

# Southwest Windpower

Renewable Energy Made Simple

## ATTENTION

THE FOUNDATION DESIGNS ARE IN ACCORDANCE WITH THE THE 2006 INTERNATIONAL BUILDING CODE (IBC 2006) AND ASCE 7-05, MINIMUM DESIGN LOADS FOR BUILDINGS AND OTHER STRUCTURES. THE FOUNDATION DESIGNS ARE FOR A 33.5-FT [10.2M] MONOPOLE WITH THE SKYSTREAM 3.7 WIND TURBINE BASED ON THE SOIL INFORMATION LISTED IN TABLE 1804.2 (IBC 2006) REFERENCED ON SHEET S-2 AND THE WIND ZONES DESCRIBED ON SHEET S-3. IT IS THE RESPONSIBILITY OF THE OWNER TO VERIFY BY GEOTECHNICAL INVESTIGATION THAT ACTUAL SOIL INVESTIGATION PARAMETERS MEET OR EXCEED THOSE SHOWN IN THE REFERENCED TABLE. IF CONDITIONS OTHER THAN THOSE DESCRIBED IN THE REFERENCED TABLE ARE ENCOUNTERED A FOUNDATION ANALYSIS SHOULD BE PERFORMED TO DETERMINE THE STRUCTURAL ADEQUACY OF THE SUBSTRUCTURE.

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**TOWER ENGINEERING PROFESSIONALS**  
 3703 JUNCTION BOULEVARD  
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 (919) 661-6351

PROJECT INFORMATION:

**33.5-FT [10.2M]  
 MONOPOLE  
 FOUNDATIONS**

**Southwest Windpower**  
 Renewable Energy Made Simple

1801 West Route 66  
 Flagstaff, AZ 86001  
 Office: (928) 779-9463

0	02-22-08
REV	DATE

DRAWN BY: JAB CHECKED BY: KMM

SHEET NUMBER:

**T-1**

REVISION:

**0**

TEP #: 080007.03

## GENERAL NOTES:

1. ALL WORK PRESENTED ON THESE DRAWINGS MUST BE COMPLETED BY THE CONTRACTOR UNLESS NOTED OTHERWISE.
2. THE CONTRACTOR MUST HAVE CONSIDERABLE EXPERIENCE IN PERFORMANCE OF WORK SIMILAR TO THAT DESCRIBED HEREIN. BY ACCEPTANCE OF THIS ASSIGNMENT, THE CONTRACTOR IS ATTESTING THAT HE DOES HAVE SUFFICIENT EXPERIENCE AND ABILITY, THAT HE IS KNOWLEDGEABLE OF THE WORK TO BE PERFORMED AND THAT HE IS PROPERLY LICENSED AND PROPERLY REGISTERED TO DO THIS WORK IN THE APPLICABLE STATE/TERRITORY.
3. ALL HARDWARE ASSEMBLY MANUFACTURER'S INSTRUCTIONS SHALL BE FOLLOWED EXACTLY AND SHALL SUPERSEDE ANY CONFLICTING NOTES ENCLOSED HEREIN.
4. IT IS THE CONTRACTOR'S SOLE RESPONSIBILITY TO DETERMINE ERECTION PROCEDURE AND SEQUENCE TO INSURE THE SAFETY OF THE STRUCTURE AND IT'S COMPONENT PARTS DURING ERECTION. THIS INCLUDES, BUT IS NOT LIMITED TO, THE ADDITION OF TEMPORARY BRACING, GUYS OR TIE DOWNS THAT MAY BE NECESSARY. SUCH MATERIAL SHALL BE REMOVED AND SHALL REMAIN THE PROPERTY OF THE CONTRACTOR AFTER THE COMPLETION OF THE PROJECT.
5. ALL MATERIALS AND EQUIPMENT FURNISHED SHALL BE NEW AND OF GOOD QUALITY, FREE FROM FAULTS AND DEFECTS AND IN CONFORMANCE WITH THE CONTRACT DOCUMENTS. ANY AND ALL SUBSTITUTIONS MUST BE PROPERLY APPROVED AND AUTHORIZED IN WRITING BY THE OWNER AND ENGINEER PRIOR TO INSTALLATION. THE CONTRACTOR SHALL FURNISH SATISFACTORY EVIDENCE AS TO THE KIND AND QUALITY OF THE MATERIALS AND EQUIPMENT BEING SUBSTITUTED.
6. THE CONTRACTOR SHALL BE RESPONSIBLE FOR INITIATING, MAINTAINING, AND SUPERVISING ALL SAFETY PRECAUTIONS AND PROGRAMS IN CONNECTION WITH THE WORK.
7. THE CONTRACTOR IS RESPONSIBLE FOR INSURING THAT THIS PROJECT AND RELATED WORK COMPLIES WITH ALL APPLICABLE LOCAL, STATE, AND FEDERAL SAFETY CODES AND REGULATIONS GOVERNING THIS WORK. CONTRACTOR SHALL SECURE ALL NECESSARY PERMITS FOR THIS PROJECT FROM ALL APPLICABLE GOVERNMENTAL AGENCIES. ALL PERMITS THAT MUST BE OBTAINED ARE THE RESPONSIBILITY OF THE CONTRACTOR. THE CONTRACTOR WILL BE RESPONSIBLE FOR ABIDING BY ALL CONDITIONS AND REQUIREMENTS OF THE PERMITS.
8. THE CONTRACTOR IS REQUIRED TO MAINTAIN ALL PIPES, DITCHES, AND OTHER DRAINAGE STRUCTURES FREE FROM OBSTRUCTION UNTIL WORK IS ACCEPTED BY THE OWNER. THE CONTRACTOR IS RESPONSIBLE FOR ANY DAMAGES CAUSED BY FAILURE TO MAINTAIN DRAINAGE STRUCTURE IN OPERABLE CONDITION.
9. ALL MATERIALS AND WORKMANSHIP SHALL BE WARRANTED FOR ONE YEAR FROM ACCEPTANCE DATE.
10. THE TOWER REACTIONS WERE OBTAINED AND THE FOUNDATIONS WERE DESIGNED IN ACCORDANCE WITH THE 2006 INTERNATIONAL BUILDING CODE (IBC 2006) AND ASCE 7-05 MINIMUM DESIGN LOADS FOR BUILDINGS AND OTHER STRUCTURES.

