directions are compatible with the global coordinate system Direction
	Advanced
	Add Close Help

Do not use both of them at the same time as the defined soil stiffness will add up.

Additional references to the discussions on these topics on the <u>Robot Forum</u>:

http://forums.autodesk.com/t5/robot-structural-analysis/buckling-length-coefficient-in-concretestructure/td-p/3092910

http://forums.autodesk.com/t5/robot-structural-analysis/column-height-should-i-stop-at-slabsor-go-all-the-way-down/td-p/3234202

http://forums.autodesk.com/t5/robot-structural-analysis/i-beam-section-choice-in-rc-elementsbeam-cross-section-menu/td-p/3251898

http://forums.autodesk.com/t5/robot-structural-analysis/consequence-of-axis-position-offsetexcentrement/td-p/3268158

http://forums.autodesk.com/t5/robot-structural-analysis/poutre-en-arc/td-p/3396489

http://forums.autodesk.com/t5/robot-structural-analysis/how-to-model-a-curved-beam-ortruss/td-p/3534426

http://forums.autodesk.com/t5/robot-structural-analysis/t-slab/td-p/3183798

http://forums.autodesk.com/t5/robot-structural-analysis/beam-offsets/m-p/3332921

http://forums.autodesk.com/t5/robot-structural-analysis/continuous-footing/td-p/5323957

http://forums.autodesk.com/t5/robot-structural-analysis/meshed-slab-supported-by-beams/tdp/3167096

http://forums.autodesk.com/t5/robot-structural-analysis/floors-span-direction/td-p/3349655

http://forums.autodesk.com/t5/robot-structural-analysis/sizing-slab/td-p/3280315

http://forums.autodesk.com/t5/robot-structural-analysis/mat-foundation-support/td-p/3899458

http://forums.autodesk.com/t5/robot-structural-analysis/aligment-of-two-column-elements-withdifferent-secction/td-p/4778935

2. Defining loads

- Live load applied on a multi span beam or slab defined in the model of a structure acts as applied (there is no automatic pattern load distribution). In case this is needed it should be replace with number of live loads defined on each of spans separately. It is suggested to do so only for currently designed level (story) or do so for a substructure saved based on the selection of a part (e.g. floor plus walls and column above and below it) of the entire model
- In case of multi-story building limit number of combinations to a reasonable value. The limit of automatically generated combinations can be entered in Job Preferences

Job Preferences	a cal dragger with	? X
Units and Formats Materials Detabases Design codes Structure Analysis Work Parameters Meshing	DEFAULTS Switch off selection synchronization between views or table Save results in external file: *.RT_ Maximal number of generated combinations 64000	5
😤 <u>O</u> pen defa	ult parameters	
■ <u>Save current pa</u>	rameters as default OK Cancel	Help

• In order to avoid the effect of unrealistic shortenings of RC Columns under self-weight of higher stories you can apply load in stages (phases)



Additional references to the discussions on these topics on the <u>Robot Forum</u>:

http://forums.autodesk.com/t5/robot-structural-analysis/load-sequencing-constructionstages/td-p/4568689

- 3. Working with the Steel Design module
- a) Setting design parameters (Member type definition)



• **Beams** - the proposed setting for typical situations is to use automatic detection of bracings as shown below:



Buckling Y Buckling Z Lateral buckling-upper flange Lateral buckling-lo	wer flange	
Define segments between bracings Define manually coordinates of the existing bracings *	Buckling coefficients of component segments	Structure Sway Non-sway
real relative Add automatically coordinates of bracings	Practice detection provider	
I at points with adjoining elements in the buckling plane	For member no.:	•
at all points where internal nodes are located	For load case: 0 SR	NF •
at points where bending moments equal zero	i real i) relative

Buckling Y Buckling Z Lateral buckling-upper flange Lateral buckling-	lower flange		
Define segments between bracings	Buckling coefficients of component	segments	
Define manually coordinates of the existing bracings *			
real (a) relative			
Add automatically coordinates of bracings	Bracing detection preview		
At points where adjoining elements are located	For member no.:		•
at all points where internal nodes are located	For load case:	0 SRNF	*1
at points where bending moments equal zero	© real	relative	
OK Cancel			Help

Buckling Y Buckling Z Lateral buckling-upper flange Lateral buckling-lo	wer flange		
Define segments between bracings	Buckling coefficients of component se	gments	
Define manually coordinates of the existing bracings *			
interview in the second			
Add automatically coordinates of bracings	Bracing detection preview		
At points where adjoining elements are located	For member no.:		•
at all points where internal nodes are located	For load case:	0 SRNF	▼
✓ at points where bending moments equal zero	<< Or contraction of the second secon	relative	*L
OK Cancel			Help

In addition for beams with large negative bending over supports you may decide to limit unrestrained lateral buckling length for the bottom flange to the parts where it is under compression • **Columns** – the use of automatic buckling length should be limited to 'box' shaped structures with perpendicular beams defined among rows of columns at levels of horizontal floors

Column		Save
length ly: 1,00	Buckling (z axis) Member length Iz: Real Coefficient	Close
Sway	Auto Non-sway	
auto 🔻	auto V	
		ĺ.
		1
25/1		
	ength ly: 1,00 gth coeff. y: Sway auto •	ength ly: 1,00 Buckling (z axis) Member length lz: Real 1,00 Coefficient Buckling length coeff. z: Auto Non-sway Buckling curve z auto

It is strongly recommended not to alter settings for member length and keep the default 1.00 coefficients in these fields.

- X Serviceability - Displacement Values Limit displacements ОК Member deflection (local system) Cancel Final deflection Help Deflection from live loads Cantilever ----y=L / 200,0(Z=L / 200,0(Node displacements (global system) I X=L / 150,0(Y=L / 150,0(Members with camber Check of displacements with camber considered Over-defined camber uy = **0,0** cm uz = **0,0** O Automatic camber (additional parameters may be found in the dialog box for calculation
- A beam vs. a cantilever (use of Cantilever check box) for SLS verification

If the check box is not marked then the deflection is checked as the distance between the line that connects the beam ends in the positions they are after applying the load and the point along the beam that 'moves' the most whereas for the cantilever check box marked what is checked is the difference in displacement of the end nodes.



5 Calculations - EN 1993-1:20	05/AC:2009	X
Verification options		
Member verification:		List
Ocode group verification:		List
Ocode group design:		List
Optimization	Options	
Limit states		
VLS :	1to20	List
SLS:	1to4 21to44	List
Calculation archive		
Save calculation results	Results storage	
OK Configuration	Calculations	lp

b) Setting Calculations parameters (Configuration dialog)

• Deciding on number of calculation points

In general it is recommended to set relatively large number of verification points along a bar (usually the default 3 is good enough only for simply supported beams with uniform or point load in its middle)



You may reduce their number when there are additional nodes along a bar as the points are set for calculation elements rather than the bar itself. This functionality is used to prevent "skipping" the point where a concentrated force is applied but in order to have it applied you need to define a point force with a calculation node:

Π	Bar	Force		_ 🗆 🗙
		Ļ	F M ×	
	Valu	es F (kN)	M (kN*m)	又 (Deg)
	X:	0.00	0.00	0,0
	Y:	0,00	0,00	0.0
	Z:	0,00	0.00	0.0
	Соо	rd. system:	Global	C Local
			Loads on eccen	tricity
	Coor	rdinate		
	x =	0,50	Relative	(x/L)
			Absolute	(m)
		Generate a ca at the point wi	alculation node nere a load is ap	plied
		Add	Close	Help

It is recommended to have the Simultaneous calculations check box marked as max/min forces are assumed as the ones with largest absolute values (sign is ignored) and such points may not be the governing ones (this depends e.g. on locations of bracings as well)

5 Configuration		X
Calculation points		ОК
Number of points:	3	
Characteristic points	Options	Cancel
Calculation parameters		
Efficiency ratio:	1,00	
Maximum slenderness:	210,00	
5 Calculations in Characte	eristic Points	×
Simultaneous calculation even-division points	ns in characteris	tic points and in the
Points for min/max values		
max Fx		
I max Fy ✓ max Fz	n n	nax Mz
Coordinates of additiona	al points	
		* L
Relative	() A	bsolute
OK Canc	el	Help

The results are displayed from the point where calculated ratio is the highest however you may run the check in an arbitrary selected location along a bar using the following settings:



• Excluding some internal forces from calculations

In some situation you may want to exclude small axial forces or bending moments to run design against simple bending or unidirectional bending with axial force instead of biaxial bending (with axial force)

This can be done by setting the limits below which the effect they cause are considered to be small enough to be neglected. It is recommended to use the relative stress limit as such definition is more "general" and can be applied to sections of different sizes. Mind to set both negative and positive values.

Member verification:	Calculation points Number of points:	Internal force	Do All:	not consider the fo	ollowing forces in o tresses in the inte	calculations: rval: MPa
Code group verification:	Characteristic points Options	⊘ Fx		min = -2	max = 2	🔽 % sig. adm
Optimization Options	Efficiency ratio: 1.00	E Fy	\square	min = 0,00	max = 0,00	🗌 % sig. adm
bads Limit state	Maximum slendemess: 210,00	Fz Fz	$[\forall]$	min = 0.00	max = 0.00	🗌 % sig. adn
ases: Uitimate	Components of complex bars are not taken into account	Mx	1	min = 0,00	max = 0,00	🗌 % sig. adr
Save calculation results	Bastic analysis	My	\checkmark	min = 0,00	max = 0.00	🗌 % sig. adr
OK Configuration Calculations Help	[6.2.6]	mz Mz	\square	min = 0.00	max = 0.00	🗌 % sig. adr
	Method 1 [Annex A] Method 2 [Annex B]	Zero]	ОК	Cancel	Help
	Fire analysis					
	Analysis according EN 1993-1-2 ; * Verification method: Resistance dor *					
	Exclude internal forces from calculations					
	Code Robot					
	Camber Take the deflections from the					

• Finding best matching section (Code group design)

In most situations you want to find a best (the same) section for selected group of elements of a model (e.g. internal columns on the 2nd floor or main girders of a roof) and the design criteria is weight (cost) rather than ratio closest to 1. In such case you need to create design groups based on list of elements from such group

Definitions - EN 1993-	-1:2005/AC:2009	
Members Groups		
Number: Basic data	1 •	New
Member list:	326 346 366 459	Sections
Name:	1	Par. sections
Material:	Steel EC3 Steel S235	
ОК	Delete Save	Help

and select the optimization parameters

Calculations - EN 1993-1:2	005/AC:2009		X	
Verification options				
Member verification:	1		List	
Code group verification:			List	
Ode group design:	1		List	
Optimization	Option	IS		
Optimization Options				X
Optimization options				
Veight		(cm)		ancel
Maximum section height:		0,0		
Minimum section height:		0.0		
Maximum flange width:		0.0		
Minimum flange thickness:		0.0		
Minimum web thickness:		0.0		
Calculations for the entire se	t of sections		Н	lelp

Mind that the code group design (contrary to the member verification) is based on the material assigned to the group rather than to elements that this group includes

Definitions - EN 19	993-1:2005/AC:2009	
Members Groups		
Number: Basic data	1 🗸	New
Member list	326 346 366 459	Sections
Name:	1	Par. sections
Material:	Steel EC3 Steel S235	
ОК	Delete Save	Help

• Finding best matching section for each beam or column of a model separately

As such operation can only be performed on groups it is necessary to create them for each of element of a model separately (one element = one group). This can be done automatically by typing all/-1 in the list of bars and pressing the ENTER key

Definitions - EN 199	3-1:2005/AC:2009	
Members Groups		
Number:	1 •	New
Member list:	all /-1	Sections
Name:	1	Par. sections
Material:	Steel EC3 Steel S235	
ОК	Delete Save	Help

• Limiting search to only these profiles which are available (on stock)

Selection of Sections	
Databases:	Section families:
Europe Eurocode 1995 User	HEA HEAA HEB
	Sections:
TT	HEB 100 HEB 120 HEB 140 HEB 160
	HEB 180 HEB 200
	Selected sections:
Delete selection Delete all	HEA 160 HEA 220 HEA 280 HEA 320 HEB 180 HEB 200
ОК	Close Help

Marking the check box moves all profiles from the marked database or family to the selected (available for design) section list.

Selecting a database allows for picking up families or single profiles

If no selection is done the design assumes that all profiles from the family of a section assigned to a beam can be used.

• Design of user created section is based on selected section type (verification path and formulas to be used) as well as entered section geometrical properties (section class determination) e.g. for I section with additional welded plates as discusses at the beginning of the presentation



When section type is left as "?" the verification is done as for a solid rectangular profile

• Managing the results of code checking

To check which elements failed and to what degree you can follow the steps illustrated on the pictures below:

