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Structural & Civil Engineering

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SHT. # 1 OF 8

JOB # 81266-R

DATE: 3-27-08
7-1-09

STRUCTURAL CALCULATIONS

PREPARED FOR:

SUN TREK SYSTEMS

PROJECT:

SOLAR POOL HEATING ATTACHMENT



7-1-09

INLAND ENGINEERING

DATE _____ SUBJECT _____ SHEET NO. 2
 BY _____ CHKD _____ JOB NO. 81266

GENERAL INFORMATION:

BUILDING CODE: 2007 CBC

MATERIAL PROPERTIESLUMBER: (STRUC. LUMBER DOUGLAS FIR LARCH)

	GRADE	Fb	Ft	Fv	E	Fc
2x AND 4x JOIST AND BEAM.....	No. 2	875	575	95	1.6x10 ⁶	1300
	No. 1	1000	575	95	1.7x10 ⁶	1300
	SELECT	1450	575	95	1.9x10 ⁶	1300
6x BEAMS & THICKER.....	No. 1	1350	675	85	1.6x10 ⁶	925
6x POSTS.....	No. 1	1350	825	85	1.6x10 ⁶	1000
GLU-LAMINATED BEAMS.....	24-F-V4	2400	1100	165	1.8x10 ⁶	1600
PSL-PARALLAM OR EQ.		2800	1850	285	2.0x10 ⁶	2700

<u>CONC.:</u>	fc	wt.
SLAB ON GRADE.....	2500 psi	150pcf
FOOTING.....	2500 psi	150pcf

MASONRY:

CONC. BLOCK.....1500 psi

REINF. STEEL:# 4 BAR AND SMALLER GR. 40.
 # 5 BAR AND LARGER GR. 60.

STRUC STEEL:

STRUC. PLATES.....Fy = 36 ksi
 PIPE COLS.....Fy = 35 ksi
 STL. TUBES.....Fy = 46 ksi

SCOPE OF WORK

SUNTREK'S SOLAR SYSTEM ATTACHMENT ON ROOF

WEIGHT OF SYSTEM : 1.5 PSF FULL

MAX. COLLECTOR SPAN = 70 FT.

DESIGN LOADS:

WIND : 85 MPH EXP. 'C'

ASSUMED HT. OF ROOF : 20 FT.

$K_z = 1.90$

$K_{zt} = 1.0$

$K_d = 1.85$

$I = 1.0$

$q_h = .00256 K_z K_{zt} K_d V^2 I$

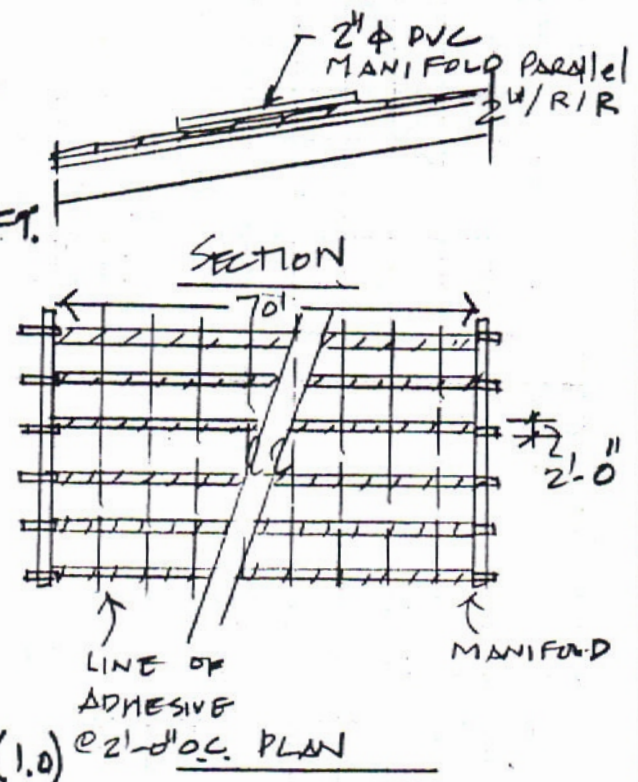
$= .00256 (1.9)(1.0)(1.85)(85)^2 (1.0)$

$= 14.15 \text{ PSF}$

NEG. EXTERNAL PRESSURE COEFF. FOR (GCP) = -0.9

$P_w = q_h [GCP - GCPI]$

$P_w = 14.15 [-0.9 - .18] = 15.3 \text{ PSF}$



@ 2'-0\"/>

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BY _____ CHKD. _____ JOB NO. 81266

