How to do good buildings - in wood

Jon Broome

JON
BROOME
ARCHITECTS

A good building -

- Embodies the needs & desires of users
- is practical
- uses energy & materials efficiently
- is good value
- adaptable and
- beautiful

Why wood?

- Renewable
- Low embodied energy
- Accessible
- Can look good

How?

INTEGRATION of -

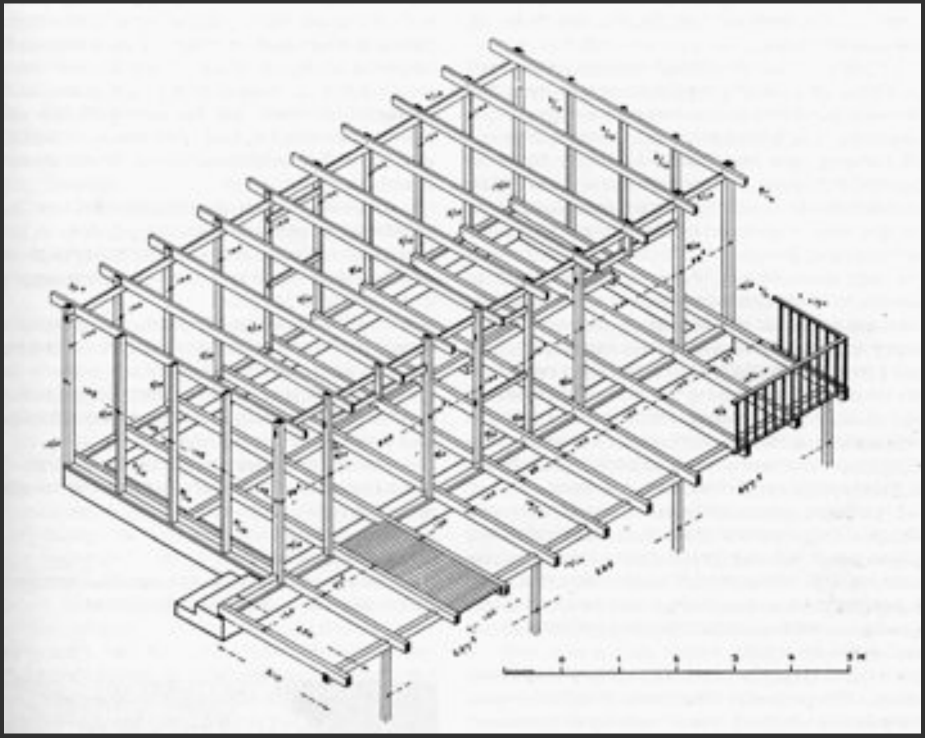
- Design with
- Structure
- Energy strategy and
- Construction method

No one answer …where we are now

Early inspiration : John Turner : Housing by People

Early inspiration : Colin Ward : Arcadia for All

Early inspiration : Walter Segal : Home & Environment



UK mass housing is generally -

- Too standardized
- Built to low standards of space & equipment
- Inflexible and
- Poor value

Exhibition of Modern Methods of Construction at the BRE

However, resident controlled housing is national policy in -

Trinidad & Tobago

Collective smallholdings

Guyana

Self -build

Individual houses

Self-build

Lewisham self-build – phase 1

Lewisham self-build – phase 2












Design

User centered : put yourself in their place

Solutions within constraints : anything is possible - but is it sensible?

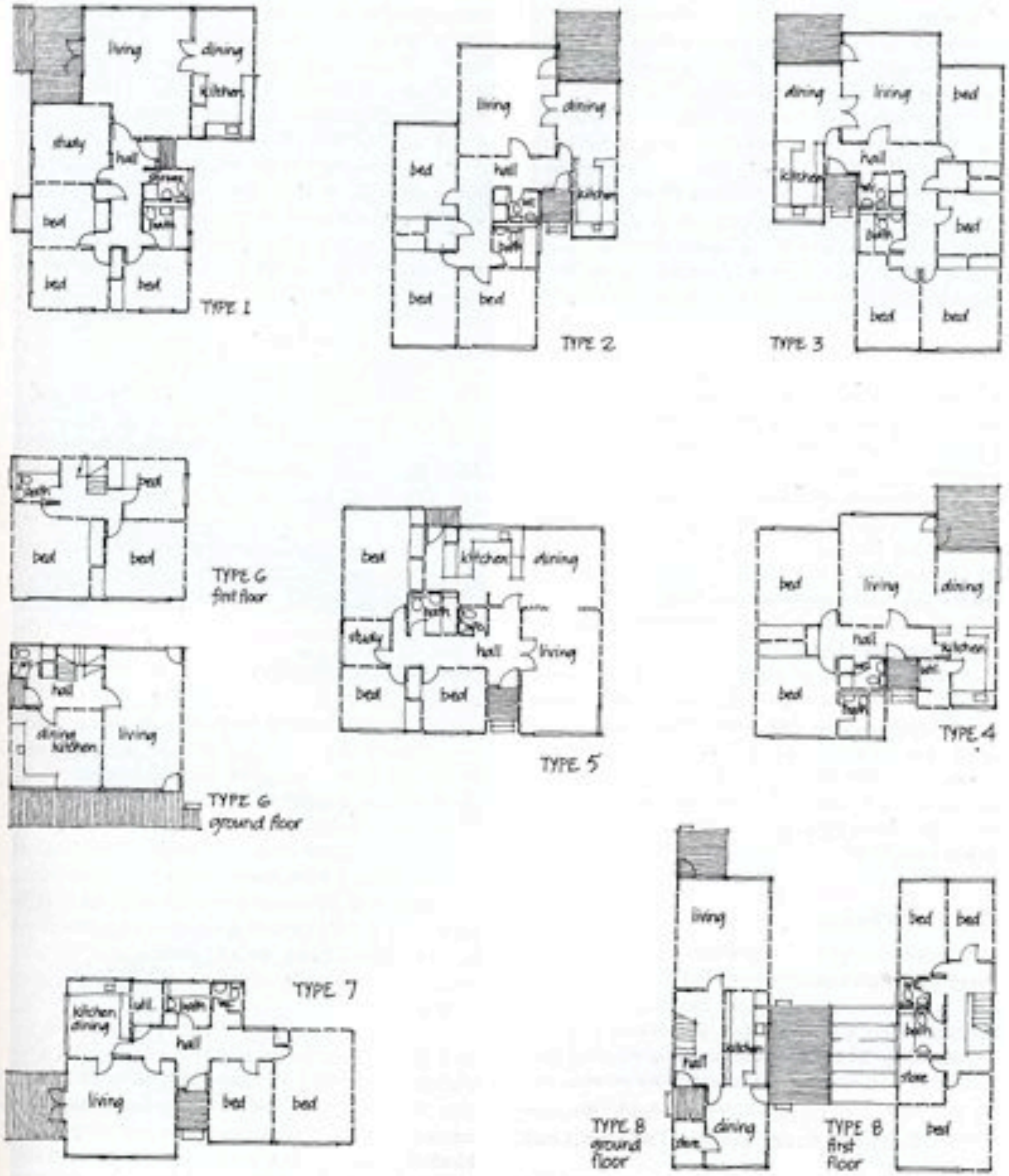
Design from the inside : then check the outside …and so on

Design for maximum usability of space and

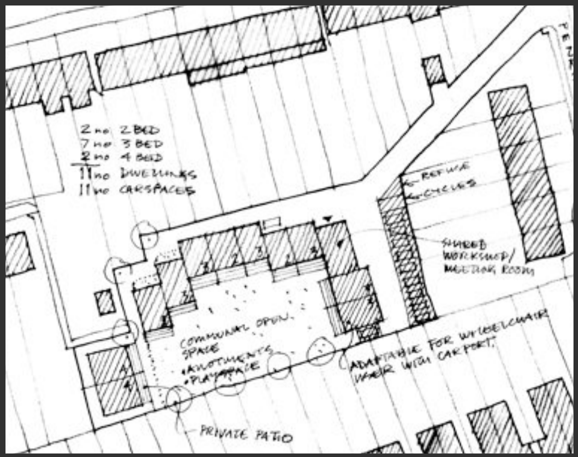
for light, view, sun and connection with outside.

