Small earth-built housing costing 24.5.2021

These are rough figures from my records, not set out here as clearly as possible.

Assumptions;
1 squ foot = .093 squ m.
1cubic m = 35.32 cubic feet.
1 cubic foot = 0.028 cubic metres
Floor area 4x4 + 5x3 + upstairs 2.5x7 = 16+15+ 17.5 = 48.5 m2
Wall length 21.5 m

Concrete:
Assume concrete, cement 20 kg bag @ $9/ bag + sand @ $25/t + gravel @ $80/t, and 1 bag yields = 2 cf cement + 4 cf sand + 2cf gravel = 8cf concrete. = .224 cubic metres
so I cubic metre of cement needs 4.5 bags of cement + = 10 bags of sand + = 4.5 bags of gravel.

Costs. (Red = checked.)
Sand $25/t ($25 for 1 t = 25x1.6 for I m3= $40 So S40/35.3 = $1.13 /cu.ft. =1.23x35 = $43/m3
gravel $ 15/ t = $0.7
= $24.5/m3
Sand is 1.6 t/m3 gravel 1.5 t/m3
So concrete 1 bag cement $9 + {2 cf gravel = .$1.40} + {4 x $1,13} = .$4.52} = $14.9
So 1 bag of cement yields 8 cf concrete costing $14.9,
So for 1 m3 of concrete you need 35.3/8 as much = i.e., 4.35 times as much of all ingredients = $64.8 So 1 m3 of concrete costs $64.8

PRICES.
Wood Bunnings 120X35 = $6.29/M
90x 45 (so = 3x2+) = $4.41
90x35 = $3.17
75x45 = $3.16/m
3x2 assume $3.50/m
75x25 = assume $1.50/m
19x12 assume $ .9

https://www.bunnings.com.au/products/building-hardware/timber/framing-timber/structural-pine/untreated-structural-pine
So assume rafters and floor bearers as if 6x1.5" (piers are close) = S7/m
3x2 at $3/m

Common brick $.99 Bunnings

Ply c $30 for 2.4x1.2 m sheet = $10.3/m2

Fibro" $8.96/m2
Ant caps c $3.50 bunnings, but tiny cost home made is .c $2.50
Corrugated iron $16/m2 Bunnings

EMBODIED ENERGY

Cement mixed 1.33mj/kg, density 1.4, so 1400kg/m3 =1,868MJ/m3
Timber 8.5 density 500 g/l mid range
But unnamed source c under 2.5???? so use 4.
Steel 20
Roof tin is my estimate 3.79 kg/m2, so @ 20 = 75.8 MJ/m2
But table says 34.8
Stainless steel 56
Gravel
Glass 15 googled 13
Glass density is 2.6 t/m3, so for 3mm glass, i.e., 330 sheet in a metre = 7.8 kg/m2
@15 MJ/kg 1 MN2 = 7.8X 13 = 101MJ/m2

Insulation 88
Clay tile 6.5
Paint water 60
Roofing iron; assume .4 mm thick,
1 sheet = 2m2 (Bunnings)
@ .4 mm = 200cm2 .4x1/100cm = 40 cc
(https://roofonline.com/weight-of-roofing-materials)
I measured above at 3.7 kg/m2, therefore 75.8mj/m2
Wood 8.5MJ/kg
*= checked
Density .5… = 500kg/m3 = .5 kg/1litre = 500kg/m3 = 4250mj/m3
120x35 = 4,200 mm2 = 42 cm2 = 4200cm3/m @ .5 density =2100g/m = 2.1kg/m =17.8MJ/m**
90x 45 = 4050mm2 2 2.02 17*
90x35 = 3150 15.8*
75x45 = 3375 16.9 *
3x2 3750 18.8*
75x25 = 1875 7.8.*
19x12 228 1

Footings:

Small crushed stone (or blue metal) rammed in trench
23.5m wall length x.45 m x .3 m; = 3.2 m^3 @$24.5 m3 = $78.4

ASSUME 1 m3 = 1.5 t and 1 t = 2.5 mj, so 1 m3 = 3.75 MJ*

so 3.2 m3 = 12 mj

If add 6 mm steel reinforcing rods set one above the other in cement,
So 2 at 22 m =20 m. assume $2/m =
$88

Assume 30 kg 440MJ

Set in cement "girder" at core of footing, 22m x .1 m x .2 m
= .45 m^3 = .45 x $64
=
$29
Density = 2.5 kg/l so 1m3 = 2500 kg and .45 m3 =450 kg =
Energy =1.9 MJ/kg
So energy = 1.9 x 450 = 855 MJ

Floor:

Rammed earth with plastic damp course and 3 mm cement
and chicken wire sealing on top. Could tile over top.

Cement 31 m2 x 3cm = 31 x .o3m3 = .93 m3 =1.2x$64.75 =
$60

1.33 mj/kg (when mixed with sand etc.) x 1200 kg = 1,596 mj

2" chicken wire, 50mx.9 m roll, $65(?) = $1.44/m2
So 40mx $1.44 =
$58

30 kg x 20 MJ =600 MJ

Membrane waterproofing. Assume $50 ?