SEIS. LOAD:

$$F_p = \frac{.4 A_p S_{DS} W_p}{(R_p / I_p)} \left(1 + 2 \frac{Z}{h} \right) \begin{cases} < F_p = 1.6 S_{DS} I_p W_p \\ > .3 S_{DS} I_p W_p \end{cases}$$

$A_p = 2.5, R_p = 3.0, I_p = 1.0, S_{DS} = \frac{2}{3} S_M S, S_M S = F_a S_s$

$F_a = 1.142, F_v = 1.784, Z = h = 20', S_s = .895$

$S_M S = (1.142)(.895) = 1.022$

$S_{DS} = \frac{2}{3} (1.022) = .681$ } SITE CLASS "D" ZIP CODE: 95336

$F_p = \frac{(.4)(2.5)(.681) W_p}{(3/1)} \left(1 + 2 \frac{20}{20} \right) = .681 W$

$F_{p \text{ MAX}} = 1.6 (.681) (I_p) W_p = 1.09 W_p$

$F_{p \text{ MIN.}} = .3 (.681) (I_p) W_p = .204 W_p$ } OK

- NOTE: * COLLECTORS ARE 2'-0" WIDE
* COLLECTORS ARE ATTACHED TO ROOF @ 2'-0" OC

T.A. OF COLLECTORS = $2' \times 2' = 4.0 \text{ S.F.}$

$W_T = 4.0 (1.5 \text{ PSF}) = 6.0 \text{ LB/FT.}$

WIND LOAD: $F_w = 15.3 \text{ PSF} (6) = 91.8 \text{ LBS/FT.}$

SEIS. LOAD: $F_s = .681 (6) = 4.08 \text{ LBS/FT.}$

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BY _____ CHKD. _____ JOB NO. 81266

CHK. ADHESIVE STRENGTH (SUNTREK SEALANT)
BASED ON TEST RESULTS PROVIDED BELOW :

AVERAGE TENSILE STRENGTH IS GIVEN AS 8.04[#]/IN
 $F_t = 24" (8.04) = 193^{\#} > 91.8^{\#}$ F.S. = 2.1 OK

The following table is a summary of the data collected during our testing:

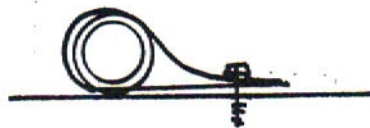
Substrates (Adherents)	Average Peel Strength (Pounds Per Linear Inch)
Suntrek Rubber Tubing / Ceramic Tile	12.156
Suntrek Rubber Tubing / Composition Roofing	10.996
Suntrek Rubber Tubing / Wood (maple)	8.045

CHK. CONNECTION OF 2" ϕ MANIFOLD:

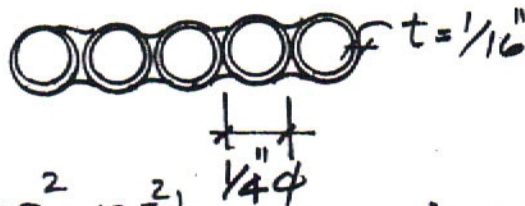
2" ϕ PVC MANIFOLD ATTACHED EVERY 28" O.C.
 TO EXIST'G. ROOF TILES FOR TILE ROOF'G.

2" ϕ PVC MANIFOLD ATTACHED EVERY 28" O.C.
 TO EXIST'G. ROOF RAFTERS FOR SHAKE OR SHINGLE ROOF'G.