Member Section Material Lay Laz Ratiof Case 9015 AA21 W 14x48 Metal-Steel 56.93 106.44 40.00 35.1257b + 1.47W. 9420 W21.3 W 14x74 Metal-Steel 18.50 72.31 1.44 17.1257D + 1.5%L 9310 X20.6 W 14x74 Metal-Steel 30.60 111.32 1.31 17.1257D + 1.5%L 9310 X20.6 W 14x74 Metal-Steel 31.69 85.68 1.24 15.1257D + 1.5%L 9330 X22 W 14x74 Metal-Steel 17.31 81.78 1.20 32.1257D + 1.5%L 9410 W20.6 W 14x74 Metal-Steel 73.3 81.78 1.08 32.1257D + 1.5%L 9210 Y20.6-2 W 8x24 Metal-Steel 49.19 10.45 1.06 31.1257D + 1.5%L 9230 V20.6-2 W 8x24 Metal-Steel 12.6 1.64 2.0 1.41.4257D + 1.5%L 9210 Y20.6-2 W 14x34 Metal-St	Besults Manage	~			-		
915 AA21 W 14x88 Metal - Steel 56.93 106.44 Acta De 129'D + 1.4'W. 9130 V220 W 14x82 Mf1. Sort by ratio .5'L + 910 V206 W 14x74 Metal - Steel 18.50 72.31 1.44 17.125'D + 1.5'L + 910 V20.6 W 14x74 Metal - Steel 35.66 91.59 1.30 17.125'D + 1.5'L + 9200 V20.6 W 14x74 Metal - Steel 37.80 85.68 1.21 17.125'D + 1.5'L + 9210 V20.6 W 14x74 Metal - Steel 17.93 81.77 1.20 21.25'D + 1.5'L + 9210 V20.6 W 14x72 Ateal - Steel 17.93 81.77 1.20 21.25'D + 1.5'L + 9210 V20.6 W 14x72 Ateal - Steel 17.31 81.77 1.20 21.25'D + 1.5'L + 9210 V20.6 W 14x73 Metal - Steel 17.4 1.68 1.68 17.1 1.25'D + 1.5'L + 9210 V20.6 W 14x74 Metal - Steel 17.30 64.82 1.68 1.72.5'D + 1.5'L +	Member	Sectio	on Material	Lav	1.87	Ratic	Case
9420 W11.3 W W H4X2 M I. Sort by ratio 15'L- 15'L- 15'L- 93'D 9310 X20.6 W W 14x74 Metal - Steel - 93'D 13.64 17.125'D + 15'L + 93'D 9310 X20.6 W W 14x74 Metal - Steel - 93'D 35.06 91.59 1.30 17.125'D + 15'L + 93'D 9300 X22 W W 14x74 Metal - Steel - 93'D 31.59 95.68 12.41 15.125'D + 15'L + 93'D 9300 W22 W W 14x74 Metal - Steel - 93'D 17.125'D - 15'L + 125'D - 15'L + 92'D 12.01 21.25'D - 15'L + 125'D - 15'L + 125'D - 15'L + 125'D - 15'L + 92'D 12.01 21.25'D - 15'L + 125'D - 15'L + 125'D - 15'L + 125'D - 15'L + 92'D 12.01 12.15'D - 15'L + 125'D - 15'L + 125'D - 15'L + 92'D 12.15'D - 15'L + 125'D - 15'L + 92'D 12.15'D - 15'L + 125'D - 15'L + 92'D 12.15'D - 15'L + 92'D 11.12'D - 15'L + 92'D 12.15'D - 15'L + 92'D 12.15'D - 15'L + 92'D 11.12'D - 15'L + 92'D 12.15'D - 15'L + 92'D 12.15'D - 15'L + 92'D 12.15'D - 15'L + 92'D 11.1	9015 AA21	× 14x4	48 Metal - Steel -	56.93	106.45	45.00	36 1.25*D + 1.4*W-
9130 Z22 W H 4x74 M_L SOFT Dy ratio 9310 X20.6 W 12x58 Metal - Steel 18.50 72.31 1.44 17 12570 + 1.571 + 9510 V20.6 W 14x74 Metal - Steel 33.68 111.32 1.31 17 12570 + 1.571 + 9300 X22 W 14x43 Metal - Steel 31.59 85.68 1.24 15 12570 - 1.571 + 9410 W20.6 W 14x47 Metal - Steel 73.31 81.78 1.20 21 2570 - 1.571 + 9410 W20.6 W 14x47 Metal - Steel 59.04 87.11 1.08 32 12570 - 1.47W 9210 Y20.62 W 8x24 Metal - Steel 17.31 81.87 1.06 17 12570 - 1.571 + 9210 Y20.62 W 8x24 Metal - Steel 17.30 84.62 1.05 32 12570 - 1.47W 9210 Y20.62 W W4x43 Metal - Steel 17.25 0.64.82 1.05 32 12570 - 1.571 + 9300 X0 W 14x74 Metal - Steel <t< td=""><td>9420 W21.3</td><td>🔀 W 14x8</td><td>32 Me1 Co</td><td></td><td>vetie</td><td></td><td>1.5*L +</td></t<>	9420 W21.3	🔀 W 14x8	32 Me 1 Co		vetie		1.5*L +
9310 X20.6 X V12x56 Metal - Steel - 43.68 111.32 1.31 171 (25°D + 1.5°L + 9320 X21.3 X V14x43 Metal - Steel - 30.68 111.32 1.31 171 (25°D + 1.5°L + 9300 X22 X V14x43 Metal - Steel - 31.59 85.68 1.24 151 (25°D + 1.5°L + 9410 W20 X V14x74 Metal - Steel - 17.31 81.70 1.20 32 1 25°D + 1.5°L + 9520 V21.3 X V14x74 Metal - Steel - 17.31 81.70 1.20 32 1 25°D + 1.5°L + 9230 Y22 X V14x74 Metal - Steel - 59.04 87.11 1.08 32 1 25°D + 1.5°L + 9210 Y20.6 X W14x74 Metal - Steel - 59.04 87.11 1.08 32 1 25°D + 1.5°L + 9211 Y20.6-2 X W14x74 Metal - Steel - 17.0 84.82 1.06 31 1.25°D + 1.5°L + 9300 X20 X W14x74 Metal - Steel - 17.0 64.82 1.02 17 1.25°D + 1.5°L + 9300 X20 X W14x74 Metal - Steel - 15°L +	9130 Z22	😢 W 14xi	74 Me 1. 50	rt by	ratio	<u> </u>	1.5*L +
9510 V20.6 W W 14x74 Metal - Steel - 43.68 111.32 1.31 17 1 25*D + 1.5*L + 9320 V21.3 W W 14x43 Metal - Steel - 35.06 91.59 1.30 17 1 25*D + 1.5*L + 9410 W20.6 W W 14x74 Metal - Steel - 37.08 95.86 1.21 17 1 25*D + 1.5*L + 9420 W21.3 W V 14x74 Metal - Steel - 17.31 81.76 1.20 32 1 25*D + 1.5*L + 9230 Y22 W V14x74 Metal - Steel - 17.31 81.76 1.20 32 1 25*D + 1.5*L + 9230 Y22 W V14x74 Metal - Steel - 17.30 64.82 1.06 17 1 25*D + 1.5*L + 9211 Y20.62 W W 14x53x1 Metal - Steel - 17.30 64.82 1.06 31 1 25*D + 1.5*L + 9211 Y20.62 W W 14x74 Metal - Steel - 17.05 64.82 1.06 31 1 25*D + 1.5*L + 9200 Y21 W 14x43 Metal - Steel - 17.6*A 0.85 14 125*D + 1.5*L + <tr< td=""><td>9310 X20.6</td><td>🔀 W 12x5</td><td>58 Metal - Steel -</td><td>18.50</td><td>72.31</td><td>1.44</td><td>17 1.25*D + 1.5*L +</td></tr<>	9310 X20.6	🔀 W 12x5	58 Metal - Steel -	18.50	72.31	1.44	17 1.25*D + 1.5*L +
9320 X21.3 X W 14X43 Metal - Steel 35.06 91.59 1.30 17 1.25'D + 1.5'L + 930 X22 X W 14X74 Metal - Steel 31.59 85.88 1.24 15 1.25'D + 1.5'L + 9410 W20 X W 14X74 Metal - Steel 17.31 81.78 1.20 32 1.25'D + 1.5'L + 920 V21.3 X W 14X74 Metal - Steel 17.31 81.78 1.20 32 1.25'D + 1.5'L + 9210 Y20.6 X W 831 9210 Y20.6 X W 831 9210 Y20.6 X W 8321 9210 Y20.6 X W 8324 Metal - Steel 49.19 104.56 1.06 17 1.25'D + 1.5'L + 9300 XA22 X W 14x74 Metal - Steel 49.19 104.56 1.06 17 1.25'D + 1.5'L + 9300 X22 X W 14x74 Metal - Steel 49.19 104.56 1.06 17 1.25'D + 1.5'L + 9300 X22 X W 14x74 Metal - Steel 17.30 64.82 1.06 31 1.25'D + 1.4'W 9215 Y21 X W 14x74 Metal - Steel 33.64 81.94 1.02 17 1.25'D + 1.5'L + 9220 Y21.3 W 14x74 Metal - Steel 51.67 4.6 0.89 17 1.25'D + 1.5'L + 9220 A21.3 W 14x74 Metal - Steel 97.72 92.00 0.88 14 1.25'D + 1.5'L + 9220 A21.3 W 14x43 Metal - Steel 70.75 88.61 0.84 17 1.25'D + 1.5'L + 921 Y21.3 W 14x43 Metal - Steel 70.75 88.61 0.84 17 1.25'D + 1.5'L + 9220 Y21.3 W 14x43 Metal - Steel 70.75 88.61 0.84 17 1.25'D + 1.5'L + 921 Y21.3 W 14x43 Metal - Steel 70.75 88.61 0.84 17 1.25'D + 1.5'L + 921 Y21.3 W 14x43 Metal - Steel 70.75 88.61 0.84 17 1.25'D + 1.5'L + 9310 X20.6 W 14x74 Metal - Steel 70.75 88.61 0.84 17 1.25'D + 1.5'L + 9310 Y20.6 X W 14x74 Metal - Steel 70.75 88.61 0.84 17 1.25'D + 1.5'L + 9310 X20.6 W 14x74 Metal - Steel 17.31 81.70 1.21 17 1.25'D + 1.5'L + 930 X22 X W 14x74 Metal - Steel 17.31 81.70 1.20 32 1.25'D + 1.5'L + 930 X22 X W 14x74 Metal - Steel 10.31 1.31 17 1.25'D + 1.5'L + 930 X22 X W 14x74 Metal - Steel 10.31 1.32 1.31 17 1.25'D + 1.5'L + 930 X22 X W 14x74 Metal - Steel 10.31 1.30 17 1.25'D + 1.5'L + 930 X22 X W 14x74 Metal - Steel 10.31 1.30 17 1.25'D + 1.5'L + 930 0.22 X W 14x74 Metal - Steel 10.31 1.30 17 1.25'D + 1.5'L + 930 0.22 X W 14x74 Metal - Steel 10.31 1.30 17 1.25'D + 1.5'L + 930 0.22 X W 14x74 Metal - Steel 10.30 1.2 1.2 17 1.25'D + 1.5'L + 930 0.22 X W 14x74 Metal - Steel 10.33 1.25'D + 1.5'L + 930 0.22 X W 14x74 Metal - Steel 10.70 1.4'W 9	9510 V20.6	🔀 W 14xi	74 Metal - Steel -	43.68	111.32	1.31	17 1.25*D + 1.5*L +
9300 x22 W W 14x43 Metal - Steel- 31.59 85.68 1.24 15.125'D + 1.5'L + 9410 W20.6 W V 14x74 Metal - Steel- 38.84 65.39 1.21 17.125'D + 1.5'L + 9500 V21.3 W V 14x74 Metal - Steel- 17.31 81.76 1.20 32.15'D + 1.5'L + 9200 V22.6 W V 14x74 Metal - Steel- 17.31 81.76 1.20 32.15'D + 1.5'L + 9210 V20.6 W W 14x74 Metal - Steel- 19.90 A3.25'D + 1.5'L + 9300 X22 W 14x61 Metal - Steel- 17.00 64.82 10.66 31.125'D + 1.5'L + 9300 X20 W W14x74 Metal - Steel- 17.00 64.82 10.21 17.125'D + 1.5'L + 9300 X20 W W14x74 Metal - Steel- 17.8'G - 7.46 0.89 17.125'D + 1.5'L + 9200 V21.3 W V14x43 Metal - Steel- 17.2'G - 0.6'S - 1.4''W- 9202 V21.3 W V14x43 Metal - Steel- 10.6'A - 1	9320 X21.3	🔀 W 14x4	43 Metal - Steel -	35.06	91.59	1.30	17 1.25*D + 1.5*L +
9410 W20.6 W 14x74 Metal Steel 38.84 65.39 1.21 17 1.25'D + 1.5'L + 9400 W20 W 14x74 Metal Steel 17.31 81.78 1.20 32 1.25'D + 1.5'L + 9200 Y22 W 14x72 Select records 1.25'D + 1.5'L + 1.25'D + 1.5'L + 9030 XA22 W W 14x53x1 Metal - Steel - 12.45 18.67 1.06 31 1.25'D + 1.5'L + 9210 Y20.6 W W 14x74 Metal Steel - 17.30 64.82 1.05 32 1.25'D + 1.5'L + 9200 X20 W W 14x74 Metal Steel - 15.78 67.46 0.89 17 1.25'D + 1.5'L + 9200 V21.3 W W14x74 Metal Steel - 15.78 67.46 0.89 17 1.25'D + 1.5'L + 9200 V21.3 W W14x74 Metal Steel - 15.78 67.46 0.89 17 1.25'D + 1.5'L + 9200 V21.3 W W14x74 Metal Steel - 15.78 67.46 0.89 17 1.25'D + 1.5'L + 9200 V21.3 W W14x43 Metal Steel - 15.78 67.46 0.89 17 1.25'D + 1.5'L + 9200 V21.3 W W14x43 Metal Steel - 28.48 88.76 0.85 32 1.25'D + 1.5'L + 921 Y21.32 W W14x43 Metal Steel - 70.75 88.61 0.84 17 1.25'D + 1.5'L + 921 Y21.32 W W14x43 Metal Steel - 70.75 88.61 0.84 17 1.25'D + 1.5'L + 9310 X206 W W14x43 Metal Steel - 70.75 88.61 0.84 17 1.25'D + 1.5'L + 9310 X206 W W14x74 Metal Steel - 70.75 88.61 0.84 17 1.25'D + 1.5'L + 9310 X206 W W14x74 Metal Steel - 70.75 88.61 0.84 17 1.25'D + 1.5'L + 9310 X206 W W14x74 Metal Steel - 70.75 88.61 0.84 17 1.25'D + 1.5'L + 9310 X206 W W14x74 Metal Steel - 70.75 88.61 0.84 17 1.25'D + 1.5'L + 9320 X21 3 W W14x32 Metal Steel - 70.75 88.61 0.84 17 1.25'D + 1.5'L + 9320 X21 3 W W14x74 Metal Steel - 70.75 88.61 0.84 17 1.25'D + 1.5'L + 9320 X21 W W14x74 Metal Steel - 70.75 88.61 0.64 17 1.25'D + 1.5'L + 9320 X21 W W14x74 Metal Steel - 70.75 8.61 0.64 17 1.25'D + 1.5'L + 9300 X20 W W14x74 Metal Steel - 70.76 8.61 0.64 17 1.25'D + 1.5'L + 9000 AA22 W W14x74 Metal Steel - 70.76 8.61 0.64 17 1.25'D + 1.5'L + 9000 X20 W W14x74 Metal Steel - 70.77 92.00 0.89 14 1.25'D + 1.5'L + 9000 V20 W W14x33 Metal Steel -	9330 X22	🔀 W 14x4	43 Metal - Steel -	31.59	85.68	1.24	15 1.25*D + 1.5*L +
9400 W20 W 14x74 Metal - Steel 17.31 81.76 1.20 32 1.25*0 + 1.4*W- 9520 Y21.3 W 14x72 2. select records 1.25*0 + 1.5*L + 9210 Y20.6 W 14x74 Metal - Steel 59.04 87.11 1.08 32 1.25*0 + 1.5*L + 9200 Y20 W 14x74 Metal - Steel 49.19 104.56 1.06 17 1.25*D + 1.5*L + 9200 X20 W 14x74 Metal - Steel 17.30 64.82 1.05 32 1.25*D + 1.4*W- 9300 X20 W 14x74 Metal - Steel 17.30 64.82 1.05 32 1.25*D + 1.4*W- 9217 Y20.6-2 W 14x74 Metal - Steel 136.64 20.67 0.65 1.41.25*D + 1.5*L + 9300 X20 W 14x74 Metal - Steel 136.64 20.67 0.65 1.41.25*D + 1.5*L + 9220 Y21.3 W 14x74 Metal - Steel 157.6 67.46 0.88 17 1.25*D + 1.5*L + 9200 A21.3 W 14x43 Metal - Steel 28.44 74.16 0.84 17 1.25*D + 1.5*L + 921 Y21.3-2 W 14x43 Metal - Steel 70.75 88.61 0.81 17 1.25*D + 1.5*L + 9310 X20.6 W 14x74 Metal - Steel 70.75 88.61 0.84 <td>9410 W20.6</td> <td>😢 W 14xi</td> <td>74 Metal - Steel -</td> <td>38.84</td> <td>65.39</td> <td>1.21</td> <td>17 1.25*D + 1.5*L +</td>	9410 W20.6	😢 W 14xi	74 Metal - Steel -	38.84	65.39	1.21	17 1.25*D + 1.5*L +
9520 V21.3 W 14x7 2. select records 125*0 + 1.5*1, + 9210 V20.6 W 8x31 125*0 + 1.5*1, + 9030 AA22 W 14x81 Metal - Steel - 59.04 87.11 1.08 321.25*0 + 1.5*1, + 9030 AA22 W 14x831 Metal - Steel - 49.19 104.56 1.06 17.125*0 + 1.5*1, + 9630 U22 W W 14x74 Metal - Steel - 124.5 18.87 1.06 31.125*0 + 1.5*1, + 9630 X20 W 14x74 Metal - Steel - 13.64 81.94 1.02 17.125*0 + 1.5*1, + 9200 X20 W 14x74 Metal - Steel - 15.64 29.67 0.65 14.125*0 + 1.5*1, + 9215 V21.3 W 14x74 Metal - Steel - 15.76 67.46 0.88 17.125*0 + 1.5*1, + 9200 AA21.3 W 14x43 Metal - Steel - 70.75 88.61 0.84 17.125*0 + 1.5*1, + 9215 V21.32 W 14x43 Metal - Steel - 70.75 88.61 0.84 17.125*0 + 1.5*1, + 9210 Y21.32 W 14x43 Metal - Steel - 70.75 88.61 0.84 17.125*0 + 1.5*1, + 9210 Y21.32	9400 W20	😢 W 14xi	74 Metal - Steel -	17.31	81.78	1.20	32 1.25*D + 1.4*W-