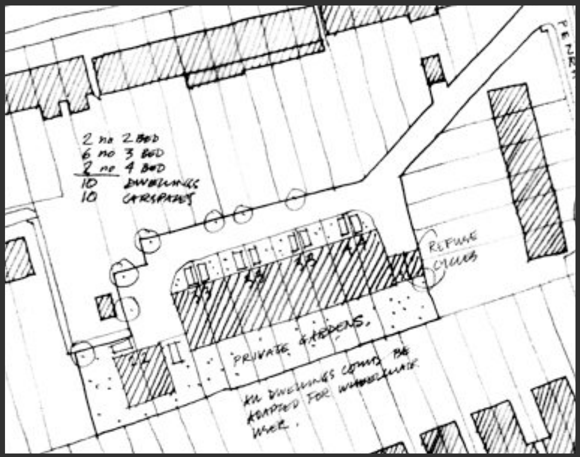
Design for the locality and create a sense of place…outside…

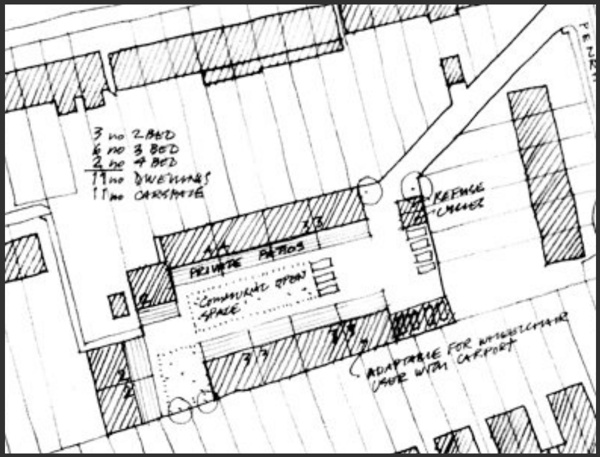
and variety and interest inside

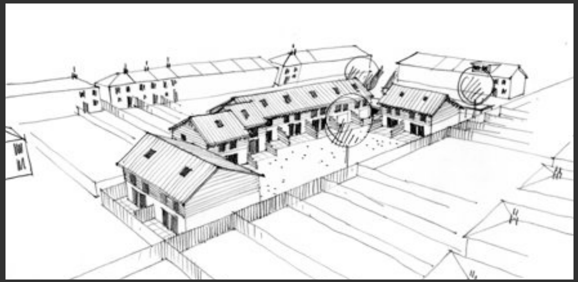


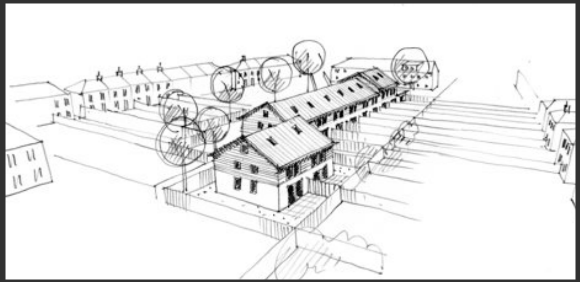
Lewisham phase one: the range of basic plans

