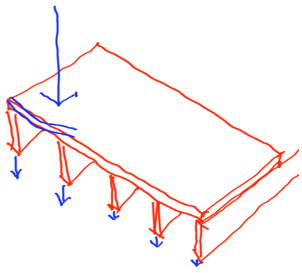
Building Loads

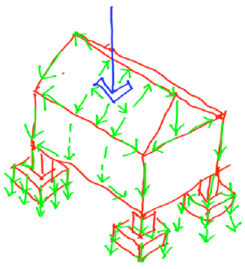
A little push puts the parts in motion…bending

- A force acting on a building imparts a load on the building structure
- The structure deflects, shedding it's load to the pieces supporting it.



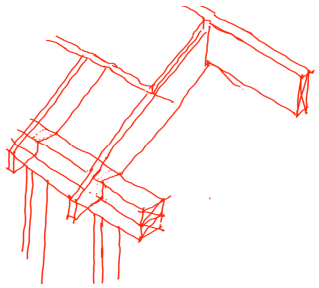
A butterfly lands…

- Ultimately the load reaches the ground through the footing
- Frame buildings usually react piece by piece to the load



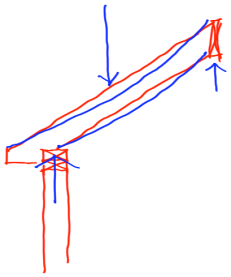
Many parts shed the load

- This framing detail shows the many parts that accept the load on the roof



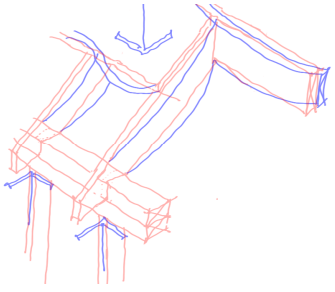
Every load causes tiny deflections

- Every load on the frame causes parts to bend
  - The plywood bends as it transfers load to the joists
  - The joists bend as they transfer loads to the ridge beam and wall
  - The ridge beam bends as it transfers load to the end walls
  - The side walls bend as they transfer load to the footings



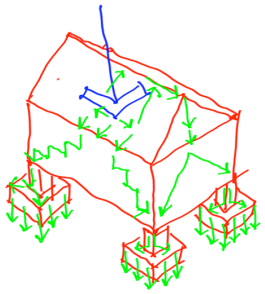
Control the bending

- We design each component to only bend so much under the anticipated load.
- If the bending or deflection exceeds the design value, the structure is not performing up to expectations
- The code sets maximum deflection for each part as a ratio of the parts' length, expressed as L/360 or L/240 to say the deflection must be limited to 1/360th of the span



Masonry sheds diagonally

- Masonry walls behave a little differently, transferring loads in little stairsteps, the kind of crack often found in masonry walls



Two kinds of loads

- Dead
  - The weight of the building materials themselves
- Live
  - The weight of occupants, furnishing and equipment
  - The load imparted on the structure from the push and pull of the wind
  - The weight of snow and rain
  - The force imparted by soil pressure and the movement of the earth in an earthquake
  - The force imparted by water during a flood

Dead loads IRC 301.2.2.2.1

- Actual weights of materials (or for seismic calculations)
  - Roof/ceiling 15psf
  - Floor 10psf
  - Ext wood framed 15 psf
  - Ext cold formed framing 14psf
  - Int wood framed 10 psf
  - Int cold formed 5 psf
  - 8 inch cmu 80 psf
  - Conc walls 85 psf

Material weights

Aluminum	165 lbs per cubic foot	Pine syp	45 lbs per cubic foot
Asphalt	45 lbs per cubic foot	Sand & gravel	125 lbs per cubic foot
Brick	150 lbs per cubic foot	Steel	495 lbs per cubic foot
Concrete	148 lbs per cubic foot	Tar	72 lbs per cubic foot
Dolomite	181 lbs per cubic foot	Water	62 lbs per cubic foot
Earth	90 lbs per cubic foot	Wool	82 lbs per cubic foot
Fir	33 lbs per cubic foot		
Glass	161 lbs per cubic foot		
Granite	168 lbs per cubic foot		
Gypsum	52 lbs per cubic foot		
Ice	57.4 lbs per cubic foot		
Paper	75 lbs per cubic foot		

Live loads table r301.5

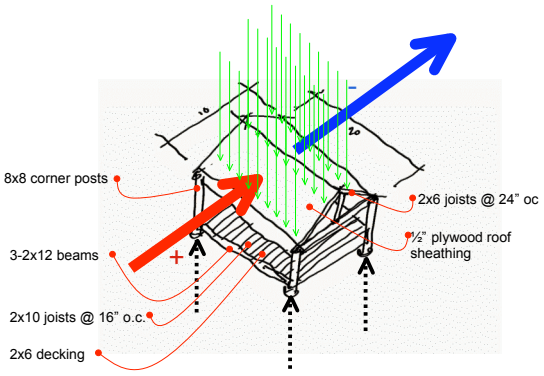
- Attics
  - With storage 20 psf
  - Without storage 10 psf
- Decks 40 psf
- Ext balconies 60 psf
- Garages 50 psf
- Rooms other than sleeping 40 psf
- Sleeping rooms 30 psf
- Stairs 40 psf

Snow loads fig r301.2(5)

- 30 psf Blacksburg
- 25 psf Roanoke
- 20 psf Richmond
- 15 psf Virginia Beach

wind

- 12:12 (45 degree slope)
  - Main roof 10.8, -10.8 psf
  - Overhangs and ridge 10.8, -13 psf
  - Rakes, lookouts, 10.8, -13 psf



How much wood?

Quantity	length	width	height	Total area cu.in.	1728
4	120	8	8	30720	17.77777778
6	240	2	12	34560	20
15	120	2	10	36000	20.83333333
40	120	2	6	57600	33.33333333
10	96	48	0.5	23040	13.33333333
30	60	2	6	21600	12.5

total cuft	117.7777778	X 45 pcf for pine lumber
total weight	5300	
total deadload	***5300***	

Live loads

People, furniture, snow, wind

floor area s.f.	200	
live load psf	40	(table r301.5)
total live load	***8000***	
snow load area	200	
snow load psf	30	(figure r301.2(5))
total snow load	***6000***	
wind load area sf	280	
wind load psf +	10.8	(table r301.2(2))
wind load psf -	13	(table r301.2(2))
total +, -	23.8	
total wind load	***6664***	

Total 20,664 pounds

Total resistance required from the earth

- Total dead load 5,300 pounds
- Total live loads 20,664 pounds
- Total load 25,964 pounds

At the corners

- Load at each column
  - 25,964 pounds / 4 columns = 6,491 pounds
- With 1,500 psf soil the footing needs to be
  - 6,491/1,500 = 4.32 s.f.
- With 2,500 psf soil the footing could be
  - 6,491/2,500 = 2.5 s.f.
- How big would the footing need to be if we used a continuous 8” cmu foundation wall instead of pad footings?