## REINFORCING STEEL NOTES:

1. THE REINFORCING STEEL SHALL CONFORM TO THE REQUIREMENTS OF ASTM A-615, GRADE 60 [EU GRADE 420]. IT SHALL BE DEFORMED AND SPLICES SHALL NOT BE ALLOWED UNLESS OTHERWISE NOTED.
2. WELDING IS PROHIBITED ON REINFORCING STEEL AND EMBEDMENTS.
3. REINFORCING CAGES SHALL BE BRACED TO RETAIN PROPER DIMENSIONS DURING HANDLING AND THROUGHOUT PLACEMENT OF CONCRETE. WHEN TEMPORARY CASING IS UTILIZED, BRACING SHALL BE ADEQUATE TO RESIST FORCES OCCURRING FROM FLOWING CONCRETE DURING CASING EXTRACTION.
4. SPACERS SHALL BE ATTACHED INTERMITTENTLY THROUGHOUT THE ENTIRE LENGTH OF TIEBACK REINFORCING TO INSURE CONCENTRIC PLACEMENT OF CAGES IN EXCAVATIONS.
5. MINIMUM CONCRETE COVER FOR REINFORCEMENT SHALL BE 3" [75mm] IF CAST IN PLACE AND 2" [50mm] COVER IF FORMWORK IS USED AS DEFINED IN ACI 318 SECTION 7.7.1. APPROVED SPACERS SHALL BE USED TO INSURE APPROPRIATE COVER ON REINFORCEMENT.

## CONCRETE NOTES:

1. WORK SHALL BE IN ACCORDANCE WITH THE LATEST REVISION OF THE ACI-318, "BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE."
2. THE CONCRETE SHALL DEVELOP A MINIMUM COMPRESSIVE STRENGTH OF 2,500 PSI [17230 kPa] IN 28-DAYS.
3. PROPORTIONS OF CONCRETE MATERIALS SHALL BE SUITABLE FOR THE INSTALLATION METHOD UTILIZED AND SHALL RESULT IN DURABLE CONCRETE FOR RESISTANCE TO LOCAL ANTICIPATED AGGRESSIVE ACTIONS. THE DURABILITY REQUIREMENTS OF ACI-318 SHALL BE SATISFIED BASED ON THE CONDITIONS EXPECTED AT THE SITE.
4. CONCRETE SHALL BE PLACED IN A MANNER THAT WILL PREVENT SEGREGATION OF CONCRETE MATERIALS, INFILTRATION OF WATER OR SOIL, AND OTHER OCCURRENCES THAT MAY DECREASE THE STRENGTH OR DURABILITY OF THE FOUNDATION.
5. FREE FALL CONCRETE MAY BE USED PROVIDED FALL IS VERTICAL DOWN WITHOUT HITTING THE SIDES OF THE EXCAVATION, FORMWORK, REINFORCING BARS, FORM TIES, CAGE BRACING, OR OTHER OBSTRUCTIONS. UNDER NO CIRCUMSTANCES SHALL CONCRETE FALL THROUGH WATER.
6. THE MAXIMUM SIZE OF THE AGGREGATE SHALL NOT EXCEED A SIZE SUITABLE FOR THE INSTALLATION METHOD UTILIZED OR 1/3-CLEAR DISTANCE BEHIND OR BETWEEN REINFORCING. THE MAXIMUM SIZE MAY BE INCREASED TO 2/3-CLEAR DISTANCE PROVIDED WORKABILITY AND METHODS OF CONSOLIDATION SUCH AS VIBRATING WILL PREVENT HONEYCOMBS AND VOIDS.