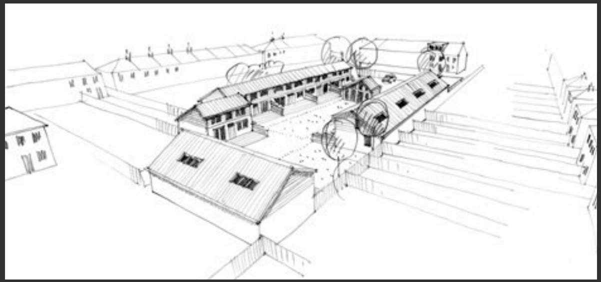


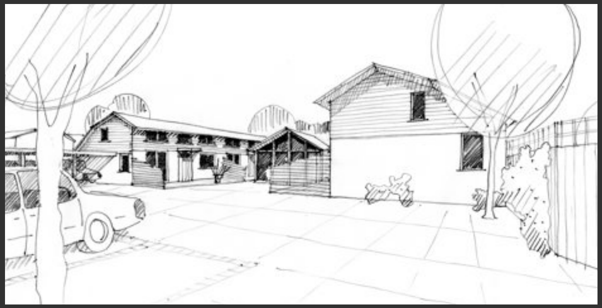












Shared space at the back

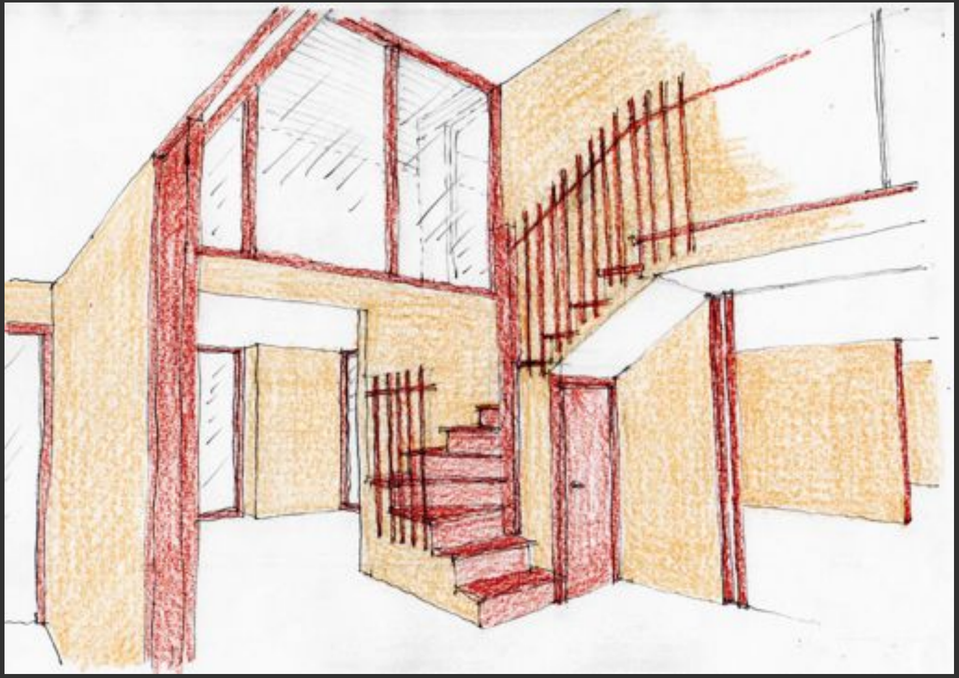
Private gardens at the back

Shared space at the front

Layout Choices

Material Choices

Final layout



Design as you go

Important reference : The Pattern Language : Christopher Alexander et al

Six Foot Balcony-167

Flow Through Rooms-131








House in Islington

House in Ditchling

Visitor’s centre in Kent

Adjacent to listed oast houses








Horsham

Guildford

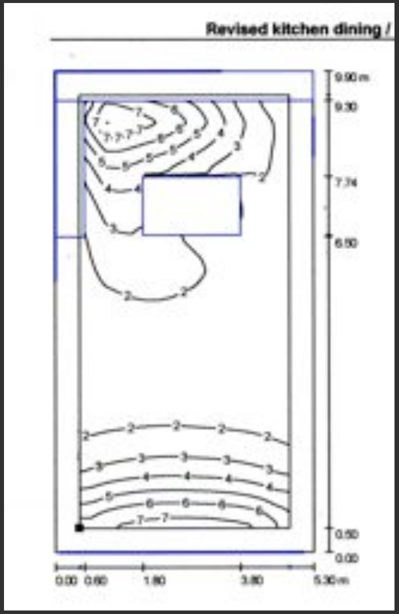
Woking

Daylight calculations

480 Daylight 4 bed.xls

	A	B	C	D	E	F
51	Angle of visible sky	Th	65			
52						
53	Ag	3.5	m2			
54						
55			Bedroom 3			
56						
57	Daylight factor	D	3.0			
58	Length	l	3.3	15.8	floor & ceiling area	
59	Width	w	2.4			
60	Height	h	2.5	28.5	area of walls	
61						
62	Reflectance	R	0.5			
63	Transmission factor	T	0.6	double glazing low E coating		
64	Angle of visible sky	Th	65			
65						
66	Ag	2.6	m2			
67						
68			Bedroom 4			
69						
70	Daylight factor	D	3.0			
71	Length	l	3.1	16.7	floor & ceiling area	
72	Width	w	2.7			
73	Height	h	2.5	29.0	area of walls	
74						
75	Reflectance	R	0.5			
76	Transmission factor	T	0.6	double glazing low E coating		
77	Angle of visible sky	Th	65			
78						
79	Ag	2.6	m2			
80						
81	DAYLIGHT FACTORS					
82						
83	DAYLIGHT CALCULATION		living room			
84						
85	Area window	Ag	3.1			
86	Length	l	5.3	35.0	floor & ceiling area	
87	Width	w	3.3			
88	Height	h	2.4	41.3	area of walls	
89						
90	Reflectance	R	0.5			
91	Transmission factor	T	0.6	double glazing low E coating		
92	Angle of visible sky	Th	65			
93						
94	Daylight Factor DF	2.1				
95						
96	DAYLIGHT CALCULATION		kitchen			
97						
98	Area window	Ag	3.3			
99	Length	l	4.0	28.8	floor & ceiling area	
100	Width	w	3.6			

Sheet1 Sheet2 Sheet3



Notes on design

Designing for actual people is much easier than some official's or developer's idea of what people want.

Contrary to what one might infer from housing professionals and developers most people like big windows and open plan living.

Architecture is not sculpture

Build as much space as you can

Structure

- Generally better on the inside of the skin
- Economic
- Efficient - calculated
- Adaptable

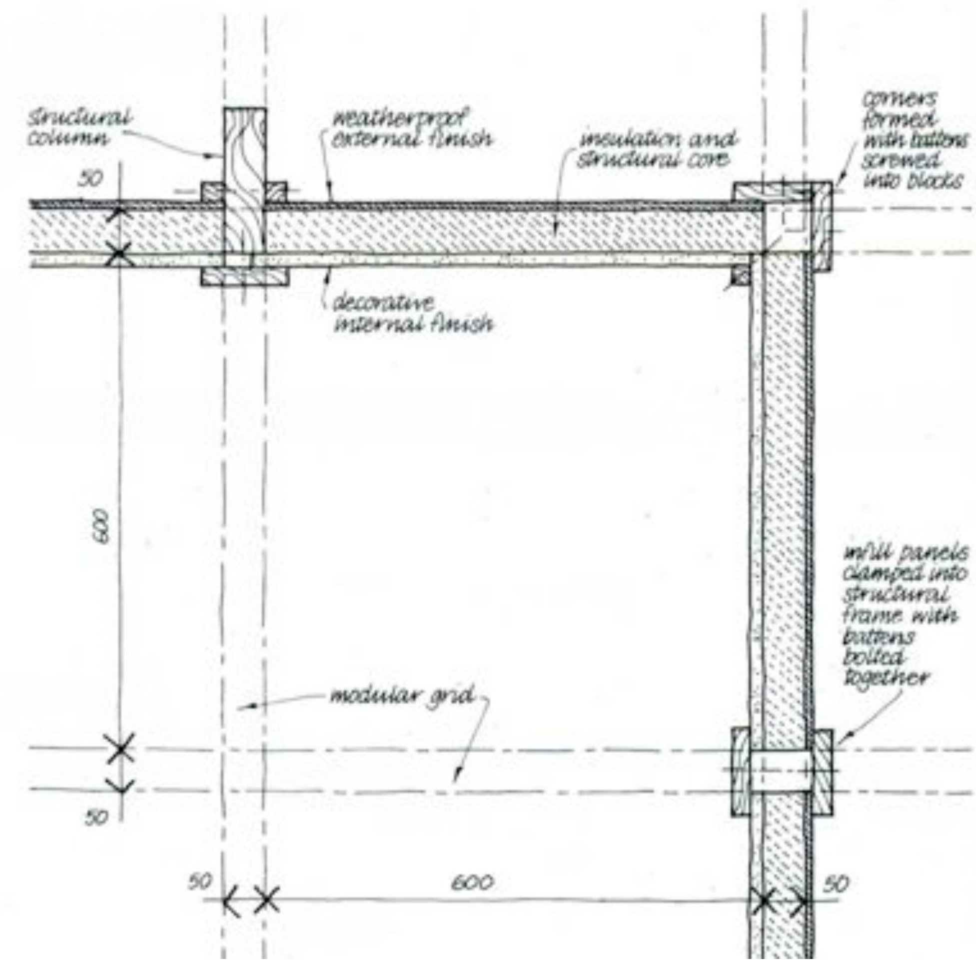
The Segal Method

Readily available materials such as plasterboard combined in their standard sizes within a