EACH 2" ϕ PVC WRAPED W/ SOLAR PANEL TUBING
 CONSISTS OF 1/4" ϕ PLASTIC TUBING (TOTAL OF 5-1/4" ϕ
 TUBING)



ALLOW. TENSILE STRENGTH = 1479 PSI FOR 1-1/4" ϕ TUBE



$$A = \pi D^2 / 4 = \frac{\pi (.25^2 - .125^2)}{4} = .036 \text{ IN}^2 \quad \Sigma A = 5(.036) = .184 \text{ IN}^2$$

$$T_{\text{ALLOW}} = 1479 \text{ PSI} (.184) = 272 \text{ \#} > 91.8 \text{ \#} \quad \text{F.S.} = 2.96$$

PHYSICALS OF SUNTREK SOLAR TUBE

SAMPLE	SLAB-DUMBBELL	TUBE
DURO, A	80	80
TENSILE STRENGTH, psi	1728	1479
ELONGATION, %	247	224
MOD@25%, psi	355	281
MOD@50%, psi	370	473
MOD@75%, psi	807	686
MOD@100%, psi	1001	899
MOD@200%, psi	1562	1448

2" ϕ PVC PIPE SCH. 40 FILLED W/ WATER

$$\Sigma \text{WT.} = \left(\overset{\text{PIPE}}{3.653} \# + \overset{\text{WATER}}{1.453} \right) \frac{28}{12} = 12. \# \quad \frac{28}{12} = 2.33 \text{ FT.}$$

$$F_s = .681 (12) = 8.17 \#$$

$$F_w = (2.33)(2)(15.3) = 71.3 \# \leftarrow \text{CONTROLS}$$

1/4" ϕ LAG SC INTO WOOD RAFTERS W/ 2" MIN. EMB.

$$T_{ALL} = 225 \# / W (2") = 450. \# > 71.3 \# \quad \underline{OK}$$

USE: 1/4" ϕ WOOD-SC 2" MIN.
EMB. INTO ROOF RAFTERS

CONN. TO ROOF TILES (CONC. TILES)

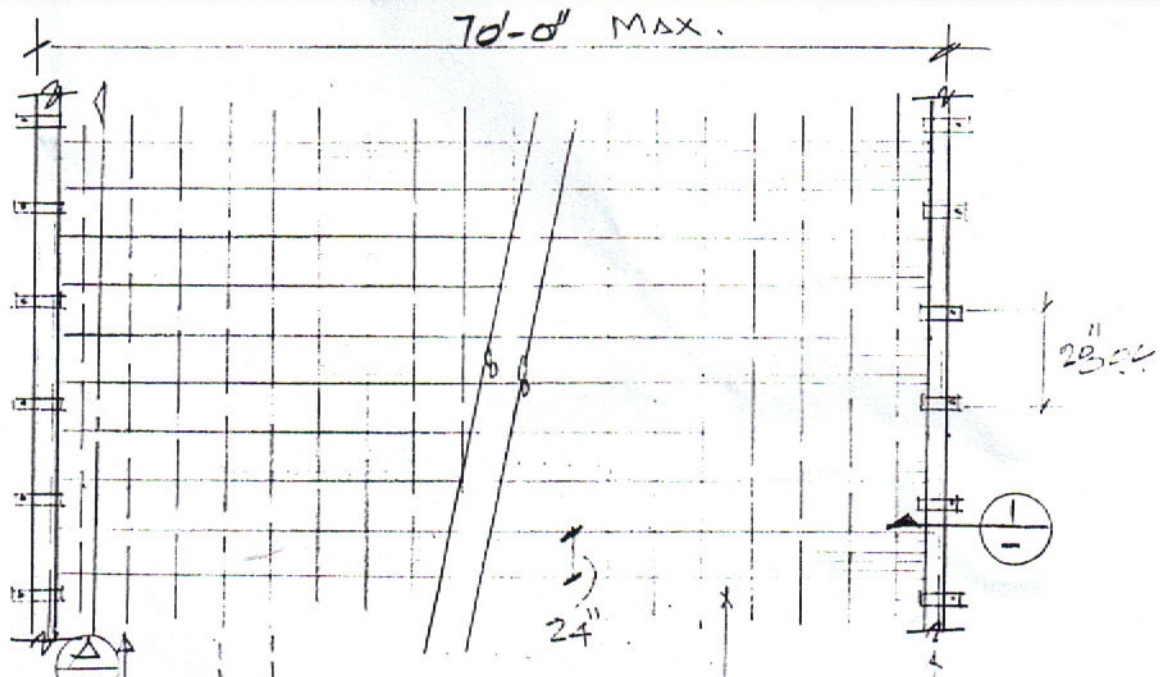
W/ 1/4" ϕ LAG-SC W/ SET EPOXY TO CONC. TILES