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### PROJECT INFORMATION:

**33.5-FT [10.2M]  
MONOPOLE  
FOUNDATIONS**

### **Southwest Windpower**

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**TABLE 1804.2 ALLOWABLE FOUNDATION AND LATERAL PRESSURE (IBC 2006)**

SOIL CLASS	DESCRIPTION	ALLOWABLE FOUNDATION PRESSURE	LATERAL BEARING (BELOW NATURAL GRADE)	LATERAL SLIDING		ASSUMED UNIT WEIGHT W/O WATER	ASSUMED INTERNAL ANGLE OF FRICTION
				COEFF. OF FRICTION	RESISTANCE		
1	CRYSTALLINE BEDROCK	12,000 psf	1,200 psf/ft	0.70	-	140 pcf	0°
		574.56 kPa	188.50 kPa/m			22 kN/m <sup>3</sup>	
2	SEDIMENTARY AND FOLIATED ROCK	4,000 psf	400 psf/ft	0.35	-	130 pcf	0°
		191.52 kPa	62.83 kPa/m			20 kN/m <sup>3</sup>	
3	SANDY GRAVEL AND/OR GRAVEL (GW AND GP)	3,000 psf	200 psf/ft	0.35	-	120 pcf	32°
		143.64 kPa	31.42 kPa/m			19 kN/m <sup>3</sup>	
4	SAND, SILTY SAND, CLAYEY SAND, SILTY GRAVEL, AND CLAYEY GRAVEL (SW,SP,SM,SC,GM AND GC)	2,000 psf	150 psf/ft	0.25	-	100 pcf	26°
		95.76 kPa	23.56 kPa/m			16 kN/m <sup>3</sup>	
5	CLAY, SANDY CLAY, SILTY CLAY, CLAYEY SILT, SILT AND SANDY SILT (CL, ML, MH AND CH)	1,500 psf	100 psf/ft	-	130 psf	90 pcf	0°
		71.82 kPa	15.71 kPa/m		6.22 kPa	14 kN/m <sup>3</sup>	



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SHEET NUMBER: <b>S-2</b>		REVISION: <b>0</b>	
		TEP #: 080007.03	

WIND ZONES	
ZONE	WIND SPEED
1	120 – 150 MPH [54 – 67 m/sec]
2	90 – 120 MPH [40 – 54 m/sec]
3	≤90 MPH [≤ 40 m/sec]

**TOWER REACTIONS - 33.5' [10.2M] MONOPOLE**

ZONE	MAXIMUM LOADING CRITERIA	FACTORED** MOMENT	FACTORED** SHEAR	FACTORED VERTICAL
1	SKYSTREAM 3.7 WIND TURBINE 150 MPH & 40 MPH W/ ½"-ICE [67 m/sec & 18 m/sec w/ 12.7mm-ICE]	70.8 kip-ft	3.04 kips	0.95 kips
		96.0 kN-m	13.52 kN	3.56 kN
2	SKYSTREAM 3.7 WIND TURBINE 120 MPH & 40 MPH W/ ½"-ICE [54 m/sec & 18 m/sec w/ 12.7mm-ICE]	60.7 kip-ft	2.40 kips	0.95 kips
		82.3 kN-m	10.68 kN	3.56 kN
3	SKYSTREAM 3.7 WIND TURBINE 90 MPH & 30 MPH W/ ¾"-ICE [40 m/sec & 13 m/sec w/ 19mm-ICE]	52.8 kip-ft	1.90 kips	1.05 kips
		71.6 kN-m	8.45 kN	4.67 kN

\*\* THE REACTIONS LISTED ARE FOR REFERENCE ONLY AND SHOULD NOT BE SUBSTITUTED FOR A STRUTURAL ANALYSIS BASED ON SITE-SPECIFIC DATA.