9230 Y22 Y2 Y 125'D + 1.5'L + 9210 Y20.6 Y W 8x31 125'D + 1.5'L + 9030 AA22 Y W 4x81 Metal - Steel - 59.04 87.11 1.08 321.25'D + 1.5'L + 9830 U22 Y W 4x53x1 Metal - Steel - 12.45 18.87 1.06 311.25'D + 1.5'L + 9830 U22 Y W 14x74 Metal - Steel - 17.30 64.82 1.05 321.25'D + 1.5'L + 9215 Y21 Y W 14x74 Metal - Steel - 33.64 81.94 1.02 17 1.25'D + 1.5'L + 9220 Y21.3 Y W 14x73 Metal - Steel - 97.72 92.00 0.68 14 1.25'D + 1.5'L + 9020 AA21.3 W W 14x43 Metal - Steel - 28.64 74.16 0.84 17 1.25'D + 1.5'L + 9015 AA21 W W 14x43 Metal - Steel - 70.75 88.61 0.84 17 1.25'D + 1.5'L + 9101 Z206 W 14x43 Metal - Steel - 70.75 88.61 0.84 17 1.25'D + 1.5'L + 9310 X206 W 14x47 Metal - Steel - 35.06<	9520 V21.3	🔀 W 14xi	2 select	reco	rds		1.25*D + 1.5*L +
9210 Y20.6 W 8x31 1.25'D + 1.5'L + 9030 A222 W 14x61 Metal - Steel - 59.04 87.11 1.08 32 1.25'D + 1.5'L + 9630 U22 W W14x53x1 Metal - Steel - 19.45 1.06 31 1.25'D + 1.5'L + 9630 U22 W W14x74 Metal - Steel - 12.45 18.87 1.06 31 1.25'D + 1.5'L + 9630 X20 W 14x74 Metal - Steel - 17.0 64.82 1.05 32 1.25'D + 1.5'L + 9530 X/20 W 14x74 Metal - Steel - 15.76 67.46 0.89 17 1.25'D + 1.5'L + 9520 Y21.3 W V14x78 Metal - Steel - 15.76 67.46 0.89 17 1.25'D + 1.5'L + 9020 A21.3 W V14x43 Metal - Steel - 77.72 92.00 0.89 14 1.25'D + 1.5'L + 915 V21.3 W V14x43 Metal - Steel - 70.75 88.61 0.84 17 1.25'D + 1.5'L + 9420 W21.3 W V14x48 Metal - Steel - 70.75 88.61 0.84 17 1.25'D + 1.5'L + 9105 AA21 W V14x48 Metal - Steel - 18.50 72.31 1.44 17 1.25'D + 1.5'L + <td>9230 Y22</td> <td>🔀 W 14xi</td> <td></td> <td></td> <td></td> <td></td> <td>1.25*D + 1.5*L +</td>	9230 Y22	🔀 W 14xi					1.25*D + 1.5*L +
9030 AA22 W 14x61 Metal - Steel 59.04 87.11 1.08 32 1.25*D + 1.4*W- 9211 Y20.6-2 W WA24 Metal - Steel 49.19 104.56 1.06 17 1.25*D + 1.5*L+ 9300 X20 W W14x53x1 Metal - Steel 17.30 64.82 1.06 31 1.25*D + 1.5*L+ 9300 X20 W W14x74 Metal - Steel 17.30 64.82 1.05 32 1.25*D + 1.5*L+ 9200 Y21.3 W W14x74 Metal - Steel 15.78 67.46 0.89 17 1.25*D + 1.5*L+ 9200 A201 W W14x43 Metal - Steel 28.84 88.76 0.85 32 1.25*D + 1.5*L+ 9200 A21.3 W W14x43 Metal - Steel 28.84 88.76 0.85 32 1.25*D + 1.5*L+ 9215 V21 W 14x43 Metal - Steel 70.75 88.61 0.84 17 1.25*D + 1.5*L+ 9420 W21.3 W 14x43 Metal - Steel 70.75 88.61 0.84 17 1.25*D + 1.5*L+ 910 Y20.6 W 14x43 Metal - Steel 18.50 72.31 1.44 17 1.25*D + 1.5*L+ 9300 X20.6 W 14x74 Metal - Steel 18.50<	9210 Y20.6	🐱 W 8x31					1.25*D + 1.5*L +
9211 72005-2 W M 5x24 Metal - Steel - 49.19 104.56 1.06 17 1.25'D + 1.5'L + 9630 V22 W M 4x74 Metal - Steel - 12.45 18.67 1.06 31 1.25'D + 1.4'W- 9215 V21 W M 4x74 Metal - Steel - 17.05 64.82 1.05 32 1.25'D + 1.5''L + 9200 V21 W M 4x74 Metal - Steel - 17.72 92.00 0.89 14 1.25'D + 1.5''L + 9200 V21.3 W M 4x43 Metal - Steel - 28.47 67.46 0.89 17 1.25'D + 1.5''L + 9020 AA21.3 W M 4x43 Metal - Steel - 28.41 74.16 0.84 14 1.25'D + 1.5''L + 9215 V21 W 14x43 Metal - Steel - 70.75 88.61 0.84 17 1.25'D + 1.5''L + 921 V21.3-2 W 14x43 Metal - Steel - 70.75 88.61 0.84 17 1.25'D + 1.5''L + 9310 X20.6 W 14x74 Metal - Steel - 50.93 106.45 4.0'O 1.5''L + 9310 X20.6 W 14x43 Metal - Steel - 35.68 124'L 17 1.25'D + 1.5''L + 1.5''L + 9310 X20.6 W 14x74 Metal - Steel -<	9030 AA22	🐱 W 14x8	61 Metal - Steel -	59.04	87.11	1.08	32 1.25*D + 1.4*W-
9930 U22 WW 14x53x1 Metal - Steel - 12.45 18.87 1.06 311 25*D + 1.4*W- 9300 X20 W 14x74 Metal - Steel - 17.30 64.82 1.05 32 1 25*D + 1.4*W- 9215 Y21 W 14x74 Metal - Steel - 15.78 67.46 0.89 17 1.25*D + 1.5*L + 9200 V21.3 W 14x43 Metal - Steel - 97.72 92.00 0.85 14 1.25*D + 1.5*L + 9020 AA21.3 W 14x43 Metal - Steel - 97.72 92.00 0.85 32 1.25*D + 1.5*L + 9020 AA21.3 W 14x43 Metal - Steel - 97.72 92.00 0.88 14 1.25*D + 1.5*L + 9020 AA21.3 W 14x43 Metal - Steel - 70.75 88.61 0.84 14 1.25*D + 1.5*L + 9215 V21.3 W 14x43 Metal - Steel - 56.93 106.45 45.00 36 1.25*D + 1.4*W- 9420 W21.3 W 14x82 M41 Sort by ratio 36 1.25*D + 1.5*L + 9310 X20.6 W 14x74 Metal - Steel - 45.68 111.32 1.3*L +	9211 Y20.6-2	W 8x24	4 Metal - Steel -	49.19	104.56	1.06	17 1.25*D + 1.5*L +
9215 Y21 X W 14X74 Metal - Steel - 17.30 64.82 1.05 32 1 2570 + 1.3*W 9215 Y21 X W 14X74 Metal - Steel - 33.64 81.94 1.02 17 1 25'0 + 1.5*L + 9220 Y21.3 W V14X78 Metal - Steel - 97.72 92.00 0.89 14 1.25*D + 1.5*L + 9020 AA21.3 W V14x43 Metal - Steel - 28.84 88.76 0.85 32 1.25*D + 1.5*L + 9020 AA21.3 W V14x43 Metal - Steel - 28.84 88.76 0.85 32 1.25*D + 1.5*L + 9215 V21 W V14x43 Metal - Steel - 70.75 88.61 0.84 17 1.25*D + 1.5*L + 9215 V21 W V14x43 Metal - Steel - 70.75 88.61 0.84 17 1.25*D + 1.5*L + 915 V21 W V14x48 Metal - Steel - 56.93 106.45 45.00 36 1.25*D + 1.5*L + 9310 X20.6 W V14x74 Metal - Steel - 43.66 72.31 1.44 17 1.25*D + 1.5*L + 9320 X21.3 W V14x74 Metal - Steel - 35.06 91.59 1.30 17 1.25*D + 1.5*L + 9330 X22 W V14x74 Metal - Steel - 35.06 91.59 1.30 </td <td>9630 U22</td> <td>WW 14</td> <td>x53x1 Metal - Steel -</td> <td>12.45</td> <td>18.87</td> <td>1.06</td> <td>31 1.25*D +1.4*W-</td>	9630 U22	WW 14	x53x1 Metal - Steel -	12.45	18.87	1.06	31 1.25*D +1.4*W-
Sector 1/21 W W Itel Steel 33.84 31.94 1.02 171 1.52 1.51 1.52 9220 Y21.3 W W/14x43 Metal Steel 15.78 67.46 0.89 171.25'D + 1.5'L + 9200 W W/14x43 Metal Steel 97.72 92.00 0.89 141.25'D + 1.5'L + 9000 W W/14x43 Metal Steel 28.84 88.76 0.85 321.25'D + 1.5'L + 9020 AA21.3 W W/14x43 Metal Steel 28.41 74.16 0.84 141.25'D + 1.5'L + 9215 V21.3 W W/14x43 Metal Steel 70.75 88.61 0.84 171.25'D + 1.5'L + 9300 X20.6 W W/14x43 Metal Steel 56.93 106.45 45.00 361.25'D + 1.5'L + 9310 X20.6 W W/14x43 Metal Steel 43.68 111.32 1.31 171.25'D + 1.5''L + 9310 X20.6 W W/14x43 Metal Steel 35.06	9300 X20	W 14x	4 Metal - Steel -	17.30	64.82	1.05	32 1.25*D + 1.4*W-
Section Metal - Steel 51.84 A48.7 Ityes 14.3 2k91.1 1.51.1 9220 Y21.3 W W14x78 Metal - Steel 15.78 67.46 0.89 14.1 25*D + 1.5*L + 9600 U20 W W14x43 Metal - Steel 27.72 92.00 0.89 14.1 25*D + 1.5*L + 9020 AA21.3 W W 14x43 Metal - Steel 28.84 88.76 0.85 32.1 25*D + 1.4*W 921 Y21.3-2 W W 14x43 Metal - Steel 28.41 74.16 0.84 14.1 25*D + 1.5*L + 9515 V21 W W 14x43 Metal - Steel - 70.75 88.61 0.84 17.1.25*D + 1.5*L + 9420 W21.3 W W 14x48 Metal - Steel - 56.93 106.45 47.00 36.1.25*D + 1.5*L + 9310 X20.6 W W 14x43 Metal - Steel - 18.50 72.31 1.44 17.1.25*D + 1.5*L + 9310 X20.6 W W 14x43 Metal - Steel - 35.06 91.59 1.30 17.1.25*D + 1.5*L + 9310 X22 W W 14x74 Metal - Steel - 38.84 65.39 1.21 <t< td=""><td>9215 Y21</td><td>W 14x</td><td>4 Metal - Steel -</td><td>33.64</td><td>81.94</td><td>1.02</td><td>17 1.25*D + 1.5*L +</td></t<>	9215 Y21	W 14x	4 Metal - Steel -	33.64	81.94	1.02	17 1.25*D + 1.5*L +
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9320 X21.3 X W 14x43 Metal - Steel - 35.06 91.59 1.30 17 1.25*D + 1.5*L + 9330 X22 X W 14x43 Metal - Steel - 31.59 85.68 1.24 15 1.25*D + 1.5*L + 9410 W20.6 X W 14x74 Metal - Steel - 38.84 65.39 1.21 17 1.25*D + 1.5*L + 9400 W20 X W 14x74 Metal - Steel - 17.31 81.78 1.20 32 1.25*D + 1.4*W- 9520 V21.3 X W 14x74 Metal - Steel - 17.31 81.78 1.20 32 1.25*D + 1.5*L + 9230 Y22 X W 14x74 Metal - Steel - 59.04 87.11 1.08 32 1.25*D + 1.5*L + 9210 Y20.6 X W 14x61 Metal - Steel - 59.04 87.11 1.08 32 1.25*D + 1.4*W- 9211 Y20.6-2 X W 8x24 Metal - Steel - 12.45 18.87 1.06 17 1.25*D + 1.5*L + 9300 X20 X W 14x74 Metal - Steel - 17.30 64.82 1.05 32 1.25*D + 1.4*W- 9210 Y21.4 W 14x74 Metal - Steel - 33.64 81.94 </td <td>Member 9015 AA21 9420 W21.3 9130 Z22 9310 X20.6</td> <td>Section Section W 14x4 W 14x4 W 14x4 W 14x4 W 14x4 W 12x5</td> <td>on Material 48 Metal-Steel- 32 Me 74 Me 58 Metal-Steel-</td> <td>Lay 56.93 rt by 18.50</td> <td>Laz 106.45 ratio 72.31</td> <td>Ratio</td> <td>Case 36 1.25*D + 1.4*W- 1.5*L + 1.5*L + 1.5*L + 1.5*L +</td>	Member 9015 AA21 9420 W21.3 9130 Z22 9310 X20.6	Section Section W 14x4 W 14x4 W 14x4 W 14x4 W 14x4 W 12x5	on Material 48 Metal-Steel- 32 Me 74 Me 58 Metal-Steel-	Lay 56.93 rt by 18.50	Laz 106.45 ratio 72.31	Ratio	Case 36 1.25*D + 1.4*W- 1.5*L + 1.5*L + 1.5*L + 1.5*L +
9330 X22 X W 14x43 Metal - Steel - 31.59 85.68 1.24 15 1.25*D + 1.5*L + 9410 W20.6 X W 14x74 Metal - Steel - 38.84 65.39 1.21 17 1.25*D + 1.5*L + 9400 W20 X W 14x74 Metal - Steel - 17.31 81.78 1.20 32 1.25*D + 1.5*L + 9200 V21.3 X W 14x74 Metal - Steel - 17.31 81.78 1.20 32 1.25*D + 1.5*L + 9230 Y22 X W 14x74 Attal - Steel - 59.04 87.11 1.08 32 1.25*D + 1.5*L + 9210 Y20.6 X W 14x61 Metal - Steel - 59.04 87.11 1.08 32 1.25*D + 1.5*L + 9030 AA22 X W 14x61 Metal - Steel - 49.19 104.56 1.06 17 1.25*D + 1.5*L + 9300 X20 X W 14x74 Metal - Steel - 17.30 64.82 1.05 32 1.25*D + 1.4*W- 9215 Y21 X W 14x74 Metal - Steel - 17.30 64.82 1.05 32 1.25*D + 1.5*L + 9200 Y21.3 W 14x74 Metal - Steel - 17.1.25*D + 1.5*L +	Member 9015 AA21 9420 W21.3 9130 Z22 9310 X20.6 9510 V20.6	Section Section W 14x4 W 14x4 W 14x4 W 14x4 W 12x5 W 14x1 W 14x1	Material 48 Metal-Steel- 32 Metal-Steel- 74 Metal-Steel- 58 Metal-Steel- 74 Metal-Steel- 74 Metal-Steel-	Lay 56.93 rt by 18.50 43.68	Laz 106.45 ratio 72.31 111.32	Ratio	Case 36 1.25*D + 1.4*W- 1.5*L + 1.5*L + 17 1.25*D + 1.5*L + 17 1.25*D + 1.5*L +
9410 W20.6 W 14x74 Metal - Steel - 38.84 65.39 1.21 17 1.25*D + 1.5*L + 9400 W20 W 14x74 Metal - Steel - 17.31 81.78 1.20 32 1.25*D + 1.4*W- 9520 V21.3 W 14x74 Petal - Steel - 17.31 81.78 1.20 32 1.25*D + 1.4*W- 9230 Y22 W 14x74 Petal - Steel - Ferrords 1.25*D + 1.5*L + 1.25*D + 1.5*L + 9210 Y20.6 W 8x31 Petal - Steel - 59.04 87.11 1.08 32 1.25*D + 1.4*W- 9210 Y20.6 W 8x31 Metal - Steel - 59.04 87.11 1.08 32 1.25*D + 1.5*L + 9030 AA22 W 14x61 Metal - Steel - 49.19 104.56 1.06 17 1.25*D + 1.5*L + 9300 W22 W W14x73 Metal - Steel - 17.30 64.82 1.05 32 1.25*D + 1.4*W- 9300 W 14x74 Metal - Steel - 17.30 64.82 1.05 32 1.25*D + 1.5*L + 9500 W 14x74 Metal - Steel - 17.38 67.46 0.89 17 1.25*D + 1.5*L + </td <td>Member 9015 AA21 9420 W21.3 9130 Z22 9310 X20.6 9510 V20.6 9320 X21.3</td> <td>Section Sec</td> <td>Material 48 Metal - Steel - 32 Metal - Steel - 74 Metal - Steel - 58 Metal - Steel - 74 Metal - Steel - 43 Metal - Steel -</td> <td>Lay 56.93 rt by 18.50 43.68 35.06</td> <td>Laz 106.45 ratio 72.31 111.32 91.59</td> <td>Ratio</td> <td>Case 36 1.25*D + 1.4*W- 1.5*L + 1.5*L + 17 1.25*D + 1.5*L + 17 1.25*D + 1.5*L + 17 1.25*D + 1.5*L +</td>	Member 9015 AA21 9420 W21.3 9130 Z22 9310 X20.6 9510 V20.6 9320 X21.3	Section Sec	Material 48 Metal - Steel - 32 Metal - Steel - 74 Metal - Steel - 58 Metal - Steel - 74 Metal - Steel - 43 Metal - Steel -	Lay 56.93 rt by 18.50 43.68 35.06	Laz 106.45 ratio 72.31 111.32 91.59	Ratio	Case 36 1.25*D + 1.4*W- 1.5*L + 1.5*L + 17 1.25*D + 1.5*L + 17 1.25*D + 1.5*L + 17 1.25*D + 1.5*L +
9400 W20 W 14x74 Metal - Steel - 17.31 81.78 1.20 32 1.25*D + 1.4*W- 9520 V21.3 W 14x74 2. select records 1.25*D + 1.5*L + 1.25	Member 9015 AA21 9420 W21.3 9130 Z22 9310 X20.6 9510 V20.6 9320 X21.3 9330 X22	Section Sec	Material 48 Metal-Steel- 32 Metal-Steel- 34 Metal-Steel- 35 Metal-Steel- 36 Metal-Steel- 37 Metal-Steel- 38 Metal-Steel- 39 Metal-Steel- 43 Metal-Steel-	Lay 56.93 rt by 18.50 43.68 35.06 31.59	Laz 106.45 ratio 72.31 111.32 91.59 85.68	Ratio	Case 36 1.25*D + 1.4*W- 1.5*L + 1.5*L + 17 1.25*D + 1.5*L + 17 1.25*D + 1.5*L + 17 1.25*D + 1.5*L + 15 1.25*D + 1.5*L +