Assume10kg x 80mj/k = 800 MJ

Walls. Length 23.5m

30 cm thick, rammed earth or cob.
Lower level 23.5 m long x 2.5 m high = 59 m2 x .3 m = 20 m3,
Upper level triangles 12.5 m2 x .3 = 3.8 m3
Total 24 m3 but windows to subtract
minus windows 2@1.2x.9 = 1.08 m2
2@ ,8x.9= 1.4 m2
= 2.5 m3 x .3 = .8 m3
Minus 2 doors = 1.7 m2 each = 3.4m2 saves 3.4x.3 m3 = 1.2 m3 earth

So **Total earth in walls** is 24 – 2 = **22 <u>m3</u>**

= tank 2 m high 1.9 m diameter
3 m high r = 2.7 m
5,500 gal

At 3 cf per barrow load = 1/12 m3, or 8 loads per m3, you **<u>need 178 loads</u>**

Tin white ant capping, homemade, 22 m x .45 m wide = 10 m2
One 8x4ft sheets i.e., 2.4m x 1.20 m = 2.9 m2 @ $60?/sheet = $20.7 / m2.
So 10 x $20.7 = =
$207

Assume 10kg = 200 MJ

Reinforcing braces ; long 4 @ c 8m = 32 m @ $3 stainless
$60
30 mj/kg stainless

Assume 5 kg @ 35 MJ = 165 MJ

<u>Windows</u>:

Home made. Housing surrounds are pre cast 3 cm cement + chicken wire., (to prevent white ants), hinges bolted into
total length top and sides and sills, 17.4 m
volume average 3 cm x 7.5 cm = 23 cm2x17.4 m =.023m2x17.40 m2 = .4m2
concrete= = $26
Each window two casement panels, hinged at sides.
Window frame wood 19x50mm x 17 m
12 x 19 mm strip x 17 m
= c 38m x $1 ? =
$38

17m 50x19 assume 3 mj/m = <u>51 mj</u>
17 m 19x15@ 1mj = <u>17mj</u>

Glass from $38/m2 up, assume $50/m2, so for 2.5 m2 =
$125

@ 101MJ/m2 = 250 MJ
Putty.
$10
Like paint…?? 60 mj
<u>Doors</u>;

Bunnings external $260-360.

Three. Homemade $100 (redo; should be much less) thick ply, 3+x1" each side + lock. $150

Housing/surrounds 3 cm cement 5.5mx 23 cm2 =.13 m2 =
$9
Door knobs and lock, Bunnings from $11, assume 3 @ $20 =
$60

??
150??

Upper floor.

Bearers 13 spaced at 60- cm = c 58 m2.
Bunnings rough 6x1, $6.3
$365

58x17.8 = 1,032MJ
So
$100
Reinforcing?? By 6 mm steel rods diagonally stressing each second bearer, 42 m =7 @ 3.5m =25m x $2/m =
$50
Or could be supported by diagonals from roof bearers above…

Floor, Yellow tongue panels, c 38 m2 2.9m2 costs $42,
so 31.5m2 =$14.5/m2 so =
$457
But edges need not be yellow tongue…ignore??

Ply is 15, so assume 60???? 1800
Weight?

Stairs 2@3m + (17 @ 60cm steps, of c120x 3cm wood, = 10m) = 16 m @$6.3m =
$101*

285mj

Roof
10 undressed bearers 125?x35, spaced at .8m, x 4.5 m to enable eaves= 90 m x $6.3/m2 =
$567*
1602 mj

Battens for iron, 6 x 7 m = 42 of 75x 25 SW @ $3??
$126

63

Tin -- area of floor 31 m2, so area roofed = c 43 m2
Multiply by 1.3 for pitch/peak = 52 m2
at $15 for .8 m2 = $19/m2,
$988
CHECKING
52 m2 x 76 MJ/m2 = 3,952MJ
But new figure is 35 so 1820

End walls upstairs.

7.5 m2 + 3.75 + 3 m2 outside = 14.5 minus 1.4 windows = 13 m2
waterproof + inside ply (Below).
Studs 13 m

Lining.
41 m2 upstairs roof = @ $9m2 for fibro
$370

15mj/m2 so 600MJ

Insulation

end walls upstairs 13 m2
Roof 8m slopes x 6.8 av length = 55 m2
Total 68 m2 = x$7.5 =

Google $50 for 6 m2 = $7.5/m2, so
$510

Table says 139mj/m3 so if 3" then 13.3/m2, so 139 mj for 13.3 m, so you need
5 packs so 5x139mj = 695 mj

Bathroom, laundry, toilet

Benches, not appliances
Toilet unit $150
Sink + taps ??$100
Shower + taps ?? $60
Washing tum $150

Lighting; 4 LEDs, switches, wire ??$60

Plumbing pipe Polypipe + fittings $100

Fasteners.

Paint

Assume $13/l,
earth wall inside = 75 m2, (ignoring windows and doors assuming those = cupboards etc.
roof 9 x8.5 = 77 m2 1 l of Dulux covers 16 m2; so 4 tins = 64 m2 paint $150??
Floor included??

4 tins – 16 litres = 1440mj

Tank

Total;		New tally	MJ
Footing	120	97	1307 if cement
Floor	136	168	2996
Walls	390	267	365
Windows	125	199	327
Doors	220	220	150
Upper floor			
bearers		364	1032
Stairs		101	285
Yellow tongue		457	1800
Doors	210	220	150
Roof			
Bearers		567	1665
Battens		126	in
tin	3000	988	1820
Lining	969	370	600
Insulation	224	510	595
Paint	150		1440

Toilet unit $150
Sink + taps ??$100
Shower + tap $60 ??
Washing tub $150
Lighting $60
Plumbing $100 770

Old estimate $6998 = $102/m2

New $7000 = $149/m2

Minimal ($150,000) house = x 21/1

But average house is 186 m2 = x 2.86 times the area.= x

Cost per m2 $1332/149= c 9/1

These two should be the same; but the two assumptions are from different sources.

Energy sum 12,689 without cement floor girders
13,996 including them. (not including the fittings list)
=1.4% of normal = 3.8% if this small house was built to normal house size.