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MONOPOLE  
FOUNDATIONS**

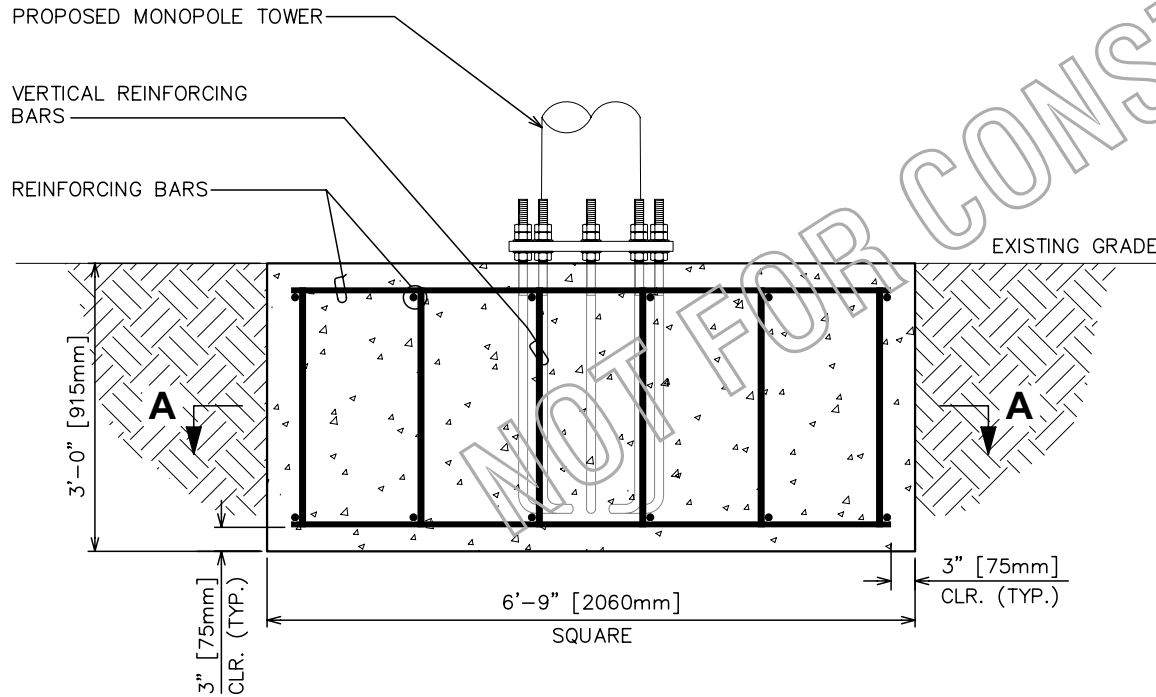
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DRAWN BY: JAB	CHECKED BY: KMM
SHEET NUMBER: <b>S-3</b>	REVISION: <b>0</b> TEP #: 080007.03

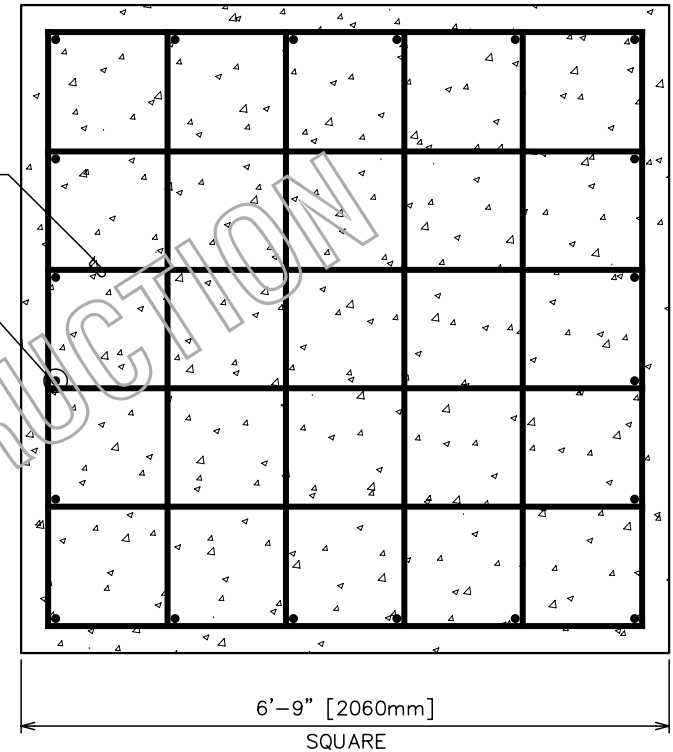
## NOTES:

1. THE FOUNDATION DESIGNS ARE BASED ON THE SOIL INFORMATION LISTED IN TABLE 1804.2 (IBC 2006) REFERENCED ON SHEET S-2. IT IS THE RESPONSIBILITY OF THE OWNER TO VERIFY BY GEOTECHNICAL INVESTIGATION THAT ACTUAL SITE SOIL PARAMETERS EQUAL OR EXCEED THOSE SHOWN IN THE REFERENCED TABLE. IF CONDITIONS OTHER THAN THOSE DESCRIBED IN THE REFERENCED TABLE ARE ENCOUNTERED A FOUNDATION ANALYSIS SHOULD BE PERFORMED TO DETERMINE THE STRUCTURAL ADEQUACY OF THE SUBSTRUCTURE.
2. IF THE FROST LINE IS KNOWN TO BE GREATER THAN THE FOUNDATION DEPTH OR THE WATER TABLE IS LESS THAN THE FOUNDATION DEPTH, THE DESIGN ENGINEER (TOWER ENGINEERING PROFESSIONALS, INC.) SHALL BE NOTIFIED PRIOR TO CONSTRUCTION AND A FOUNDATION ANALYSIS OR RE-DESIGN SHALL BE PERFORMED.