9520 V21.3 X W 14x72 1.25*D + 1.5*L + 9230 Y22 X W 14x72 1.25*D + 1.5*L + 9210 Y20.6 X W 8x31 1.25*D + 1.5*L + 9030 AA22 X W 14x61 Metal - Steel - 59.04 87.11 1.08 32 1.25*D + 1.5*L + 9030 AA22 X W 14x61 Metal - Steel - 49.19 104.56 1.06 17 1.25*D + 1.5*L + 9630 U22 X W 14x53x1 Metal - Steel - 12.45 18.87 1.06 31 1.25*D + 1.4*W- 9030 X20 X W 14x74 Metal - Steel - 17.30 64.82 1.05 32 1.25*D + 1.4*W- 9215 Y21 X W 14x74 Metal - Steel - 33.64 81.94 1.02 17 1.25*D + 1.5*L + 9520 V22. W 14x74 Metal - Steel - 51.64 29.67 0.05 1.4 2.55*D + 1.5*L + 9520 V21.3 W 14x74 Metal - Steel - 15.78 67.46 0.89 17 1.25*D + 1.5*L + 9600 U20 W 14x43 Metal - Steel - 97.72 92.00 0.89 14 1.25*D + 1.5*L + 9221 Y21.3 W 14x43 Metal - Steel - 28.84 88.76 0.85 32 1.25*D + 1.5*	Member 9015 AA21 9420 W21.3 9130 Z22 9310 X20.6 9510 V20.6 9320 X21.3 9330 X22 9410 W20.6	Section Sec	Material 48 Metal-Steel- 32 Metal-Steel- 34 Metal-Steel- 35 Metal-Steel- 36 Metal-Steel- 37 Metal-Steel- 38 Metal-Steel- 39 Metal-Steel- 43 Metal-Steel- 43 Metal-Steel- 44 Metal-Steel-	Lay 56.93 rt by 18.50 43.68 35.06 31.59 38.84	Laz 106.45 ratio 72.31 111.32 91.59 85.68 65.39	Ratio	Case 36 1.25*D + 1.4*W- 1.5*L + 1.5*L + 17 1.25*D + 1.5*L + 17 1.25*D + 1.5*L + 17 1.25*D + 1.5*L + 15 1.25*D + 1.5*L + 17 1.25*D + 1.5*L +
9230 Y22 X W 14x7 1.25*D + 1.5*L + 9210 Y20.6 X W 8x31 1.25*D + 1.5*L + 9030 AA22 X W 14x61 Metal - Steel - 59.04 87.11 1.08 32 1.25*D + 1.5*L + 9030 AA22 X W 14x61 Metal - Steel - 49.19 104.56 1.06 17 1.25*D + 1.5*L + 9630 U22 X W 14x53x1 Metal - Steel - 12.45 18.87 1.06 31 1.25*D + 1.4*W- 9300 X20 X W 14x74 Metal - Steel - 17.30 64.82 1.05 32 1.25*D + 1.4*W- 9300 X20 X W 14x74 Metal - Steel - 33.64 81.94 1.02 17 1.25*D + 1.5*L + 9500 V22 X W 14x74 Metal - Steel - 51.64 29.67 0.05 1.4 2.95*D + 1.5*L + 9500 V22 X W 14x74 Metal - Steel - 15.78 67.46 0.89 17 1.25*D + 1.5*L + 9600 U20 W W 14x74 Metal - Steel - 97.72 92.00 0.89 14 1.25*D + 1.5*L + 9020 A21.3 W W 14x43 Metal - Steel - 28.84 88.76 0.85 32 1.25*D + 1.5*L + 9221 Y21.3-2 <td>Member 9015 AA21 9420 W21.3 9130 Z22 9310 X20.6 9510 V20.6 9320 X21.3 9330 X22 9410 W20.6 9420 X21.3 9330 X22 9410 W20.6 9400 W20</td> <td>Section Sec</td> <td>Material 48 Metal-Steel- 32 Metal-Steel- 32 Metal-Steel- 34 Metal-Steel- 35 Metal-Steel- 36 Metal-Steel- 37 Metal-Steel- 43 Metal-Steel- 43 Metal-Steel- 43 Metal-Steel- 74 Metal-Steel- 74 Metal-Steel- 74 Metal-Steel-</td> <td>Lay 56.93 rt by 18.50 43.68 35.06 31.59 38.84 17.31</td> <td>Laz 106.45 ratio 72.31 111.32 91.59 85.68 65.39 81.78</td> <td>Ratio</td> <td>Case 36 1.25°D + 1.4°W- 1.5°L + 1.5°L + 1.4°W-</td>	Member 9015 AA21 9420 W21.3 9130 Z22 9310 X20.6 9510 V20.6 9320 X21.3 9330 X22 9410 W20.6 9420 X21.3 9330 X22 9410 W20.6 9400 W20	Section Sec	Material 48 Metal-Steel- 32 Metal-Steel- 32 Metal-Steel- 34 Metal-Steel- 35 Metal-Steel- 36 Metal-Steel- 37 Metal-Steel- 43 Metal-Steel- 43 Metal-Steel- 43 Metal-Steel- 74 Metal-Steel- 74 Metal-Steel- 74 Metal-Steel-	Lay 56.93 rt by 18.50 43.68 35.06 31.59 38.84 17.31	Laz 106.45 ratio 72.31 111.32 91.59 85.68 65.39 81.78	Ratio	Case 36 1.25°D + 1.4°W- 1.5°L + 1.5°L + 1.4°W-
9210 Y20.6 W 8x31 1.25*D + 1.5*L + 9030 AA22 W 14x81 Metal - Steel - 59.04 87.11 1.08 32 1.25*D + 1.4*W- 9211 Y20.6-2 W 8x24 Metal - Steel - 49.19 104.56 1.06 17 1.25*D + 1.5*L + 9630 U22 W 14x53x1 Metal - Steel - 12.45 18.87 1.06 31 1.25*D + 1.4*W- 9300 X20 W 14x74 Metal - Steel - 17.30 64.82 1.05 32 1.25*D + 1.4*W- 9300 X20 W 14x74 Metal - Steel - 33.64 81.94 1.02 17 1.25*D + 1.5*L + 9530 V/22 W 14x74 Metal - Steel - 51.64 29.67 0.95 1.4 1.25*D + 1.5*L + 9630 V/22 W 14x74 Metal - Steel - 15.78 67.46 0.89 17 1.25*D + 1.5*L + 9600 U20 W 14x43 Metal - Steel - 97.72 92.00 0.89 14 1.25*D + 1.5*L + 9020 AA21.3 W 14x43 Metal - Steel - 28.84 88.76 0.85 32 1.25*D + 1.5*L + 9215 V21.32 W 14x43 Metal - Steel - 28.84 88.61 0.84 17 1.25*D + 1.5*L +	Member 9015 AA21 9420 W21.3 9130 Z22 9310 X20.6 9510 V20.6 9320 X21.3 9330 X22 9410 W20.6 9420 X21.3 9330 X22 9410 W20.6 9400 W20 9520 V21.3	Section Sec	Material 48 Metal-Steel- 32 Metal-Steel- 32 Metal-Steel- 33 Metal-Steel- 43 Metal-Steel- 43 Metal-Steel- 43 Metal-Steel- 43 Metal-Steel- 43 Metal-Steel- 74 Metal-Steel- 74 Metal-Steel- 74 Metal-Steel- 74 Metal-Steel- 74 Metal-Steel- 74 Metal-Steel-	Lay 56.93 rt by 18.50 43.68 35.06 31.59 38.84 17.31	Laz 106.45 ratio 72.31 111.32 91.59 85.68 65.39 81.78	Ratio	Case 36 1.25°D + 1.4°W- 1.5°L + 1.5°L + 1.5°L + 17 1.25°D + 1.5°L + 17 1.25°D + 1.5°L + 17 1.25°D + 1.5°L + 15 1.25°D + 1.5°L + 32 1.25°D + 1.4°W- 1.25°D + 1.5°L +
9030 AA22 W 14x61 Metal - Steel - Metal - Steel - 9211 59.04 87.11 1.08 32 1.25*D + 1.4*W- 911 9211 Y20.6-2 W W 8x24 Metal - Steel - 919 104.56 1.06 17 1.25*D + 1.5*L + 9630 11.25*D + 1.5*L + 9630 11.25*D + 1.5*L + 9300 X20 W 14x74 Metal - Steel - 921 12.45 18.87 1.06 31 1.25*D + 1.5*L + 9300 32 1.25*D + 1.4*W- 921 9300 X20 W W 14x74 Metal - Steel - 93.64 33.64 81.94 1.02 17 1.25*D + 1.5*L + 9530 V/22 10.9 11.4*X74 Metal - Steel - 92.07 0.95 11.4 2.5*D + 1.5*L + 9500 U20 11.2 25*D + 1.5*L + 9600 U20 11.2 125*D + 1.5*L + 97.72 92.00 0.89 17 1.25*D + 1.5*L + 9020 AA21.3 W 14 4x43 Metal - Steel - 97.72 92.00 0.89 14 1.25*D + 1.5*L + 9020 AA21.3 W 14 4x43 Metal - Steel - 28.84 88.76 0.85 32 1.25*D + 1.5*L + 921 Y21.3-2 W 14 4x43 Metal - Steel - 28.84 74.16 0.84 14 1.25*D + 1.5*L + 9515 V21 W 12x55 Metal - Steel - 70.75 88.61	Member 9015 AA21 9420 W21.3 9130 Z22 9310 X20.6 9510 V20.6 9330 X22 9410 W20.6 9400 W20.6 9420 V21.3 9420 V21.3 9520 V21.3 9230 Y22	Section Sec	Material 45 Metal-Steel- 32 Metal-Steel- 32 Metal-Steel- 34 Metal-Steel- 35 Metal-Steel- 36 Metal-Steel- 37 Metal-Steel- 43 Metal-Steel- 43 Metal-Steel- 43 Metal-Steel- 74 Metal-Steel-	Lay 56.93 rt by 18.50 43.68 35.06 31.59 38.84 17.31 recol	Laz 106.45 ratio 72.31 111.32 91.59 85.68 65.39 81.78 rds	Ratio	Case 36 1.25*D + 1.4*W- 1.5*L + 1.5*L + 1.5*L + 17 1.25*D + 1.5*L + 17 1.25*D + 1.5*L + 17 1.25*D + 1.5*L + 15 1.25*D + 1.5*L + 12 1.25*D + 1.4*W- 1.25*D + 1.5*L + 1.25*D + 1.5*L +
9211 Y20.6-2 W W 8x24 Metal - Steel - 49.19 104.56 1.06 17 1.25*D + 1.5*L + 9630 U22 W WW 14x53x1 Metal - Steel - 12.45 18.87 1.06 31 1.25*D + 1.4*W- 9300 X20 W W 14x74 Metal - Steel - 17.30 64.82 1.05 32 1.25*D + 1.4*W- 9215 Y21 W W 14x74 Metal - Steel - 33.64 81.94 1.02 17 1.25*D + 1.5*L + 9530 Y22 W W 14x43 Metal - Steel - 51.64 29.67 0.95 14.1.25*D + 1.5*L + 9220 Y21.3 W W14x43 Metal - Steel - 15.78 67.46 0.89 17 1.25*D + 1.5*L + 9600 U20 W W14x43 Metal - Steel - 97.72 92.00 0.89 14 1.25*D + 1.5*L + 9020 AA21.3 W W 14x43 Metal - Steel - 28.84 88.76 0.85 32 1.25*D + 1.4*W- 9211 Y21.3-2	Member 9015 AA21 9420 W21.3 9130 Z22 9310 X20.6 9510 V20.6 9330 X22 9410 W20.6 9400 W20 9520 V21.3 9230 Y22 9210 Y20.6	Section Sec	Material 45 Metal-Steel- 32 Metal-Steel- 32 Metal-Steel- 33 Metal-Steel- 43 Metal-Steel- 43 Metal-Steel- 43 Metal-Steel- 43 Metal-Steel- 43 Metal-Steel- 74 Metal-Steel- 75 Select	Lay 56.93 rt by 18.50 43.68 35.06 31.59 38.84 17.31 recol	Laz 106.45 ratio 72.31 111.32 91.59 85.68 65.39 81.78 rds	Ratio	Case 36 1.25*D + 1.4*W- 1.5*L + 1.5*L + 1.5*L + 17 1.25*D + 1.5*L + 17 1.25*D + 1.5*L + 17 1.25*D + 1.5*L + 15 1.25*D + 1.5*L + 17 1.25*D + 1.5*L + 1.25*D + 1.5*L + 1.25*D + 1.5*L + 1.25*D + 1.5*L +
9630 U22 WW 14x53x1 Metal - Steel - 12.45 18.87 1.06 31 1.25*D + 1.4*W- 9300 X20 W 14x74 Metal - Steel - 17.30 64.82 1.05 32 1.25*D + 1.4*W- 9215 Y21 W 14x74 Metal - Steel - 33.64 81.94 1.02 17 1.25*D + 1.5*L + 9530 Y22 W 14x43 Metal - Steel - 51.64 29.67 0.95 14.1 25*D + 1.5*L + 9530 Y22 W 14x43 Metal - Steel - 15.78 67.46 0.89 17 1.25*D + 1.5*L + 9600 U20 W 14x43 Metal - Steel - 97.72 92.00 0.89 14 1.25*D + 1.5*L + 9020 AA21.3 W 14x43 Metal - Steel - 28.84 88.76 0.85 32 1.25*D + 1.4*W- 9221 Y21.3-2 W 14x43 Metal - Steel - 28.41 74.16 0.84 14 1.25*D + 1.5*L + 9215 V21 W 14x43 Metal - Steel - 70.75 88.61 0.84 17 1.25*D + 1.5*L +	Member 9015 AA21 9420 W21.3 9130 Z22 9310 X20.6 9510 V20.6 9320 X21.3 9330 X22 9410 W20.6 9400 W20 9520 V21.3 9230 Y22 9210 Y20.6 9030 AA22	Section Sec	Material 48 Metal - Steel- 32 Metal - Steel- 34 Metal - Steel- 35 Metal - Steel- 43 Metal - Steel- 43 Metal - Steel- 44 Metal - Steel- 45 Metal - Steel- 46 Metal - Steel- 47 Metal - Steel- 48 Metal - Steel- 49 Metal - Steel- 40 Metal - Steel- 41 Metal - Steel- 42 Metal - Steel- 43 Metal - Steel- 44 Metal - Steel- 45 Metal - Steel- 46 Metal - Steel- 47 Metal - Steel- 48 Metal - Steel- 49 Metal - Steel-	Lay 56.93 rt by 18.50 43.68 35.06 31.59 38.84 17.31 recoi	Laz 106.45 ratio 72.31 111.32 91.59 85.68 65.39 81.78 rds 87.11	Ratio	Case 36 1.25*D + 1.4*W- 1.5*L + 1.5*L + 1.5*L + 17 1.25*D + 1.5*L + 17 1.25*D + 1.5*L + 17 1.25*D + 1.5*L + 15 1.25*D + 1.5*L + 17 1.25*D + 1.5*L + 1.25*D + 1.5*L + 1.5*L + 1.25*D + 1.5*L + 1.5*L + 1.55*L + 1.5*L + 1.55*L + 1.5*L + 1.55*L + 1.5*L + 1.55*L + 1.5*L + 1.55*L + 1.5*L + 1.55*L +
9300 X20 X W 14x74 Metal - Steel - 17.30 64.82 1.05 32 1.25*D + 1.4*W- 9215 Y21 X W 14x74 Metal - Steel - 33.64 81.94 1.02 17 1.25*D + 1.5*L + 9530 V22 W W 14x43 Metal - Steel - 51.64 29.67 0.95 14.1 25*D + 1.5*L + 9220 Y21.3 W W14x78 Metal - Steel - 15.78 67.46 0.89 17 1.25*D + 1.5*L + 9600 U20 W W14x43 Metal - Steel - 97.72 92.00 0.89 14 1.25*D + 1.5*L + 9020 AA21.3 W W 14x43 Metal - Steel - 28.84 88.76 0.85 32 1.25*D + 1.4*W- 9221 Y21.3-2 W W 14x43 Metal - Steel - 28.41 74.16 0.84 14 1.25*D + 1.5*L + 9515 V21 W 12x65 Metal - Steel - 70.75 88.61 0.84 17 1.25*D + 1.5*L +	Member 9015 AA21 9420 W21.3 9130 Z22 9310 X20.6 9510 V20.6 9320 X21.3 9330 X22 9410 W20.6 9400 W20 9520 V21.3 9230 Y22 9210 Y20.6 9030 AA22 9211 Y20.6-2	Section Sec	Material 48 Metal - Steel- 32 Metal - Steel- 32 Metal - Steel- 36 Metal - Steel- 43 Metal - Steel- 43 Metal - Steel- 43 Metal - Steel- 44 Metal - Steel- 45 Metal - Steel- 46 Metal - Steel- 47 Metal - Steel- 48 Metal - Steel- 49 Metal - Steel- 40 Metal - Steel- 41 Metal - Steel- 42 Metal - Steel- 43 Metal - Steel-	Lay 56.93 rt by 18.50 43.68 35.06 31.59 38.84 17.31 recoi	Laz 106.45 ratio 72.31 111.32 91.59 85.68 65.39 81.78 rds 87.11 104.56	Ratio	Case 36 1.25*D + 1.4*W- 1.5*L + 1.5*L + 1.5*L + 17 1.25*D + 1.5*L + 17 1.25*D + 1.5*L + 17 1.25*D + 1.5*L + 15 1.25*D + 1.5*L + 32 1.25*D + 1.5*L + 1.25*D + 1.5*L + 1.5*L + 1.55*L + 1.5*L + 1.55*L + 1.55*L + 1.55*L + 1.5*L + 1.55*L +
9215 Y21 W W 14x74 Metal-Steel- 33.64 81.94 1.02 17 1.25*D + 1.5*L + 9530 Y22 W W 14x43 Metal-Steel 51.64 29.67 0.95 14.1.25*D + 1.5*L + 9220 Y21.3 W W14x78 Metal-Steel 15.78 67.46 0.89 17 1.25*D + 1.5*L + 9600 U20 W W14x43 Metal-Steel 97.72 92.00 0.89 14 1.25*D + 1.5*L + 9020 AA21.3 W W14x43 Metal-Steel 28.84 88.76 0.85 32 1.25*D + 1.4*W- 9221 Y21.3-2 W W 14x43 Metal-Steel 28.41 74.16 0.84 14 1.25*D + 1.5*L + 9215 V21 W W 14x43 Metal-Steel 28.41 74.16 0.84 14 1.25*D + 1.5*L + 9515 V21 W 12x65 Metal-Steel - 70.75 88.61 0.84 17 1.25*D + 1.5*L +	Member 9015 AA21 9420 W21.3 9130 Z22 9310 X20.6 9510 V20.6 9320 X21.3 9330 X22 9410 W20.6 9400 W20 9520 V21.3 9230 Y22 9210 Y20.6 9030 AA22 9211 Y20.6-2 9630 U22	Section Sec	Material 48 Metal - Steel- 32 Metal - Steel- 34 Metal - Steel- 35 Metal - Steel- 43 Metal - Steel- 74 Metal - Steel-	Lay 56.93 rt by 18.50 43.68 35.06 31.59 38.84 17.31 recoi	Laz 106.45 ratio 72.31 111.32 91.59 85.68 65.39 81.78 rds 87.11 104.56 18.87	Ratio	Case 36 1.25*D + 1.4*W- 1.5*L + 1.5*L + 1.5*L + 17 1.25*D + 1.5*L + 17 1.25*D + 1.5*L + 17 1.25*D + 1.5*L + 15 1.25*D + 1.5*L + 12 1.25*D + 1.5*L + 1.25*D + 1.5*L +
