

### 7.0 Structural Breadth

The suggested solar water heating system provides energy savings by reducing the natural gas consumed at the building. This equipment will be installed on the building's flat roof and consequently there will have to be a structural analysis to ensure that the existing structure can handle the loads imposed by the additional equipment.

The weight of each collector was conservatively estimated:

Collector Weight: 133 lb  
Water in Collector: 230 lb  
Heaviest Support Available: 781 lb  
Total Weight = 1144 lb/collector

**Table 7.1 – Conservative Collector Weight Estimate**

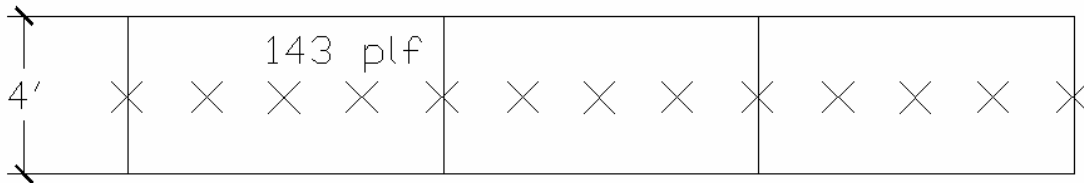
Area of each collector: 4 ft x 8ft = 32 ft<sup>2</sup>

Pressure and Distributed Load Calculation:

Pressure:  
 $P = 1144 \text{ lb} / 35.4 \text{ ft}^2$   
 $P = 36 \text{ lb/ft}^2$

Distributed Load:  
 $W = 36 \text{ lb/ft}^2 * 4 \text{ ft}$   
 $W = 144 \text{ lb/ft}$

**Table 7.2 – Pressure and Distributed Load Calculations**



**Figure 7.1 – Dead Load Imposed From Solar Collector and Support Structure**

For a typical 6 ft tributary area:

Point Load Calculation:  
 $P = 143 \text{ lb/ft} * 6 \text{ ft} \rightarrow P = 858 \text{ pounds}$

The dead load of the joist used for the roof structure has a dead load of 21 pounds per linear foot (plf).

STANDARD LOAD TABLE/LONG SPAN STEEL JOISTS, LH-SERIES  
Based on a Maximum Allowable Tensile Stress of 30 ksi

Joist Designation	Approx. Wt in Lbs. Per Linear Ft. (Joists Only)	Depth in inches	SAFELOAD* in Lbs. Between		CLEAR SPAN IN FEET															
			47-59	60-64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
40LH08	16	40	16600	16600	254	247	241	234	228	222	217	211	206	201	196	192	187	183	178	174
40LH09	21	40	21800	21800	332	323	315	306	298	291	283	276	269	263	256	250	244	239	233	228
40LH10	21	40	24000	24000	367	357	347	338	329	321	313	305	297	290	283	276	269	262	255	249
40LH11	22	40	26200	26200	399	388	378	368	358	349	340	332	323	315	308	300	293	286	279	273

Figure 7.2 – Joist Selection Used In Roof Design

The superimposed dead load is 25 lb/ft<sup>2</sup> which translates to 150 plf because of the 6 ft tributary area. The total dead load for from the joist is 171 plf as calculated in below in Table 7.3.

Joist Dead Load: 21 plf  
Superimposed Dead Load: 150 plf  
 Total Dead Load: 171 plf

Table 7.3 – Dead Load Calculation for Joist

The maximum allowable total moment for the joist selected is 80.9 foot-kips.

$$M_{\max} = \frac{w \cdot l^2}{8} + \frac{P \cdot l}{2}$$

$$M_{\max} = \frac{171 \cdot 42^2}{8} + \frac{858 \cdot 42}{2}$$

$$M_{\max} = 55.7 \text{ foot-kips}$$

Table 7.4 – Maximum Total Moment Applied on Joist from Equipment

55.7 foot-kips < 80.9 foot-kips → The solar equipment can be safely installed on the roof.