(6)-#6 [K19] REINFORCING BARS SPACED EQUALLY EACH WAY, TOP AND BOTTOM (24 TOTAL)

#7 [K22] VERTICAL REINFORCING BARS SPACED EQUALLY AS SHOWN (20 TOTAL)



### SECTION A-A

SCALE:  $\frac{1}{2}'' = 1'-0''$   
[12.7mm = 304.8mm]

DESIGN IS BASED ON SOIL CLASS 5:  
 $q_{all} = 1500 \text{ psf [71.82 kPa]}$

## FOUNDATION - WIND ZONE 1

SCALE:  $\frac{1}{2}'' = 1'-0''$  [12.7mm = 304.8mm]



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**S-4A**

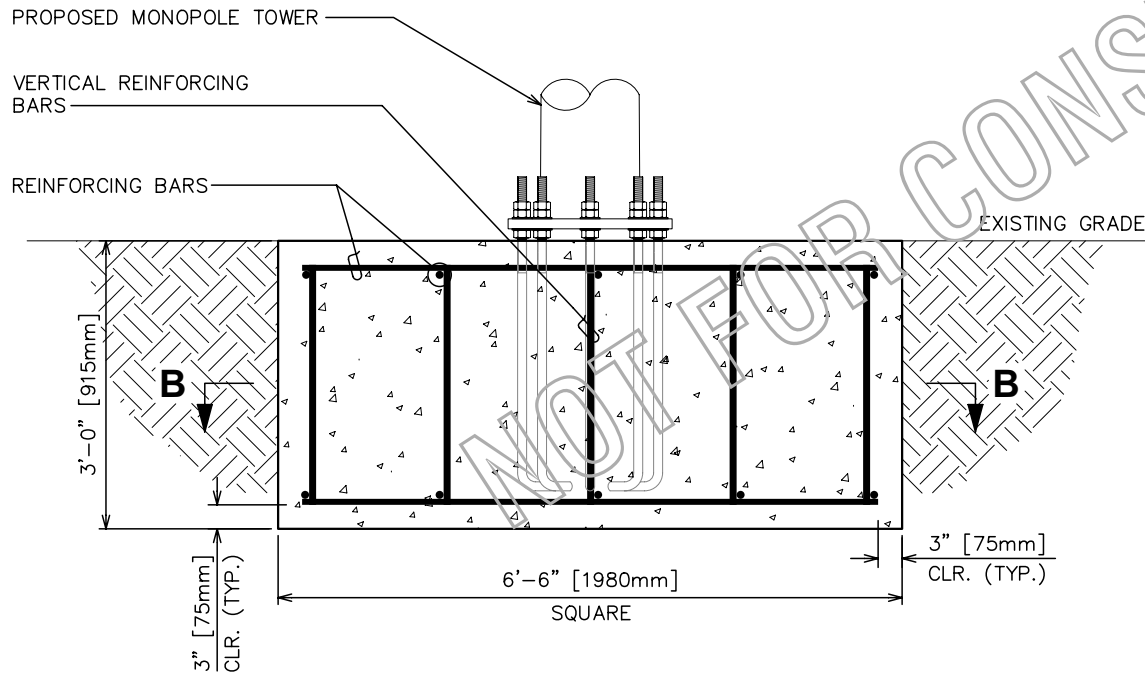
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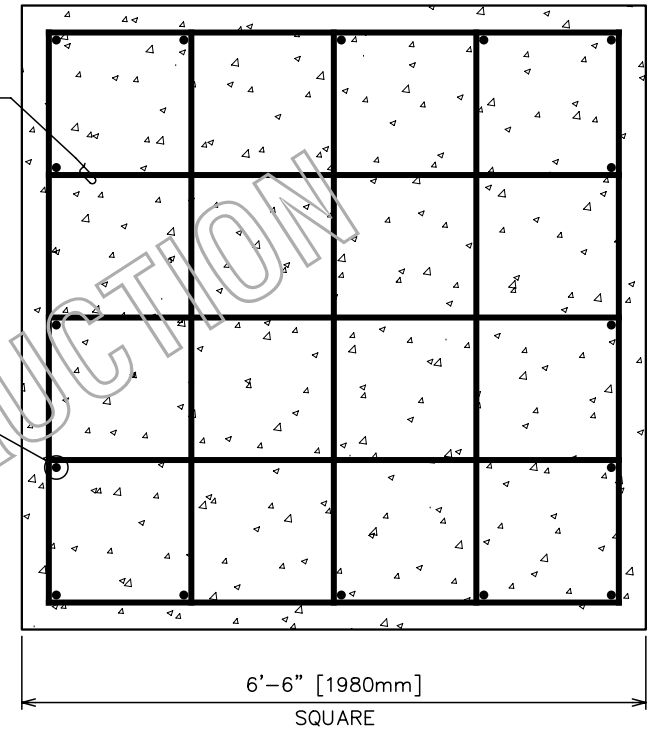
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(5)-#7 [K22] REINFORCING BARS SPACED EQUALLY EACH WAY, TOP AND BOTTOM (20 TOTAL)