9530 V/22 10 W 14x43 Metel Steel 51.64 29.67 0.95 14.1.25*D + 1.5*L + 9220 Y21.3 10 W14X78 Metal - Steel - 15.78 67.46 0.89 17.1.25*D + 1.5*L + 9600 U20 10 W 14x43 Metal - Steel - 97.72 92.00 0.89 14.1.25*D + 1.5*L + 9020 AA21.3 10 W 14x43 Metal - Steel - 28.84 88.76 0.85 32.1.25*D + 1.4*W- 9221 Y21.3-2 W 14x43 Metal - Steel - 28.41 74.16 0.84 14.1.25*D + 1.5*L + 9515 V21 W 12x65 Metal - Steel - 70.75 88.61 0.84 17.1.25*D + 1.5*L +	Member 9015 AA21 9420 W21.3 9130 Z22 9310 X20.6 9510 V20.6 9320 X21.3 9330 X22 9410 W20.6 9420 V21.3 9230 V21.3 9230 V22 9210 V20.6 9030 AA22 9211 Y20.6 9630 U22 9630 U22 9300 X20	Sectic Section Sect	Material 48 Metal - Steel- 32 Metal - Steel- 34 Metal - Steel- 35 Metal - Steel- 43 Metal - Steel- 43 Metal - Steel- 43 Metal - Steel- 43 Metal - Steel- 44 Metal - Steel- 45 Metal - Steel- 46 Metal - Steel- 47 Metal - Steel- 47 Metal - Steel- 48 Metal - Steel- 49 Metal - Steel- 41 Metal - Steel- 42 Metal - Steel- 43 Metal - Steel- 44 Metal - Steel- 45 Metal - Steel- 46 Metal - Steel- 47 Metal - Steel- 48 Metal - Steel-	Lay 56.93 rt by 18.50 43.68 35.06 31.59 38.84 17.31 recoi 59.04 49.19 12.45 17.30	Laz 106.45 ratio 72.31 111.32 91.59 85.68 65.39 81.78 rds 87.11 104.56 18.87 64.82	Ratio 15.00 15.00 15.00 1.44 1.31 1.30 1.24 1.21 1.20 1.08 1.06 1.06 1.05	Case 36 1.25*D + 1.4*W- 1.5*L + 1.5*L + 1.5*L + 17 1.25*D + 1.5*L + 17 1.25*D + 1.5*L + 17 1.25*D + 1.5*L + 17 1.25*D + 1.5*L + 12 1.25*D + 1.5*L + 1.25*D + 1.5*L + 1.25*D + 1.5*L + 1.25*D + 1.5*L + 1.25*D + 1.5*L + 32 1.25*D + 1.4*W- 17 1.25*D + 1.4*W- 12 1.25*D + 1.4*W- 13 1.25*D + 1.4*W- 13 1.25*D + 1.4*W- 14 1.25*D + 1.4*W- 15 1.25*D + 1.4*
9220 Y21.3 W W14X78 Metal - Steel - 15.78 67.46 0.89 17 1.25*D + 1.5*L + 9600 U20 W W14x43 Metal - Steel - 97.72 92.00 0.89 14 1.25*D + 1.5*L + 9020 AA21.3 W W 14x43 Metal - Steel - 28.84 88.76 0.85 32 1.25*D + 1.4*W- 9221 Y21.3-2 W W 14x43 Metal - Steel - 28.41 74.16 0.84 14 1.25*D + 1.5*L + 9515 V21 W W 12x65 Metal - Steel - 70.75 88.61 0.84 17 1.25*D + 1.5*L +	Member 9015 AA21 9420 W21.3 9130 Z22 9310 X20.6 9510 V20.6 9320 X21.3 9330 X22 9410 W20.6 9420 V21.3 9320 X21.3 9330 X22 9410 W20.6 9400 W20 9520 V21.3 9230 Y22 9210 Y20.6 9030 AA22 9211 Y20.6-2 9630 U22 9300 X20 9215 Y21	Sectic S W 14x4 W 14x8 W 14	Material 48 Metal - Steel - 32 Metal - Steel - 34 Metal - Steel - 35 Metal - Steel - 43 Metal - Steel - 44 Metal - Steel - 45 Metal - Steel - 46 Metal - Steel - 47 Metal - Steel - 47 Metal - Steel - 48 Metal - Steel - 49 Metal - Steel - 41 Metal - Steel - 42 Metal - Steel - 43 Metal - Steel - 44 Metal - Steel - 45 Metal - Steel - 46 Metal - Steel - 47 Metal - Steel - 48 Metal - Steel - 44 Metal - Steel - 45 Metal - Steel -	Lay 56.93 rt by 18.50 43.68 35.06 31.59 38.84 17.31 recoi 59.04 49.19 12.45 17.30 33.64	Laz 106.45 ratio 72.31 111.32 91.59 85.68 65.39 81.78 rds 87.11 104.56 18.87 64.82 81.94	Ratio 15.00 15.00 15.00 1.44 1.30 1.24 1.21 1.20 1.08 1.06 1.06 1.05 1.02	Case 36 1.25*D + 1.4*W- 1.5*L + 1.5*L + 1.5*L + 17 1.25*D + 1.5*L + 17 1.25*D + 1.5*L + 17 1.25*D + 1.5*L + 17 1.25*D + 1.5*L + 125*D + 1.5*L + 1.25*D + 1.5*L + 1.25*D + 1.5*L + 1.25*D + 1.5*L + 32 1.25*D + 1.4*W- 17 1.25*D + 1.4*W- 17 1.25*D + 1.4*W- 17 1.25*D + 1.4*W- 17 1.25*D + 1.5*L + 31 1.25*D + 1.4*W- 17 1.25*D + 1.5*L + 32 1.25*D + 1.5*L + 31 1.25*D + 1.5*L + 32 1.25*D + 1.5*L + 31 1.25*D + 1.5*L + 32 1.25*D + 1.5*L + 32 1.25*D + 1.5*L + 31 1.5*L + 31 1.55*L + 31
9600 U20 W 14 x43 Metal - Steel - 97.72 92.00 0.89 14 1.25*D + 1.5*L + 9020 AA21.3 W W 14x43 Metal - Steel - 28.84 88.76 0.85 32 1.25*D + 1.4*W- 9221 Y21.3-2 W W 14x43 Metal - Steel - 28.41 74.16 0.84 14 1.25*D + 1.5*L + 9515 V21 W W 12x65 Metal - Steel - 70.75 88.61 0.84 17 1.25*D + 1.5*L +	Member 9015 AA21 9420 W21.3 9130 Z22 9310 X20.6 9510 V20.6 9320 X21.3 9330 X22 9410 W20.6 9420 V21.3 9330 X22 9410 W20.6 9400 W20 9520 V21.3 9230 Y22 9210 Y20.6 9030 AA22 9211 Y20.6-2 9630 U22 9300 X20 9215 Y21 9215 Y21 9230 X20	Sectic Sectic SW 14x8 W 14x	Material 48 Metal - Steel - 32 Metal - Steel - 34 Metal - Steel - 35 Metal - Steel - 43 Metal - Steel - 74 Metal - Steel -	Lay 56.93 rt by 18.50 43.68 35.06 31.59 38.84 17.31 recoi 59.04 49.19 12.45 17.30 33.64 51.64	Laz 106.45 ratio 72.31 111.32 91.59 85.68 65.39 81.78 rds 87.11 104.56 18.87 64.82 81.94 20.87	Ratio 1.44 1.31 1.20 1.24 1.21 1.20 1.08 1.06 1.06 1.05 1.02 0.95	Case 36 1.25*D + 1.4*W- 1.5*L + 1.5*L + 1.5*L + 17 1.25*D + 1.5*L + 17 1.25*D + 1.5*L + 17 1.25*D + 1.5*L + 17 1.25*D + 1.5*L + 1.25*D + 1.5*L + 1.25*D + 1.5*L + 1.25*D + 1.5*L + 1.25*D + 1.5*L + 32 1.25*D + 1.4*W- 17 1.25*D + 1.4*W- 17 1.25*D + 1.5*L + 31 1.25*D + 1.4*W- 17 1.25*D + 1.5*L + 31 1.25*D + 1.5*L + 31 1.25*D + 1.5*L + 31 1.25*D + 1.5*L + 31 1.25*D + 1.5*L + 32 1.25*D + 1.5*L + 31 1.25*D + 1.5*L + 32 1.25*D + 1.5*L + 32 1.25*D + 1.5*L + 32 1.25*D + 1.5*L + 33 1.25*D + 1.5*L + 34 1.25*D + 1.5*L + 34 1.25*D + 1.5*L + 35 1.25*D + 1.5*L + 36 1.25*D + 1.5*L + 36 1.25*D + 1.5*L + 37 1.25*D + 1.5*L + 38 1.5*
9020 AA21.3 M W 14x43 Metal - Steel - 28.84 88.76 0.85 32 1.25*D + 1.4*W- 9221 Y21.3-2 M W 14x43 Metal - Steel - 28.41 74.16 0.84 14 1.25*D + 1.5*L + 9515 V21 M W 12x65 Metal - Steel - 70.75 88.61 0.84 17 1.25*D + 1.5*L +	Member 9015 AA21 9420 W21.3 9130 Z22 9310 X20.6 9510 V20.6 9320 X21.3 9330 X22 9410 W20.6 9420 V21.3 9320 X21.3 9330 X22 9410 W20.6 9400 W20 9200 Y21.3 9230 Y22 9211 Y20.6-2 9630 U22 9300 X20 9215 Y21 9230 Y22 9200 X20 9215 Y21 9220 Y21.3	Section Sec	Material 48 Metal - Steel - 32 Metal - Steel - 34 Metal - Steel - 35 Metal - Steel - 43 Metal - Steel - 44 Metal - Steel - 45 Metal - Steel - 46 Metal - Steel - 47 Metal - Steel - 48 Metal - Steel - 49 Metal - Steel - 41 Metal - Steel - 42 Metal - Steel - 43 Metal - Steel - 44 Metal - Steel - 45 Metal - Steel - 46 Metal - Steel - 47 Metal - Steel - 48 Metal - Steel -	Lay 56.93 rt by 18.50 43.68 35.06 31.59 38.84 17.31 recoi 59.04 49.19 12.45 17.30 33.64 51.64	Laz 106.45 ratio 72.31 111.32 91.59 85.68 65.39 81.78 rds 87.11 104.56 18.87 64.82 81.94 29.67 67.46	Ratio 1.44 1.31 1.30 1.24 1.21 1.20 1.08 1.06 1.06 1.05 1.02 0.95 0.89	Case 36 1.25*D + 1.4*W- 1.5*L + 1.5*L + 1.5*L + 17 1.25*D + 1.5*L + 17 1.25*D + 1.5*L + 17 1.25*D + 1.5*L + 15 1.25*D + 1.5*L + 1.25*D + 1.5*L + 1.25*D + 1.5*L + 1.25*D + 1.5*L + 1.25*D + 1.5*L + 32 1.25*D + 1.5*L + 31 1.25*D + 1.5*L + 31 2.25*D + 1.4*W- 32 1.25*D + 1.5*L + 11 2.5*D + 1.5*L + 14 4 25*D + 1.5*L + 17 1.25*D + 1.5*L + 14 4 25*D + 1.5*L + 17 1.25*D + 1.5*L + 16 4 25*D + 1.5*L + 17 1.25*D + 1.5*L + 17 1.25*L
9221 Y21.3-2 W 14 1.25*D + 1.5*L + 9515 V21 W 12x65 Metal - Steel - 70.75 88.61 0.84 14 1.25*D + 1.5*L +	Member 9015 AA21 9420 W21.3 9130 Z22 9310 X20.6 9510 V20.6 9320 X21.3 9330 X22 9410 W20.6 9420 V21.3 9230 Y22 9210 Y20.6 9030 AA22 9211 Y20.6-2 9630 U22 9300 X20 9215 Y21 9220 Y21.3 9600 U20	Section Sec	Material 48 Metal - Steel- 32 Metal - Steel- 34 Metal - Steel- 35 Metal - Steel- 43 Metal - Steel- 43 Metal - Steel- 43 Metal - Steel- 43 Metal - Steel- 44 Metal - Steel- 45 Metal - Steel- 46 Metal - Steel- 47 Metal - Steel- 48 Metal - Steel- 49 Metal - Steel- 41 Metal - Steel- 42 Metal - Steel- 43 Metal - Steel- 44 Metal - Steel- 45 Metal - Steel- 46 Metal - Steel- 47 Metal - Steel- 48 Metal - Steel- 49 Metal - Steel- 43 Metal - Steel-	Lay 56.93 rt by 18.50 43.68 35.06 31.59 38.84 17.31 recoi 59.04 49.19 12.45 17.30 33.64 51.64 15.78 97.72	Laz 106.45 ratio 72.31 111.32 91.59 85.88 65.39 81.78 rds 87.11 104.56 18.87 64.82 81.94 29.67 67.46 92.00	Ratio 1.44 1.31 1.30 1.24 1.21 1.20 1.08 1.06 1.06 1.05 1.02 0.95 0.89 0.89 0.89	Case 36 1.25*D + 1.4*W- 1.5*L + 1.5*L + 1.5*L + 17 1.25*D + 1.5*L + 17 1.25*D + 1.5*L + 17 1.25*D + 1.5*L + 15 1.25*D + 1.5*L + 1.25*D + 1.5*L + 1.25*D + 1.5*L + 1.25*D + 1.5*L + 32 1.25*D + 1.5*L + 32 1.25*D + 1.5*L + 32 1.25*D + 1.5*L + 17 1.25*D + 1.5*L + 31 1.25*D + 1.5*L + 14 1.25*D + 1.5*L + 15*L + 1
9515 V21 W 12x65 Metal - Steel - 70.75 88.61 0.84 17 1.25*D + 1.5*L +	Member 9015 AA21 9420 W21.3 9130 Z22 9310 X20.6 9510 V20.6 9320 X21.3 9330 X22 9410 W20.6 9420 V21.3 9330 X22 9410 W20.6 9520 V21.3 9230 Y22 9210 Y20.6 9030 AA22 9630 U22 9211 Y20.6-2 9630 U22 9211 Y20.6-2 9630 U22 9211 Y20.6-2 9630 U22 9215 Y21 9530 Y22 9220 Y21.3 9600 U20 9020 AA21.3	Section Sec	Material 48 Metal - Steel- 32 Metal - Steel- 34 Metal - Steel- 35 Metal - Steel- 43 Metal - Steel- 43 Metal - Steel- 43 Metal - Steel- 43 Metal - Steel- 44 Metal - Steel- 45 Metal - Steel- 46 Metal - Steel- 47 Metal - Steel- 48 Metal - Steel- 44 Metal - Steel- 45 Metal - Steel- 44 Metal - Steel- 45 Metal - Steel- 46 Metal - Steel- 47 Metal - Steel- 48 Metal - Steel- 49 Metal - Steel- 40 Metal - Steel- 43 Metal - Steel- 44 Metal - Steel- 43 Metal - Steel-	Lay 56.93 rt by 18.50 43.68 35.06 31.59 38.84 17.31 recoi 49.19 12.45 17.30 33.64 51.64 15.78 97.72 28.84	Laz 106.45 ratio 72.31 111.32 91.59 85.68 65.39 81.78 rds 87.11 104.56 18.87 64.82 81.94 29.67 67.46 92.00 88.76	Ratio 1.44 1.31 1.30 1.24 1.21 1.20 1.08 1.06 1.06 1.06 1.06 1.02 0.95 0.89 0.89 0.85	Case 36 1.25*D + 1.4*W- 1.5*L + 1.5*L + 1.5*L + 1.5*L + 1.5*L + 17 1.25*D + 1.5*L + 17 1.25*D + 1.5*L + 15 1.25*D + 1.5*L + 1.25*D + 1.5*L + 1.25*D + 1.5*L + 1.25*D + 1.5*L + 1.25*D + 1.5*L + 32 1.25*D + 1.4*W- 17 1.25*D + 1.4*W- 17 1.25*D + 1.5*L + 14 1.25*D + 1.5
	Member 9015 AA21 9420 W21.3 9130 Z22 9310 X20.6 9510 V20.6 9320 X21.3 9330 X22 9410 W20.6 9420 V21.3 9330 X22 9410 W20.6 9400 W20 9520 V21.3 9230 Y22 9211 Y20.6 9030 AA22 9630 U22 9630 U22 9630 U22 9300 X20 9215 Y21 9520 V21.3 9600 U20 9020 AA21.3 9020 AA21.3 9221 Y21.3-2	Section Sectio	Material 48 Metal - Steel- 32 Metal - Steel- 34 Metal - Steel- 35 Metal - Steel- 43 Metal - Steel- 43 Metal - Steel- 43 Metal - Steel- 43 Metal - Steel- 44 Metal - Steel- 45 Metal - Steel- 46 Metal - Steel- 47 Metal - Steel- 48 Metal - Steel- 44 Metal - Steel- 45 Metal - Steel- 46 Metal - Steel- 47 Metal - Steel- 48 Metal - Steel- 49 Metal - Steel- 41 Metal - Steel- 42 Metal - Steel- 43 Metal - Steel-	Lay 56.93 rt by 18.50 43.68 35.06 31.59 38.84 17.31 recoi 49.19 12.45 17.30 33.64 15.78 97.72 28.84 28.41	Laz 106.45 ratio 72.31 111.32 91.59 85.68 65.39 81.78 rds 87.11 104.56 18.87 64.82 81.94 29.67 67.46 92.00 88.76 74.16	Ratic 1.44 1.31 1.30 1.24 1.21 1.20 1.08 1.06 1.06 1.06 1.06 1.05 1.02 0.95 0.89 0.89 0.85 0.84	Case 36 1.25*D + 1.4*W- 1.5*L + 1.5*L + 1.5*L + 17 1.25*D + 1.5*L + 17 1.25*D + 1.5*L + 17 1.25*D + 1.5*L + 15 1.25*D + 1.5*L + 125*D + 1.5*L + 1.25*D + 1.5*L + 1.25*D + 1.5*L + 1.25*D + 1.5*L + 32 1.25*D + 1.5*L + 32 1.25*D + 1.5*L + 11 1.25*D + 1.5*L + 32 1.25*D + 1.5*L + 11 1.25*D + 1.5*L + 11 1.25*D + 1.5*L + 11 1.25*D + 1.5*L + 12 1.25*D + 1.5*L + 14 1.25*D + 1.5*L + 15 1.25*D + 1.5*L + 16 1.25*D + 1.5*L + 17 1.25*D + 1.5*L + 18 1.25*D +