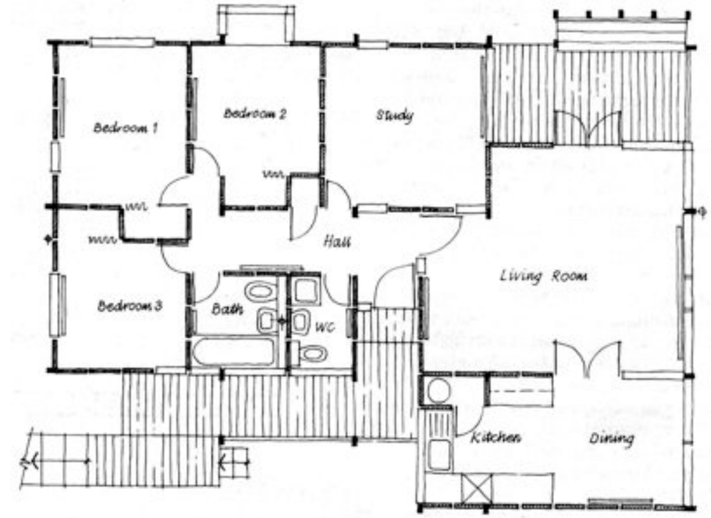
post and beam timber frame set out on a

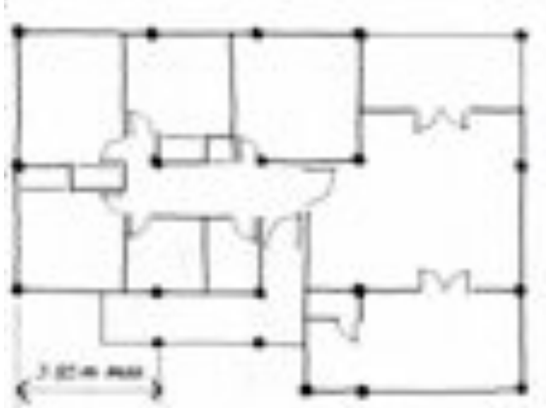
modular ‘tartan’ grid using

dry jointing techniques such as bolts and screws

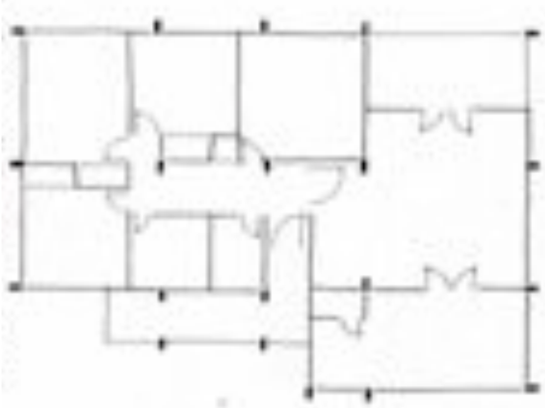


The plan comes before the structure





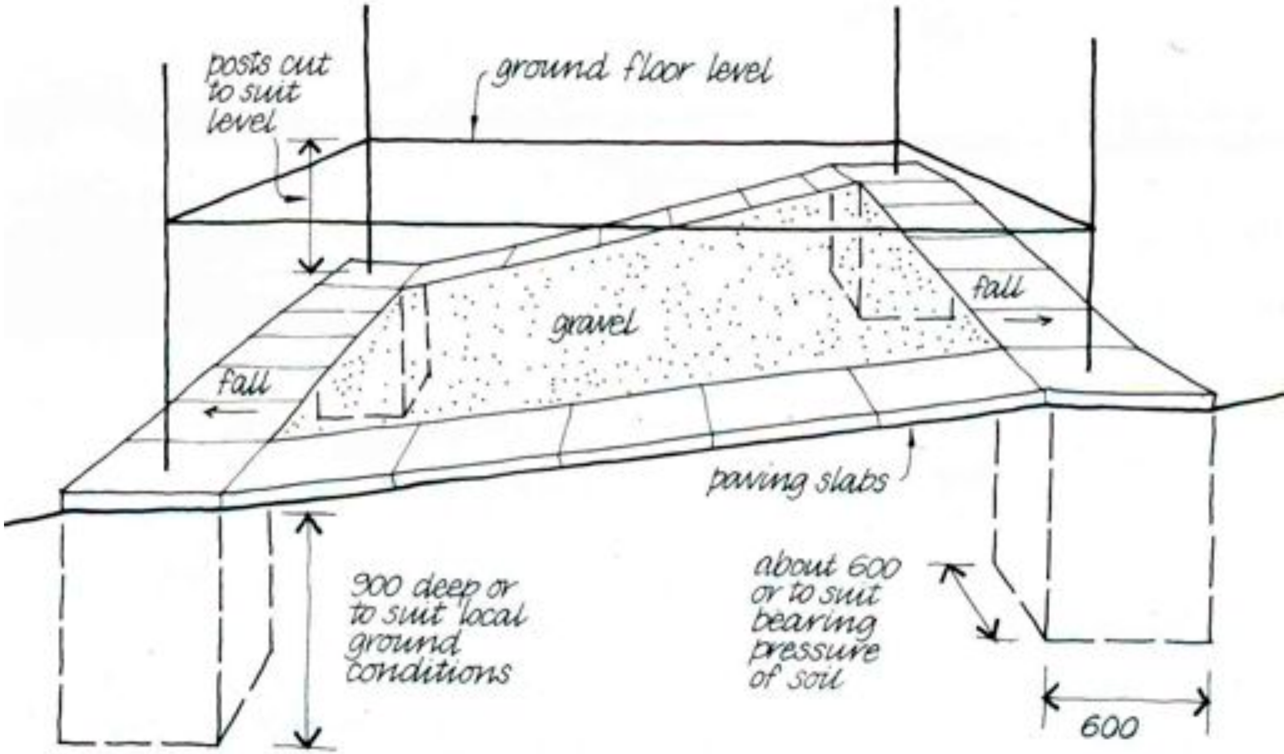
Set frame lines & position columns & bracing.
Consider cantilevers