#8 [K25] VERTICAL REINFORCING BARS SPACED EQUALLY AS SHOWN (16 TOTAL)



## SECTION B-B

SCALE:  $\frac{1}{2}" = 1'-0"$   
[12.7mm = 304.8mm]

DESIGN IS BASED ON SOIL CLASS 5:  
 $q'_{all} = 1500 \text{ psf [71.82 kPa]}$

## FOUNDATION - WIND ZONE 2

SCALE:  $\frac{1}{2}" = 1'-0"$  [12.7mm = 304.8mm]



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**S-4B**

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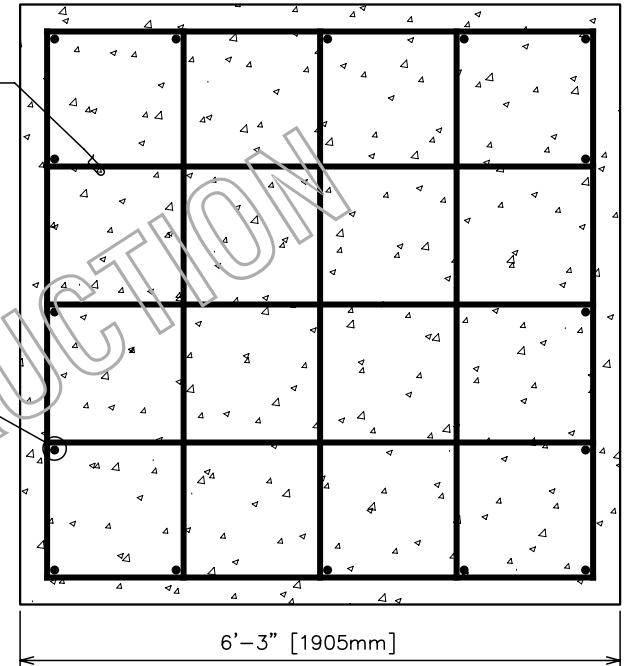
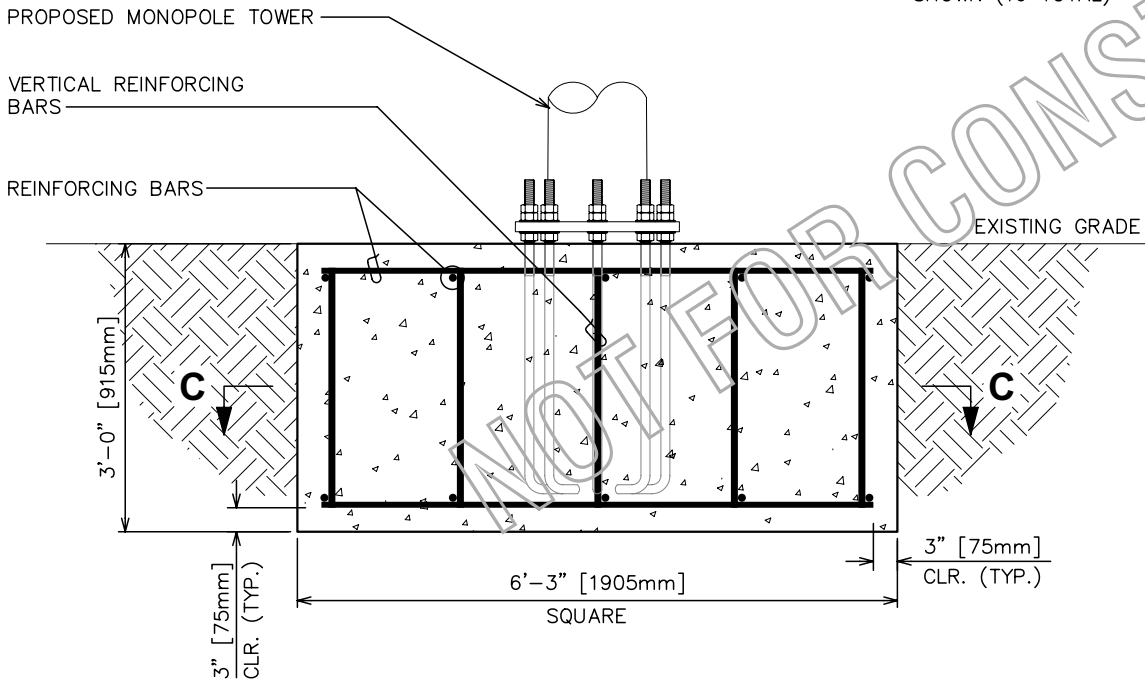
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## NOTES:

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(5)-#7 [K22] REINFORCING BARS SPACED EQUALLY EACH WAY, TOP AND BOTTOM (20 TOTAL)

#8 [K25] VERTICAL REINFORCING BARS SPACED EQUALLY AS SHOWN (16 TOTAL)



### SECTION C-C

SCALE:  $\frac{1}{2}'' = 1'-0''$   
[12.7mm = 304.8mm]

DESIGN IS BASED ON SOIL CLASS 5:  
 $q_{all} = 1500 \text{ psf [71.82 kPa]}$

## FOUNDATION - WIND ZONE 3

SCALE:  $\frac{1}{2}'' = 1'-0''$  [12.7mm = 304.8mm]



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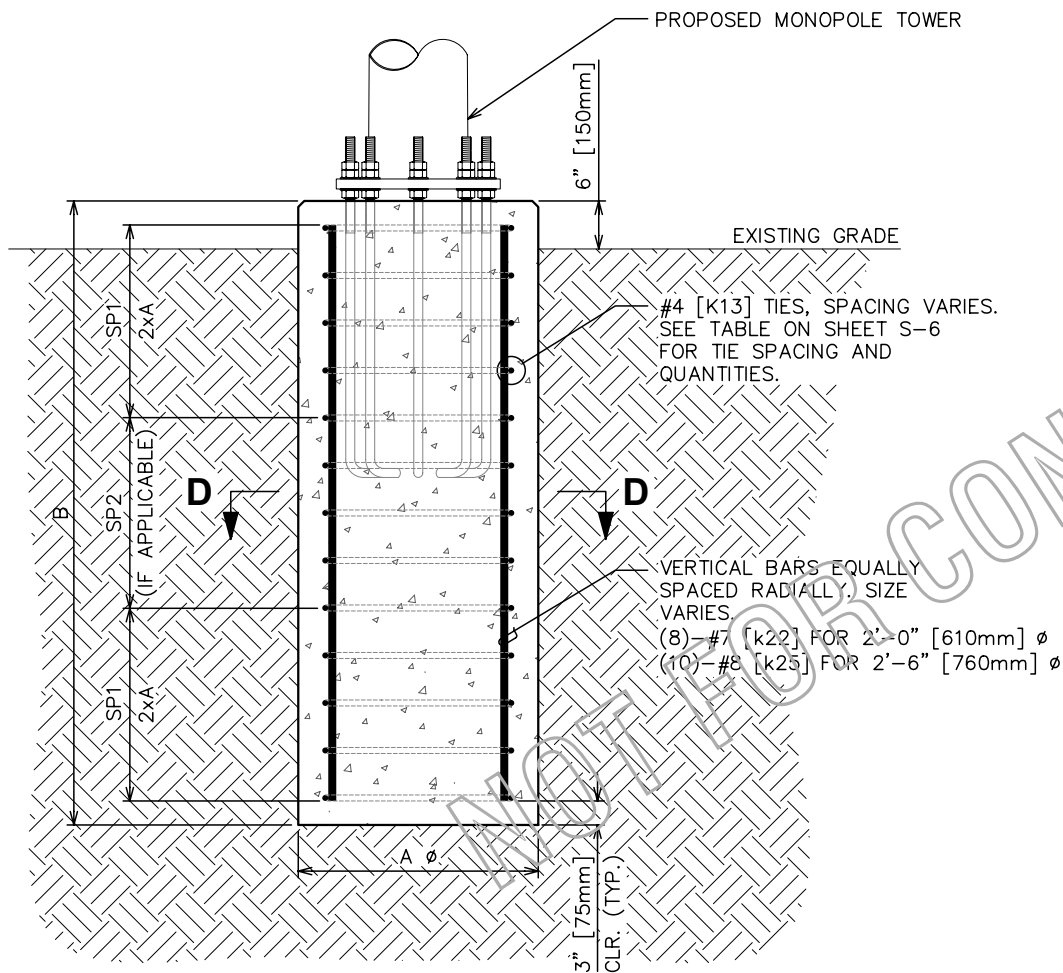
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**S-4C**

REVISION:

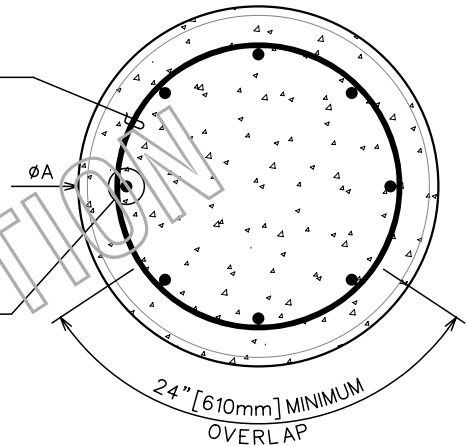
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#4 [K13] TIES, SPACING VARIES. SEE TABLE ON SHEET S-6 FOR TIE SPACING & QUANTITIES.