Additional references to the discussions on these topics on the <u>Robot Forum</u>:

http://forums.autodesk.com/t5/robot-structural-analysis/problem-with-custom-sections/tdp/3379315

http://forums.autodesk.com/t5/robot-structural-analysis/bar-deflection-code-check-cantilevercheck-box-usage/td-p/3300335

http://forums.autodesk.com/t5/robot-structural-analysis/calculation-points-in-steel-design/tdp/3345899

http://forums.autodesk.com/t5/robot-structural-analysis/steel-design-results/td-p/3446635

http://forums.autodesk.com/t5/robot-structural-analysis/steel-design/m-p/3340849

http://forums.autodesk.com/t5/robot-structural-analysis/ltb-amp-steel-bracket/td-p/3385765

http://forums.autodesk.com/t5/robot-structural-analysis/need-help-in-design-a-steelbuilding/td-p/3443633

http://forums.autodesk.com/t5/robot-structural-analysis/autodesk-robot-structural-analysissteel-design-elements-which/m-p/3501700

http://forums.autodesk.com/t5/robot-structural-analysis/steel-beam-design-issue/td-p/3622270

http://forums.autodesk.com/t5/robot-structural-analysis/code-group-verification-vs-member-verification/td-p/3667094

http://forums.autodesk.com/t5/robot-structural-analysis/steel-beams-verification-without-axialforce/td-p/4948536

http://forums.autodesk.com/t5/robot-structural-analysis/metal-beam/td-p/4962944

4. Working with the RC Design modules

• To add new reinforcement bar grade or diameter you select and edit reinforcement bar database