Position columns relative to grid

Post & Beam Frame

Foundations

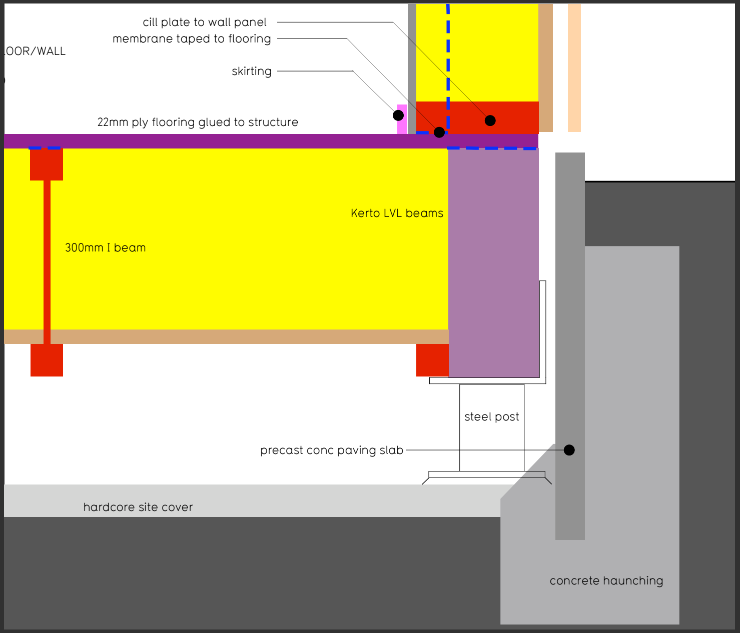


Hand dug pads

Auger bases


Concrete piles

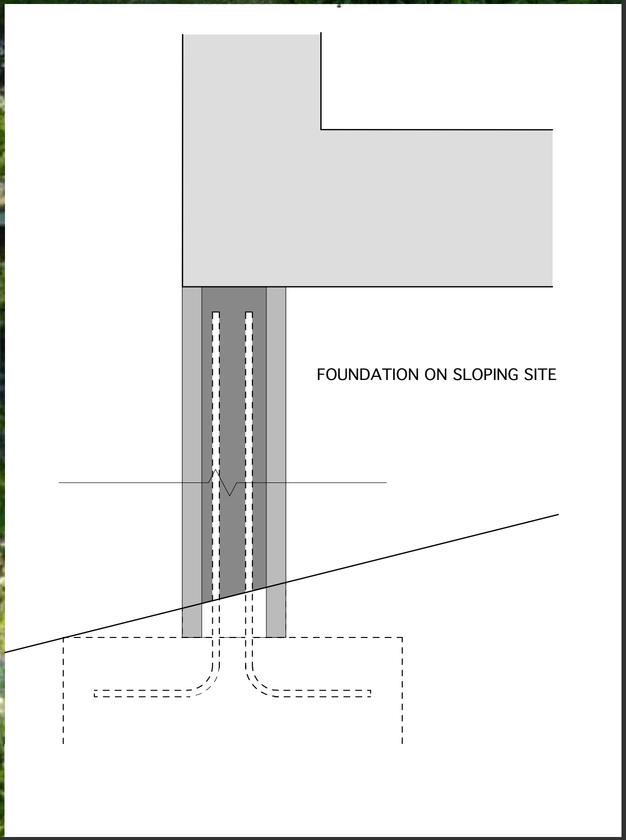

Steel screw piles


cill plate to wall panel
membrane taped to flooring
skirting
22mm ply flooring glued to structure
Kerto LVL beams
300mm I beam
steel post
precast conc paving slab
hardcore site cover
concrete haunching

Walls, windows, doors & partitions at will

Panel structure

No redundant structure leads to greater economy
Retain individual foundations



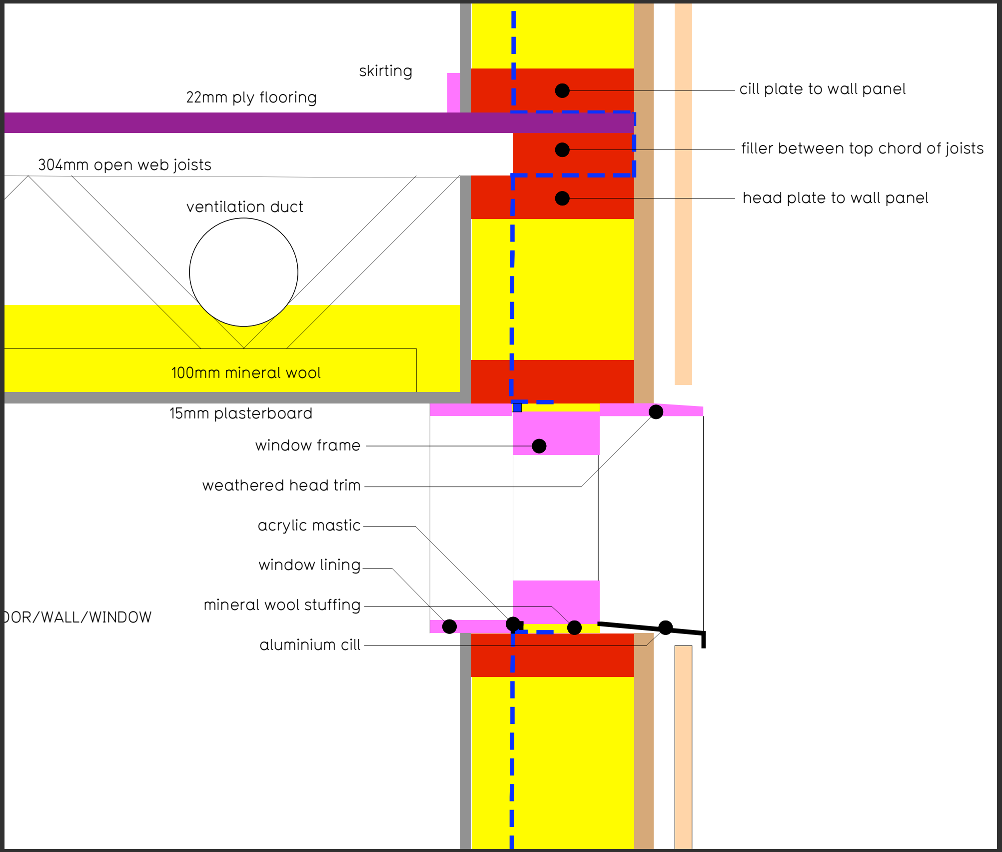
Cold bridging

2 layer structure creates thermal break
Angle wind braces
Additional strength
Greater economy

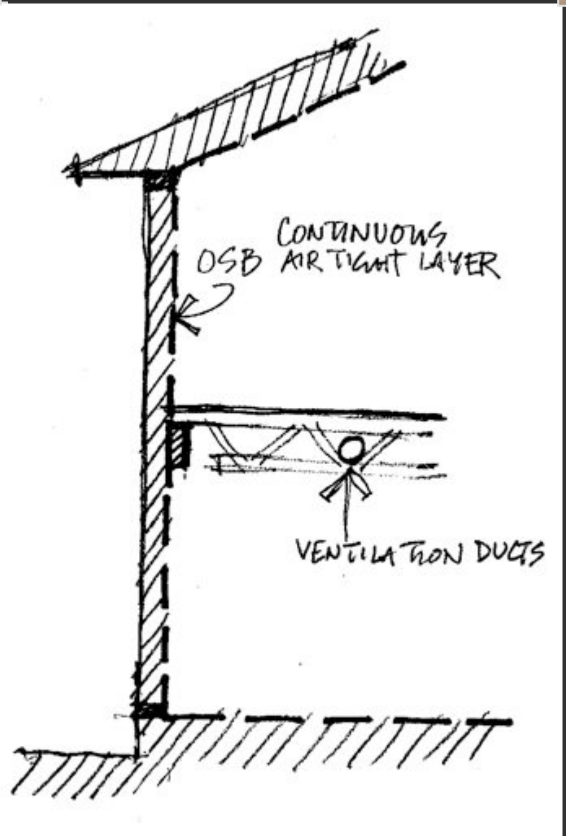
Platform frame

Clear spans party wall to party wall

Off-site prefabrication / stick build on site



House for 3 generations in Sussex



Balloon frame

Office in Waterloo relocated and reconfigured as nursery in Stockwell

Poles

Strong & efficient

Low cost

Visitor centre near Litchfield

Glulam for large spans

Relocatable tenant’s hall in Camden

Generally timber frame engineering design pays little attention to cold bridging & uses rules of thumb which leads to redundant structure which increases cost and heat loss.

Engineer not aware of need for external insulation to avoid thermal bridging at floor level

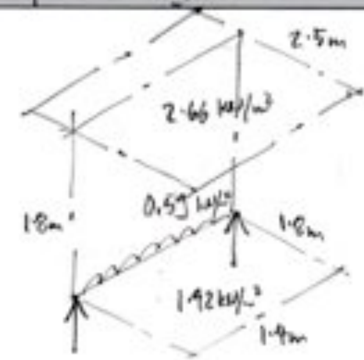
Open web joists accommodate ventilation ducts in first floor. But engineer left design of first floor to subcontractor who incorporated solid trimming beams.

Inexperienced engineer omitted to design for double cantilever at corners of roof.