VERTICAL BARS EQ. SPACED RADIALLY. SIZE VARIES.  
 (8)-#7 [k22] FOR 2'-0" [610mm]  $\phi$   
 (10)-#8 [k25] FOR 2'-6" [760mm]  $\phi$



**SECTION D-D**

SCALE: N.T.S.

**NOTES:**

1. THIS DRAWING DOES NOT REPRESENT THE ACTUAL FOUNDATION, IT IS FOR REFERENCE ONLY, SEE SHEET S-6 FOR DIMENSIONS AND REINFORCEMENT QUANTITIES.
2. THE FOUNDATION DESIGNS ARE BASED ON THE SOIL INFORMATION LISTED IN TABLE 1804.2 (IBC 2006) REFERENCED ON SHEET S-2. IT IS THE RESPONSIBILITY OF THE OWNER TO VERIFY BY GEOTECHNICAL INVESTIGATION THAT ACTUAL SITE SOIL PARAMETERS EQUAL OR EXCEED THOSE SHOWN IN THE REFERENCED TABLE. IF CONDITIONS OTHER THAN THOSE DESCRIBED IN THE REFERENCED TABLE ARE ENCOUNTERED A FOUNDATION ANALYSIS SHOULD BE PERFORMED TO DETERMINE THE STRUCTURAL ADEQUACY OF THE SUBSTRUCTURE.
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**FOUNDATION ALTERNATIVE - PIER**

SCALE: N.T.S.

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## 33.5-FT [10.2M] MONOPOLE FOUNDATION DIMENSIONS - PIER

ZONE	SOIL CLASS	DIMENSION		VERTICAL REINFORCEMENT		TIE SPACING		#4 [K13] TIE QUANTITY
		A	B	SIZE	QUANTITY	SP1	SP2	
<b>1</b>	1	2'-0" [610mm]	6'-0" [1830mm]	#7 [K22]	8	6"± [150mm] O.C.	-	12
	2	2'-0" [610mm]	8'-0" [2440mm]	#7 [K22]	8	6"± [150mm] O.C.	-	16
	3	2'-0" [610mm]	11'-0" [3350mm]	#7 [K22]	8	6"± [150mm] O.C.	10"± [255mm] O.C.	20
	4	2'-0" [610mm]	14'-6" [4420mm]	#7 [K22]	8	6"± [150mm] O.C.	12"± [305mm] O.C.	23
	5	2'-6" [760mm]	33'-0" [10060mm]	#8 [K25]	10	6"± [150mm] O.C.	11.7"± [300mm] O.C.	44

ZONE	SOIL CLASS	DIMENSION		VERTICAL REINFORCEMENT		TIE SPACING		#4 [K13] TIE QUANTITY
		A	B	SIZE	QUANTITY	SP1	SP2	
<b>2</b>	1	2'-0" [610mm]	6'-0" [1830mm]	#7 [K22]	8	6"± [150mm] O.C.	-	12
	2	2'-0" [610mm]	8'-0" [2440mm]	#7 [K22]	8	6"± [150mm] O.C.	-	16
	3	2'-0" [610mm]	10'-0" [3050mm]	#7 [K22]	8	6"± [150mm] O.C.	9"± [230mm] O.C.	19
	4	2'-0" [610mm]	13'-0" [3960mm]	#7 [K22]	8	6"± [150mm] O.C.	10.8"± [275mm] O.C.	22
	5	2'-0" [610mm]	22'-0" [6705mm]	#7 [K22]	8	6"± [150mm] O.C.	11.6"± [295mm] O.C.	31

ZONE	SOIL CLASS	DIMENSION		VERTICAL REINFORCEMENT		TIE SPACING		#4 [K13] TIE QUANTITY
		A	B	SIZE	QUANTITY	SP1	SP2	
<b>3</b>	1	2'-0" [610mm]	6'-0" [1830mm]	#7 [K22]	8	6"± [150mm] O.C.	-	12
	2	2'-0" [610mm]	8'-0" [2440mm]	#7 [K22]	8	6"± [150mm] O.C.	-	16
	3	2'-0" [610mm]	8'-0" [2440mm]	#7 [K22]	8	6"± [150mm] O.C.	-	16
	4	2'-0" [610mm]	10'-0" [3050mm]	#7 [K22]	8	6"± [150mm] O.C.	9"± [230mm] O.C.	19
	5	2'-0" [610mm]	15'-0" [4570mm]	#7 [K22]	8	6"± [150mm] O.C.	11.1"± [280mm] O.C.	24



**TOWER ENGINEERING PROFESSIONALS**  
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PROJECT INFORMATION:

**33.5-FT [10.2M]  
 MONOPOLE  
 FOUNDATIONS**

**Southwest Windpower**

Renewable Energy Made Simple

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