EXX DEFAULTS	-) 🖻 👗 🛙	a ×∃	변 변	k?											
Units and Formats		No	o Steel	Diameter	Diameter Real	MaxLengt h	Mass	HookLen9 0	HookLen1 35	HookLen1 80	StirrupBe ndFormer Diam	HookBend FormerDi am	BarBendF ormerDia m	Character isticYield Stress	PlainBar	BarSize	Stirrug
Steel and timber s		27	7 B500C	32	32	12	6.31	5	5	5	7	7	7	5e+008		32	
- Vehicle loads Database Database Name	Database Description	28	8 B500C	36	36	12	7.99	5	5	5	7	7	7	5e+008		36	
Standard loads EN 1992-1-1		25	9 B500C	40	40	12	9.87	5	5	5	7	7	7	5e+008		40	
Building soils EC2 - ICELAND		30	0 B500A	6	6	12	0.222	5	5	5	4	4	4	5e+008		6	
Bolts EC2 - ITALIAN NAD		31	1 B500A	8	8	12	0.395	5	5	5	4	4	4	5e+008		8	
- Anchor bolts NEN-EN		32	2 B500A	10	10	12	0.617	5	5	5	4	4	4	5e+008		10	
Reinforcing bars		33	3 B500A	12	12	12	0.888	5	5	5	4	4	4	5e+008		12	
- Wire fabrics		34	4 B500A	14	14	12	1.21	5	5	5	4	4	4	5e+008		14	
Design codes		35	5 B500A	16	16	12	1.58	5	5	5	4	4	4	5e+008		16	
Structure Analysis 🔻 🕴 III	•	36	6 B500B	6	6	12	0.222	5	5	5	4	4	4	5e+008		6	
III +		37	7 B500B	8	8	12	0.395	5	5	5	4	4	4	5e+008		8	
Onen default parameters		38	8 B500B	10	10	12	0.617	5	5	5	4	4	4	5e+008		10	
Shell delagir balaneters		39	9 B500B	12	12	12	0.888	5	5	5	4	4	4	5e+008		12	
Save current parameters as default	ancel Help	40	0 B500B	14	14	12	1.21	5	5	5	4	4	4	5e+008		14	
		41	1 B500B	16	16	12	1.58	5	5	5	4	4	4	5e+008		16	
		42	2 B500B	18	18	12	2	5	5	5	1	1 7	7	5e+008		18	
		1	▶\Bar d	lefinition (Formula (Hooks (Descripti	on /	_	•							1
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In the same way it is possible to add or edit the list of wire fabrics (meshes)

Job Preferences	2 X	E C:	ProgramDa	ta\Autodes	sk\Structur	al\Commo	n Data\201	5\DATA\Re	einf\fabric_l	EN 1992-1-	1.xml						
	-		Ba 🕺 🛍		19 12	k?											
Units and Formats		No	NAME	BASE ADETS	CHECKED	SECTION Sh (m2/m)	SPACING Eh (cm)	LENGTH Lh (m)	DIAMETE R Dh (m)	END Ar (cm)	END Av (cm)	REL LAP (Rh "Eh)	ABS LAP Rh (cm)	SECTION Sv (m2/m)	SPACING vh (cm)	LENGTH Lv (m)	DIAME R Dv (I
Databases Steel and timber a		1	10-150,500	-1		0.000523	15	5	0.01	1	1	3	0	0.000523	15	2.35	0
Vehicle loads Database Database		3	4-150,4000	-1		8.4e-005	20	4	0.004	0.5	0.5	3	0	8.4e-005	20	2.35	0.0
- Standard loads - Building soils		4	4-150,5000	0		8.4e-005	15	5	0.004	1	1	3	0	8.4e-005	15	2	0.0
Bolts		6	5-150,4000	-1		0.000131	15	4	0.005	0.5	0.5	3	0	0.000131	15	2.92	0.0
- Anchor bolts		7	6-150,5000	0		0.000189	15	5	0.006	1	1	3	0	0.000189	15	2.35	0.0
- Wire fabrics		8	6-200,5000	-1		0.000141	20	5	0.005	1	1	3	0	0.000141	20	2.35	0.0=
Design codes		10	8-150,5000	-1		0.000335	15	5	0.008	1	1	3	0	0.000335	15	2.35	0.0
Image: A state of the state		11	8-200,5000	-1		0.000252	20	5	0.008	1	1	3	0	0.000252	20	2.35	0.0
Cpen default parameters		F															_
Save current parameters as default OK Cancel	Help																
		•	Reinfo	rcing net	Descrip	otion / For	mula 🛔 Ho	ooks / Ste	el /	•		111					× F
			Help												OK		Cancel

The description tabs provide information about each of the columns.

FormulaName	Formula		- Â		No	ID Table	Field	Unit	desc001
BarBendFormerDiam	BarBendFormerDiam * Diameter			ll b	1	1 BarDef	Steel	0	Type of steel
BarHookBendFormerDiam	HookBendformerDiam * Diameter			1111	2	2 BarDef	Diameter	mm	Diameter of bar core
Bartfooki,en135	Hookl,en135 * Diameter				3	3 BarDef	DiameterReal	mm	External diameter of ribbed bar
BarHookLen135Seis	HookLen135 * Diameter			UH 0	4	4 BarDef	MaxLength	m	Maximum length of produced bar
BarttookLen180	HookLen150 * Diameter			1111	5	5 BarDef	Mass	kgim	Mass of 1m bar
BarHookLen180Seis	Hooki,en180 * Diameter				6	6 BarDef	HookLen90		Minimum length of straigth segment of hook 90degree
BarHookLen90	HookLen90 * Diameter			1111	7	7 BarDef	HookLen135		Minimum length of straigth segment of hook 135degree
SarHookLen90Sels	HookLen90 * Diameter				8	8 BarDef	HookLen180		Minimum length of straigth segment of hook 180degree
Diameter	Diameter			1111	9	9 BarDef	StirrupBendFormerDiam		Minimum bending diameter coefficient of strrups
Nameter/Real	DiameterReal				10	10 BarDef	HookBendFormerDiam		Minimum bending diameter coefficient of hooks
Vass	Mass		1		11	11 BarDef	BarBendFormerDiam		Minimum bending diameter coefficient of bar shapes
Maxi, ength	Maxi, ength				12	12 BarDef	Characteristic Yield Stress	NH2	Characteristic yield stress of reinforcement
Iteel	Steel			1111	13	13 BarDef	PlainBar		Plain or ribbed (deformed) bars. If plain - yes.
StirrupBendFormerDiam	StirrupBendFormerDiam * Diameter				14	14 BarDef	BarSize		Type of # (for ACI), No. (for CSA), diameter (for the remaining codes)
StirrupHookBendFormerDiam	HookBendFormerDiam * Diameter				15	15 BarDef	StimupHookLen Seis		Length of a hook in seismic environment.
StirrupHookLen135	max(HockLen135 * Diameter, 50)			UU F					
tirrupHookLen135Seis	maxiHookLen135 * Diameter, 50)								
StirrupHookLen180	HookLen180 * Diameter								
StirrupHockLen180Seis	HookLen150 * Diameter								
StirrupHookLen90	max/StirrupHookLen90 * Diameter, 70)								
StirrupHookLen90Seis	max/StrrupHookLen90 * Diameter, 70)								
Bar definition A Formula (Hook	ks (Description /	 			< > \Ba	ar definition ∦ Form	ula (Hooks) Description /		·

a) RC Beam Design module

• Import form a model

To import a beam from a model you need to select bars which define it and press the indicated button



In addition to decision about loads you want to import mind to check the supports tab to see if the automatic selection (based on supporting element type and its size) has been done correctly



• Calculation options

By default a beam is designed against the simple bending with values checked in 11 points. These settings can be changed in the Advanced (calculation) options dialog

K Advanced Options	X
Support moment redistribution	1
Reduction of support moments by	
for ULS,ALS: 0 % Auto	for SLS: 0 %
Avoid compressive reinforcement at a supp	ort
Calculation span length for concrete supports	
according to code	axis
Moment on extreme support (pinned): Minimum reinforcement area on the support: Participation of stirrups in shear reinforcement	$ \begin{array}{c c} \beta_{1} = & 0,15 \\ \beta_{2} = & 0,2500 \\ \beta_{3} = & 0,5000 \end{array} * M(max) $
Number of calculation points in the span:	11
Cantilever length for which the resistance verification is not performed	1,00 m
Automatic generation of self-weight for new	w beams
Axial force taken into account	
Display diagrams for all combinations	
 Verification only for positive deflections Redistribution of a shear force near support 	ts
Additional calculation points	
OK Can	cel Help

In addition it is possible to decide if you want to calculate reinforcement for bending moment and shear force from support's face or its middle by selecting a support type type

				8	
Length:	3,50	(m)			Advanced
Left support			Right sup	port	
width:	0,40	(m)	Width:	0,40	(m)
Name:	V1		Name:	V2	
Туре:	pinned	•	Type:	ninned	-
🔘 Concrete	e 🍳 M	Masonry	Concret	ete 💿 l	Masonry

• Reinforcement pattern (distribution)

The decision of support type influences the range of generation of stirrups. In case you want to design a beam with concrete supports for bending moments from its middle but you don't want to have any stirrups generated over supports you may need to change the default settings



To include constructional reinforcement in beam's capacity you need to set its steel grade as being the same as the one selected for the longitudinal (main) one.

b) RC Column Design module

RC Columns in a model should be defined as a single bar elements (between levels of beams or floors) rather than a chain of smaller ones or a single element running through all the stories. In case of a column defined "inside" a "meshed" wall you should ignore the warning about nodes defined along its length.



• Import form a model (grouping)

RC columns are exported from a model in the same way as beams but it is possible (similarly to the group design in the Steel Design module) calculate identical reinforcement for group of RC columns of the same geometry

							-		Im Columns - Parameters of RC Elements
								溫	
						5,0	-	f	Simple cases
									Manual combinations
							=		Selected regulation for generation of combinations:
							-		RC regulation
								a	EN 1990-2002
						0,0			
							-		Grouping type
									According to story
									Create stories for elements not assigned to stories
									According to geometry
									Column chain
									Always display this dialog box
									Automatically run calculations
									OK Cancel Help

• Calculation options

By default columns are calculated for axial force and bi-directional bending but it is possible to include shear and SLS design or limit bending to one direction only (when the other direction bending moment is small enough to be neglected or a column is a 'part' of a wall)

Calculation Options - EN 199	02-1-1:2004 AC:2008; Regulation - E	N 1990:2002	X	
General Concrete Longitudina	I reinf. Transversal reinf.			
Method of calculating biaxially be	ent rectangular columns		ОК	1
$(M_{Bdx} / M_{Rdx})^{\alpha} + (M_{Bdy} / M_{Rdy})^{\alpha}$	M_{Rdy} $^{\alpha} \leq 1.0$		Cancel	
Based on stress distribution			Help	
Simplified second order analysis	method			
Nominal stiffness				
Nominal curvature			Delete	
Nominal stiffness with effective	ve modulus of elasticity 5.8.7.2 (4)			
Precast column Reinforcement optimization level High Minimum (relative) 1,00 capacity: 1,00 Design for simple bending My direction	Seismic Advanced Cover (cm) Transversal reinforcement Longitudinal reinforcement Longitudinal reinf. axis c >= 3,0 Fixed Deviations Mz direction	Advan	ced options considered ing considered ses considered OK Ca	incel Help
Fire provisions				
			1	

Mind that buckling parameters are taken from the Member type label assigned to a column in a model.

III R/C Member Type	Buckling model		X
D × I ⊂ E S & B P → # BC Column # RC Beam × Delete	Bracing system Direction Y Off Structure Sway Ly= 4,00 m ky= 1,00	Total structure height: 17,00 m Number of vertical elements m: 1 Disortion 7 Structure \bigcirc Non-sway \bigcirc Sway $L_z = 4,00$ m $k_z = 1,00$	Apply Close Help
3			Delete
Beam Column			
Member RC Column]		
Buckling with respect to Y axis Member length ly a tsupport faces a tsupport faces a tsupport faces a tsupport face a t	.:to Z axis		
Buckling length coefficient Ky: 1.00 Maximum and displacement	efficient		
Maximum node displacement Add uy = 10.0 cm uz = 10.0 cm Add Note Save Close	litional parameters Help		

c) RC Spread Footing Design module

• Import form a model (grouping)

Design of a spread footing is based on reactions imported from selected support nodes. It is important to match the directions of support with the direction of the local coordinate system of a column as the design of the spread footing is based on obtained values of reactions.

Support Def	inition	Support direction
Pigid Electe	Cisting Con Nuclinear	Direction of the local x axis
Figid Elastic	Fiction Gap Nonlinear	() angle
Label:	Support_1	Alpha (Z axis) = 0.0 (Deg)
		Beta (Y axis) = 0.0 (Deg)
Fixed	Uplift	Gamma (X axis) = 0.0 (Deg)
directions:		© node
VUX	None 🔻	number=
VU 🔽	None 👻	○ point
VZ	None 💌	coordinates= (m)
RX RX	None 💌	OK Cancel Help
RY RY	None 🔻	
RZ	None 💌	
Angle		
Support direc compatible w coordinate sy	ctions are ith the global ystem	
	Advanced	
Add	Close He	Ip



It is possible to group nodes in order to have identical foundations in these locations.