Important resource :
Structural Timber Design to Eurocode 5 :
Porteus & Kermani

CLIENT	SITE	DATE	REV
Babington/Wright	New Carmel, Sedlescombe	15.12.10	

FLOOR BEAM 14



Clear span of beam		= 1.40 m	Effective span	L	=	1.45 m
Roof load width of load		2.50 m				
Imposed roof load		2.66 kN/m^2				
Wall height		1.80 m				
Wall dead load		0.59 kN/m^2				
Width of floor load		= 1.80 m				
Superficial floor load		= 1.92 kN/m^2				
Assume section	b	= 75 mm	then self weight		=	0.07 kN/m
	d	= 175 mm				
Total UDL on joist	w	= 11.24 kN/m				
Maximum bending moment	M	= wL^2/8 kNm			=	2.95 kNm
Applied bending stress	fa	= M/Z	where section modulus	Z	=	bd^2/6
		= 7.72 N/mm^2				
Max permissable stress	fp	= fg x K3 x K7 x K8	where grade stress bending C24	fg	=	7.50 N/mm^2
			load duration factor long term	K3	=	1.00
			depth factor	K7	=	1.061
		= 7.96 N/mm^2	> applied bending stress			
Deflection	Δ	= 5wL^4/384EI	where E min C24	E	=	7200 N/mm^2
		= 2.68 mm				
Maximum permissible		= 0.003 x L				
		= 4.35 mm	> actual deflection			

THEREFORE USE 75 X 175 C24 GRADE

Notes on structure

Designers in general should have a much better understanding of structural design.

This is because structural engineers often need to be challenged to obtain an efficient and cost effective solution.

Analysis of timber structures is largely simple arithmetic with a certain amount of experience to know how to apply it………

Assess loads - dead, imposed and load duration

Position joints in beams if availability of long timbers makes necessary

Trace loads from top for critical members - roof joist / floor joist /roof beam / floor beam / column

Determine beam conditions; simply supported, continuous or cantilever

Determine size and grade of joists and beams by checking bending and deflection. (Shear governs short heavily loaded beams or special conditions such as notches)

Assess end fixity of columns

Determine size and grade of columns depending on load & slenderness.

Design joints. Often limiting factor in timber structures. Determine number, size and spacing of bolts by checking loads parallel and perpendicular to the grain and end and edge distances.

Check wind loads. Determine dynamic load on building depending on location, degree of shelter, pressure coefficient which is a function of height and width of building. Check uplift, overturning and bracing

Check foundations. Permissible ground bearing pressure a function of the type of soil.

Energy

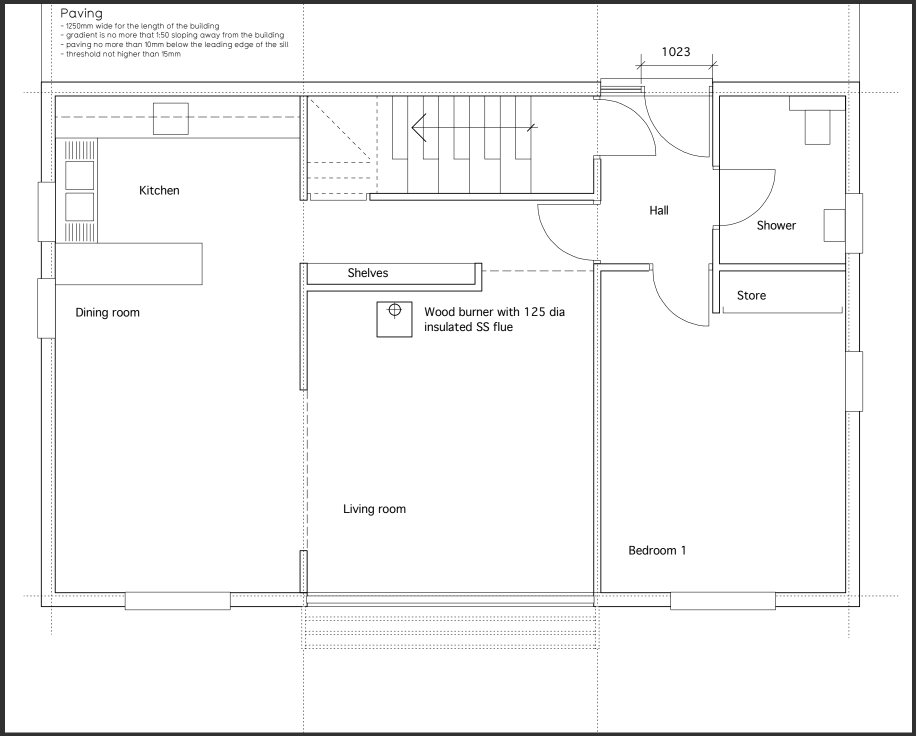
Basic strategy to reduce demand as far as possible and then consider renewable sources of energy.

Use Passivhaus software as design tool

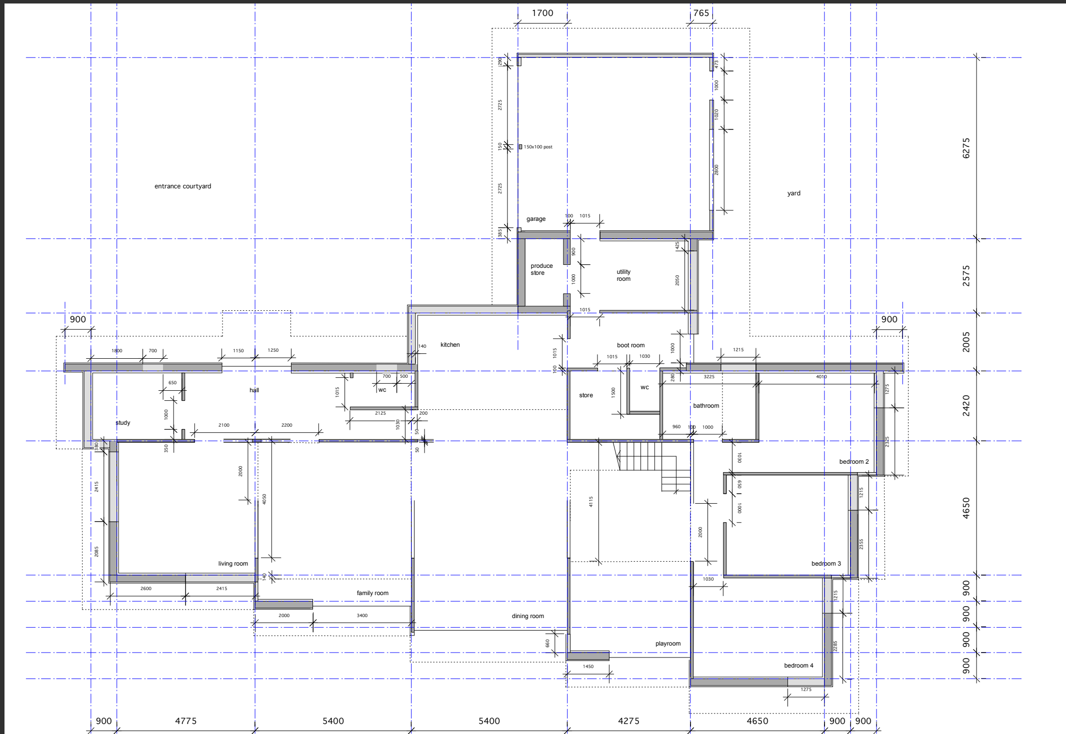
Well insulated, airtight envelope as simple as possible with minimum thermal bridging