$$T_{ALL} = 90. \# > 71.3 \# \quad \underline{OK}$$

USE: 1/4" ϕ LAGS W/
SHIELD EPOXY INTO
CONC. TILES

COVER HOLES W/ MASTIC
TO PREVENT LEAKAGE



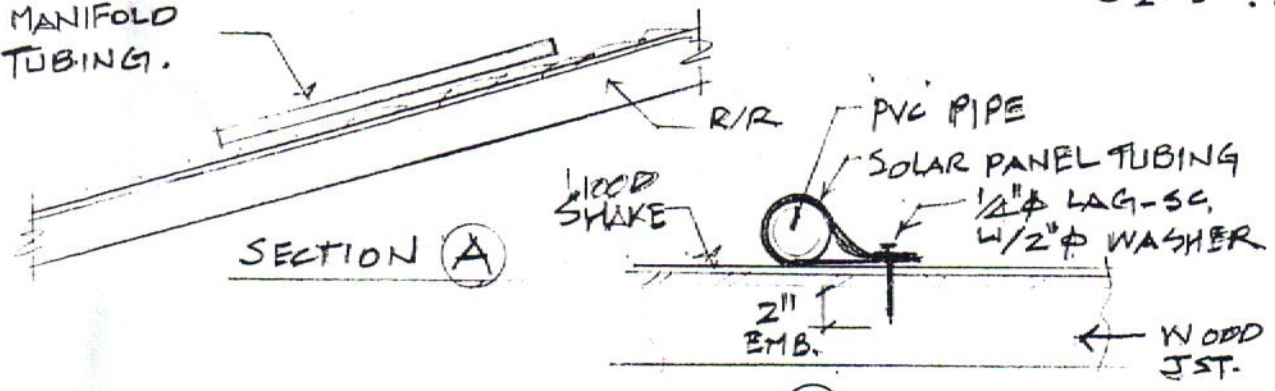
LINE OF ADHESIVE @ 2'-0" O.C.

PLAN

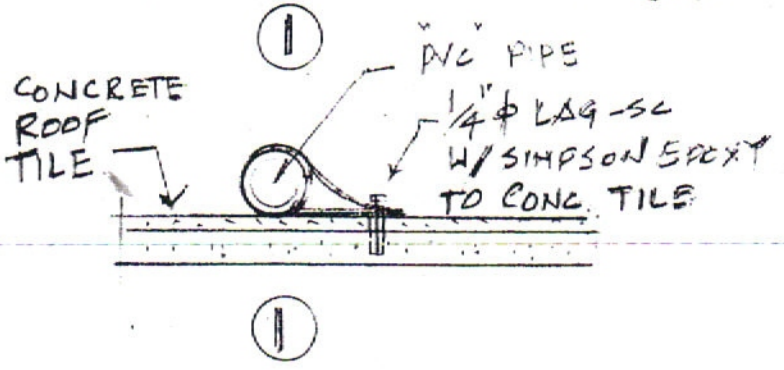
MANIFOLD PIPE

COLLECTOR PANELS @ 2'-0" O.C.

MANIFOLD TUBING.



SECTION A



CONCRETE ROOF TILE

PVC PIPE
1/4" LAG-SC
W/ SIMPSON EPOXY TO CONC. TILE