When two supported nodes are selected it is possible to design a common foundation for both columns located in these nodes



It is important to match the directions of local coordinate systems of the columns



d) Design of RC Continuous Footing

• For a strap foundation under isolated columns use the RC Continuous Footing module

Mind to set the Structure object type as a Bar rather than a Beam



• For a strap foundation under a wall with defined linear support at the bottom edge use the RC Spread footing module in the continuous footing mode



e) RC Slab Required Reinforcement module

• Global averaging of forces

Plate and Shell Reinforcement				
List of panels:	<<	 Calculations 	Verification	
Calculations for panel no.:				Calculate
Calculated panels:				Close
Limit states		Deflection verification		
ULS 1		Method:		
SLS		Equivalent stiffness (Elastic)		
ACC		O With stiffness update (FEM)		
Method: equivalent mom. (Wood&Arm	ier) 🔻	Displacement (+)	Auto 💌	
Globally averaged design forces	d walls)	Displacement (-)	Auto 💌	Help

The option should only be used for a situation when a slab is modeled as number of smaller panels and there are no other panels defined in another planes. Otherwise it should be switched off.



🌈 Plate and She	ell Reinforcement				_ 🗆 🛛 🗶
List of panels:	1to5	<<	 Calculations 	○ Verification	
Calcu	lations for panel no.:				Calculate
	Calculated panels:				Close
Limit states			Deflection verification		
ULS	1		Method:		
SLS			 Equivalent stiffness (Elastic) 		
ACC			O With stiffness update (FEM)		
Method:	equivalent mom. (Wood	&Armer) 🔻	Displacement (+)	Auto	
Globally aver	raged design forces		Displacement (-)	Auto	Help
Reduction of f	forces (at supports or above column	ns and walls)	()		

• Reduction of peek of bending moments over point supports

As the values of bending moments in these locations are larger than existing in reality you can reduce them based on the actual size of a support (column). The range of the reduction depends on the mesh size therefore you need to match the dimensions of elements of the mesh and panel's supports e.g. size of elements being approximately from a half to the size of a real support.



File Edit View Geometry	Loads Analys	is Results	Design	Autodesk F	Robot Structural /	Analysis Professio	inal 2014 - Project	red2 - Results (F	EM): evailable			_	-		Type a keyword or p	wase 🚯	88 A	0.00	- P X
	660	0		QQ	13 Y 18	M 🖬 😆	1 🖉 🖭 🛲	Geometry			_								
1 . 1	- 6?		1 2.0	OMB1	- 1 2		- 0												
Object Inspector Image: Control of the contro of the control of the control of the control of the co	mesh 0.05r	0,82 0,36	-6,89 -	11,01 -12	2,72 -10,97 ,54 -11,21	-6,81 : -7,46 -2,33	2,24 10,60 2 10,16 2	2 1,62 10,6 2 5,08 10,1	60 2,24 16 -2,3	-6,81 - 3 -7,46	10.97 _1	2,72 -11 12,54 -11	,01 -6,89 ,06 -7,15	0,82 0,36	Maps		2 : COMB1 Uniform lu Self-wei	Translation Translation vector (dX: dY: dZ = 0	m) 1.00: 2.00: (
(i) ≫ Ban 0/2 (ii) ጭ Panels 0/10 Auallay dipicts	mesh 0.1n	0,82 0,61 0,61 0,61	-6,89 - -6,29 -1 -6,96 -	0,68 -12 10,96 -12 10,96 -12	,72 -10,97 ,72 -11,06 2,53 -10,92 ,72 -11,06	-6,81 : -6,99 -6,91 -6,99	3,18 11,74 2,98 9,79 2 3,18 11,74	20,32 10,6 20,32 10,2 23,51 9,7 20,32 10,2	50 2,24 20 1,93 ⁹ 2,98 20 1,93	-6,81 - -6,99 - -6,91 - -6,99 -	10,97 -1 11,06 - 10,92 11,06	12,72 -11 12,72 -1 ^{12,53} -10 12,72 -1	0,68 -6,29 0,68 -6,29 0,68 -6,96 0,68 -6,29	0,82 0,61 131 0,07 0,61	Color pulette: Automatic 25.33 22.75 3.20.75 3.20.75	(ale •		Nodes: Bements: Edit mode © Copy © Move Number of repetition	5.
III Geonsetry (Grages / Name Value Unit -	mesh 0.3 m	0,62	-1/ -6,57 -1/	0,41 -12 -11,13 -1: ^{0,41} -12	,77 -10,82 2,51 -10,71 ,77 ^{-10,82}	-5,78 -5,73 -5,78	2,53 10,90 2,38 10,54 2,53 10,90	20,11 7, 21,42 7, 20,11 7,	.92 0,14 .60 0,06 .92 0,14	-6,78 -5,73 -5,78 -	10,82	12,77 12,51 -11, 12,77 ¹	10,41 13 -6,57 10,41	0,62 1,07 0,62	User loca: Mar. 25.3327 & 69.81xh) Mar. 25.2555 & 69.81xh) Marken Sciones: 1 Deam Deam Server Marken Sciones: 1 Marken W WW Marken W WW Marken W WW Marken W WW Marken W WW Marken W WW Marken W Marken	Dorson: 13 Nomaize Pomaize roomalization FE meth description Jeyed Help	My 5kNir Max=12, Min=-22, kPa kN/m 2!	m 65 50	008 日本 (1) 日本 (1) 日本 (1) 日本 (1) (1) (1) (1) (1) (1) (1) (1) (1) (1)
	mesh 0.5m	0,38	,47 -1	-12, 0,50 -12 -12,	74 -10,56 2,51 74 ^{-10,56}	6 -4,45 1 6 -4,45 1	1,89 10,06 1,89 10,06	20,37 9,71	1,89 - 9 1,89 -	4,45 -1 4,45 -1	0,56 - 0,56	-12,74 12,51 -1 -12,74	0,50 -4	0,38 47 0,38			22 15 10 11 9, 6, 3,	2,75 9,50 6,25 3,00 75 50 25 0,0	#
	mesh 1m	0,20 x 0,20		-12,8 -12,8	3 	3,40 0, 3,40 0,	28 2 28 2	22,69 xz	0,28 0,28 Y = 0,00 m	-8,40 -8,40 Base		-12,83 -12.83		0,20		Case	-3 -6 -9 -1 MXX, (kf Direction es: 2 (CO	9,25 9,75 12,95 Vm/m) X MB1) • (₩.∞∞	-
Unew [2]12] 龍光 句句句										Results (Fi	EM): availabl		1311	<u>Al</u> 13	B R100x20 ↓1 x=1	2,00; y=11,60; z=0,00	□ 0,0	10 [m] [k	N] [Deg]



• Selection of forces included in the reinforcement design

You can exclude small axial forces from reinforcement calculations selecting the simple bending mode as well as exclude bending moments using the compression/tension one.

Name:	RC floor del A (ekstra nedsenk)					
Reinforcemer	nt calculations for shells					
Туре:	bending + compression/tension 💌					
Main reinforc	bending + compression/tension em simple bending compression/tension					
🔘 Along X a	xis					
🔘 Along Y a	xis					
Along Z at	xis					
Any direct	ion in Cartesian system					
Any direct	ion in Polar system					
Coordinate						
Point 1 :	0,00; 0,00; 0,00					
Point 2 :	0,71; -1,00; 0,00					

Mind that for some codes there is large difference between minimal area of reinforcement for elements under pure tension (such situation may happen for the bending + compression/tension) and under bending.

• Influence of maximal allowed bar spacing on calculated required area of reinforcement

At the stage of calculations of required area of reinforcement you may not know what bar diameter will be finally used therefore you may assume it as larger one for safety reasons (arm of internal forces; cracks). In such case for lightly loaded slabs you may get large values due to maximal allowed bar spacing. This effect can be disabled by checking the check box marked below:

F EN 1992-1-1	📕 EN 1992-1-1:2004 AC:2008 Reinforcement Parame 😑 💷 💌							
General Materi	General Materials SLS Parameters Reinforcement							
Bar dimension	s							
d1:	12 🔻	d2:	12 🔻					
d1':	12 🔻	d2':	12 🔻					
Cover (cm)								
c1:	3,0	c2:	3,0					
c1' :	0,0	c2 ':	0,0					
	Deviations							
Unidirectional reinforcement								
Membrane re	Membrane reinforcement in one laver							
Minimum reinf	Minimum reinforcement							
None	○ None							
For FE for v	For FE for which reinforcement As>0							
For the whole panel								
Small risk of brittle failure 9.3.1.1(1)								
Disable spacing conditions 9.3.1.1(3)								
Disable SLS conditions 7.3.2(2)								
	Note	Add	Close	Help				

• Calculations of "cracked" slab deflection

Plate and Shell Reinforcement								
List of panels:	ALL	<<	Calculations	 Verification 				
Calculations for p	panel no.:				Calculate			
Calculate	d panels:				Close			
			Deflection verification					
			Method:					
			Equivalent stiffness (Elastic)					
			O With stiffness update (FEM)					
			Displacement (+)		Halp			
			✓ Displacement (-)	•	Пеір			

The equivalent stiffness method is the approximated approach based on scaling the deflection obtained from the static analysis of a model by elastic stiffness of a panel to its "averaged" cracked stiffness factor. Due to assumption of this method it should not be used to raft foundation on elastic soil and you should check the values of displacements obtained from static analysis instead.

The stiffness update method is based on calculations of entire model with each element of a panel having its stiffness updated (reduced) according to calculated area of reinforcement and crack width. This verification can only be done for a single load case or combination at a time.

• Correction of an excessive deflection by additional reinforcement

If you mark Reinforcement adjust for deflection then the additional reinforcement is added in the locations where the calculated cracked stiffness of a slab is much smaller than in other locations. In some situations this may result in having very large area of reinforcement in isolated places across the slab.



Alternative approach is to reduce the allowable crack width which will result in having much more uniform distribution of "additional" reinforcement needed to keep cracks below the new limits which will also reduce the deflection of a slab.



f) RC Slab Provided Reinforcement module

• Orientation of a slab imported from a model

The direction is governed by the local X axis of a panel (as defined in a model)



• Punching verification

The check is based on real support (column) size therefore it is required to provide this information when nodal supports are defined. This can be done in their advanced parameters.

Support Definition - Advanced								
For calculation of plate and shell provided reinforcement, support treated as:								
💿 nodal support								
olumn rectangular								
Dimensions (mm)								
a= 500 b= <mark>500</mark>								
Equivalent elasticity of support								
Column through two stories								
Height of the lower column:	L1= (m)							
Fixing of the column end:	fixed							
Height of the upper column:	L2=(m)							
Fixing of the column end:	fixed 👻							
Material parameters:								
Young's modulus:	E= (MPa)							
Poisson ratio:	v= [·]							
	OK Cancel Help							

• Manual definition of reinforcement zones

As program deletes reinforcement bars which are generated in the same place it is recommended to indicate a basic panel while creating overlapping zones.

Calculation errors	Reinforcement
	Bending Reinforcement maps
The second sec	
	List of possible solutions:
	1 20+10kG 1 2066.02kG
	Bars
	Coordinates (p1; p2) (m) p1 p2 Coordinates (p1; p2) (m) p1 p2
	0.69 0.88 : 1.20 2.77 Modfy Add
· · · · · · · · · · · · · · · · · · ·	Zone pasic S Increase of Reinforcement Zone panel S S Increase of (cm2/m)
•	eters (cm) +n At As eters (cm) +n At As
	1 1 + 16 20,0 10,05 10,05 10,05 10,65 1/54 20 14,0 21,04 22,44 +1,40 5 1/54 20 14,0 21,04 22,44 +1,40 5 1/54 20 0 152 1 571 -0.04
	2 1/2+ 20 250 1/257 1/257 000 7 1/1+ 12 250 4/52 4/52 0/0
	4 1/4+ 12 25,0 3.39 4,52 +1.14 14 1/14+ 16 25,0 7.74 8,04 +0.30
	2005.03-G
	Coordinates (p1; p2) (m) p1 p2
	Add Y+ Zone panel V S zone (cm2/m)
	x ₊ Zone panel
	name param relations and the decision of the second
	1 1/1+ 1/4+ 20 12,5 V 1 11.03 17,09 +6.06 7 1/7+ 12 25.0 4.52 4.52 0.00
	<u>2</u> 172+ 20 25,0 12,57 12,57 0,00 14 177+ 16 12,5 √ 1 12,27 12,57 +0.30

g) Design of RC Walls

The design of provided reinforcement in a vertical panel (wall) can be done either in the same way as for slab (RC Slab Required Reinforcement calculations in either compression/tension or bending + compression tension mode followed by the RC Slab Provided Reinforcement) when its Structure Object Type is set as Panel or Floor



or (for selected design codes) in the RC Wall Design module when a panel Structure Object type is set as Wall. In this case out of the plane bending is neglected.



Additional references to the discussions on these topics on the <u>Robot Forum</u>:

http://forums.autodesk.com/t5/robot-structural-analysis/provided-real-reinforcement-bardiameter-list-how-to-add-new/td-p/3263604

http://forums.autodesk.com/t5/robot-structural-analysis/rc-beams-design-of-structure-beam-atthe-column-face/td-p/3229182

http://forums.autodesk.com/t5/robot-structural-analysis/beam-design/td-p/3486810

http://forums.autodesk.com/t5/robot-structural-analysis/rc-beams-primary-beam-secondarybeam-connection/td-p/3712360

http://forums.autodesk.com/t5/robot-structural-analysis/dimensionnement-poutre/tdp/4303006

http://forums.autodesk.com/t5/robot-structural-analysis/afp-and-support-reinforcement/tdp/3330609

http://forums.autodesk.com/t5/robot-structural-analysis/construction-reinforcement-inbeams/td-p/3370355

http://forums.autodesk.com/t5/robot-structural-analysis/robot-2013-crack-width-in-columnaccording-to-eurocode/td-p/3400611

http://forums.autodesk.com/t5/robot-structural-analysis/rc-column-design-iternal-calculationnodes/td-p/3518270

http://forums.autodesk.com/t5/robot-structural-analysis/combined-footings/td-p/3187330

http://forums.autodesk.com/t5/robot-structural-analysis/combined-footing/td-p/4889394

http://forums.autodesk.com/t5/robot-structural-analysis/footing/td-p/3417443

http://forums.autodesk.com/t5/robot-structural-analysis/robot-continuous-foundationdesign/td-p/5030176

http://forums.autodesk.com/t5/robot-structural-analysis/elastic-and-nonelastic-slab-deflection-verifications/td-p/3217594

http://forums.autodesk.com/t5/robot-structural-analysis/how-dose-reinforcement-be-increasedto-reduce-deflections/td-p/3269435 http://forums.autodesk.com/t5/robot-structural-analysis/minimum-reinforcement-on-slabs/tdp/3729178

http://forums.autodesk.com/t5/robot-structural-analysis/global-smoothing-and-reduce-forcesabove-supports-methodology/td-p/3796129

http://forums.autodesk.com/t5/robot-structural-analysis/slab-punching-check/td-p/3792458

http://forums.autodesk.com/t5/robot-structural-analysis/rc-slab-punching-shear-check/tdp/4609147

http://forums.autodesk.com/t5/robot-structural-analysis/design-of-core-wall-by-using-robot/mp/3596518

http://forums.autodesk.com/t5/robot-structural-analysis/design-of-core-wall-by-using-robot/mp/3596518