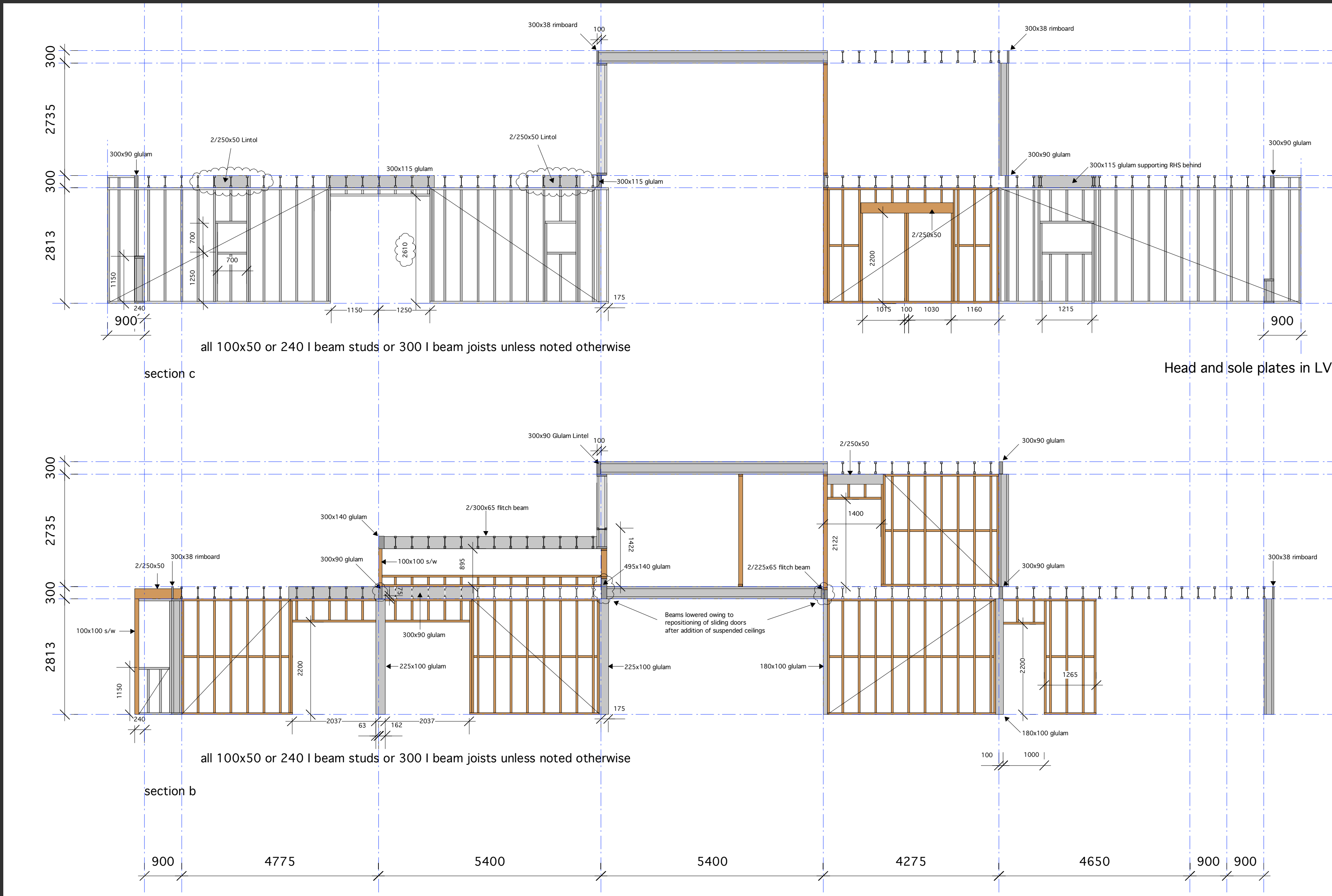
Heat recovery ventilation

Consider shading to prevent overheating in summer



Wood fired in Scotland


1700
765
entrance courtyard
garage
yard
produce store
utility room
kitchen
boot room
hall
wc
store
wc
bathroom
study
bedroom 2
living room
bedroom 3
family room
dining room
playroom
bedroom 4
900
900
6275
2575
2005
2420
4650
900
900
900
900
900
4775
5400
5400
4275
4650
900
900



300x38 rimboard
100
300x38 rimboard
2/250x50 Lintol
2/250x50 Lintol
300x90 glulam
300x115 glulam
300x115 glulam
300x90 glulam
300x115 glulam supporting RHS behind
300x90 glulam
300
2735
300
2813
700
700
1250
1150
2610
2/250x50
2200
240
175
1150
1250
1015
100
1030
1160
1215
900
900
all 100x50 or 240 I beam studs or 300 I beam joists unless noted otherwise
section c
Head and sole plates in LVL
300x90 Glulam Lintel
100
2/250x50
300x90 glulam
2/300x65 flitch beam
300x140 glulam
1422
2122
1400
300x90 glulam
100x100 s/w
895
495x140 glulam
2/225x65 flitch beam
300x90 glulam
2/250x50
300x38 rimboard
300x38 rimboard
100x100 s/w
300x90 glulam
Beams lowered owing to
repositioning of sliding doors
after addition of suspended ceilings
225x100 glulam
225x100 glulam
180x100 glulam
2200
2200
1265
1150
240
2037
63
162
2037
175
180x100 glulam
100
1000
all 100x50 or 240 I beam studs or 300 I beam joists unless noted otherwise
section b
900
4775
5400
5400
4275
4650
900
900

Thermal bridging

Cross battens reduce thermal bridges which can be up to 30% of the heat loss through envelope.

External fibre insulating board reduces remaining thermal bridges around openings & perimeter of panels. (100mm common in passive construction.)

Well insulated & airtight in 1987?

Airtight construction

Membrane on the inside of the construction within service void.

Eliminate cold draughty loft

Windows sealed to membrane with acrylic mastic on inside of construction

Issues with airtight construction

Definite plane for airtight layer clearly on drawings

Understanding & commitment from general contractor.

Passed on to subcontractors & properly supervised.

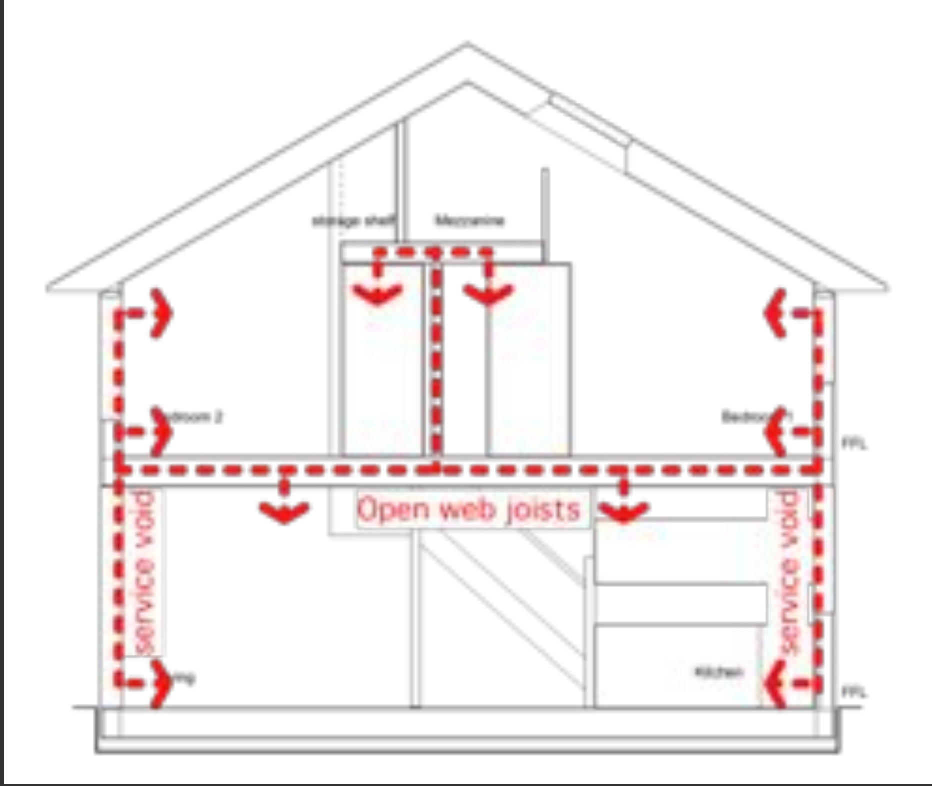
Internal membrane requires strip incorporated into the wall/first floor junction which can get damaged and wet.

OSB far more robust air barrier. Also acts as wind bracing and vapour control layer

Services

Designed to minimize penetrations with clear routes.

Soil stack, boiler flue; cluster incoming gas, water, power, phone & tv; fresh air inlet and exhaust.



Kitchen, wc & bathroom layout designed for efficiency with minimum pipe runs and sizes.

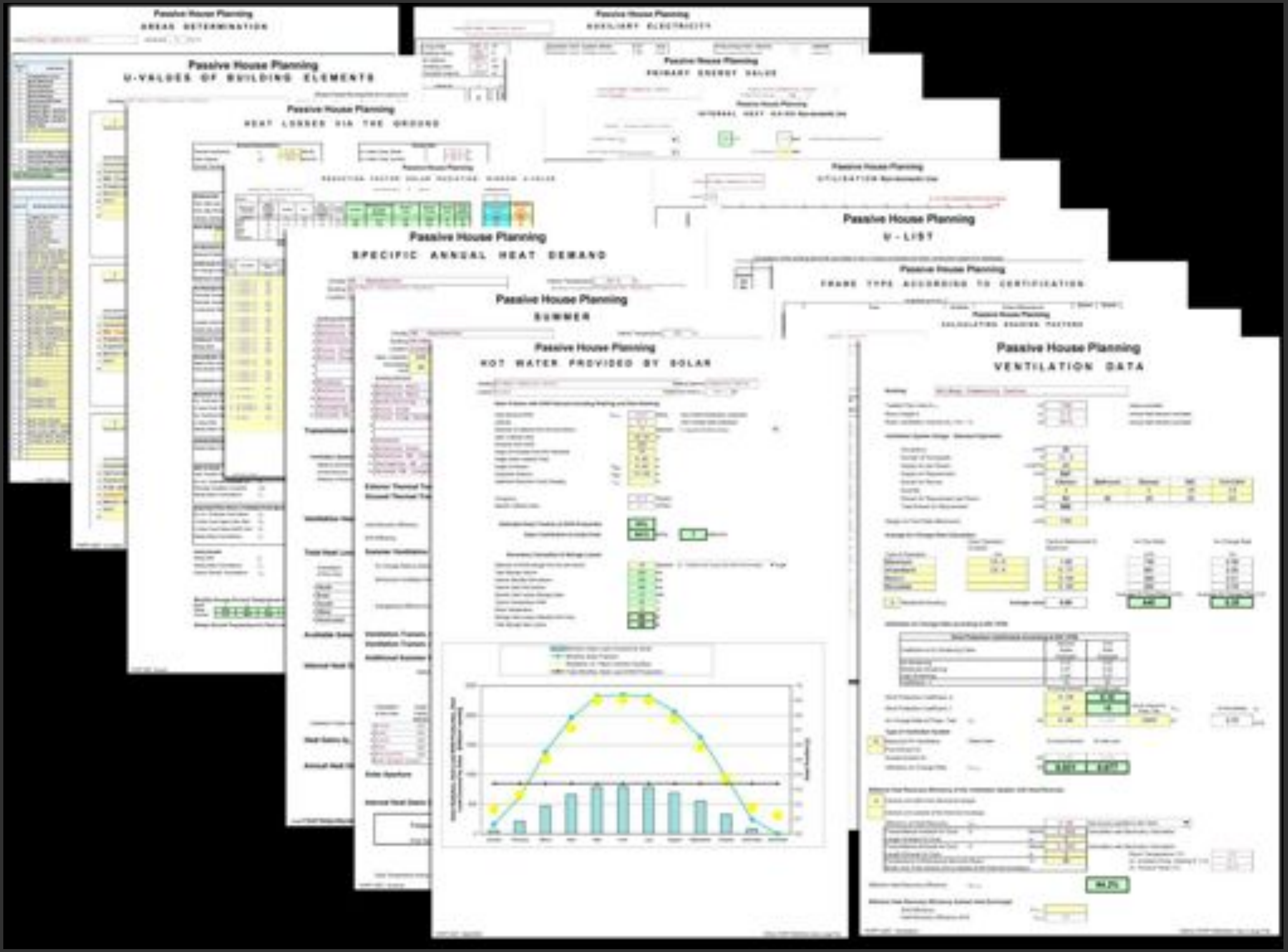
Dead-legs and hidden joints avoided by use of manifolds for heating and water with 10mm polybutylene pipes.

Ventilation issues

Recirculating cooker hoods added to kitchens to reduce cooking smells.

Industry has matured & gained experience of design, installation & commissioning in intervening 4 years.


Important resource : PHPP



Notes on energy

High energy performance need cost very little : it's a question of priority.

Space for equipment is usually too small

Airtight buildings are difficult

Membranes are not robust enough in this context

Lobbies can be avoided

MVHR machines should be readily accessible

Thermal mass is generally not critical

Construction

Imagine you are building the building…how do you position each component…how do you fix it…?

Minimize embodied energy - can be significant proportion of overall energy content

Rules of thumb -

- Use materials as efficiently as possible
- Natural in preference to highly manufactured
- Local in preference to imported
- Recycled or reused in preference to virgin resources

Important resource :
Handbook of Sustainable Building : Anink, Boonstra & Mak

ENVIRONMENTAL PREFERRENCE METHOD

- Compares products and materials on the market & ranks them according to ENVIRONMENTAL impacts; resource depletion, emissions, energy, waste etc. from extraction through production to disposal - does not take into account cost, aesthetics.
- Basic selection given is proven and little or no additional cost
- Much more accessible than Life Cycle Analysis (LCA) for making choices in construction & materials

Wall structure

First preference	Second preference	Third preference	Not recommended	Comments
Timber frame Earth Straw bale Local stone Recycled bricks	Sand-lime bricks	Hollow concrete blocks with recycled aggregate SIPS	Concrete blocks with no recycled aggregate New bricks Cement mortar	Timber to be untreated Concrete blocks to include recycled aggregate Use lime mortar

Wall cladding

First preference	Second preference	Third preference	Not recommended	Comments
Durable timber Shingles	Brickwork Tile hanging Lime render	Fibre/cement, resin-bonded and plywood cladding panels	Non-sustainable tropical hardwood Treated softwood Cement render	European timber is preferred to Canadian cedar. Reclaimed bricks and lime mortar are both good.

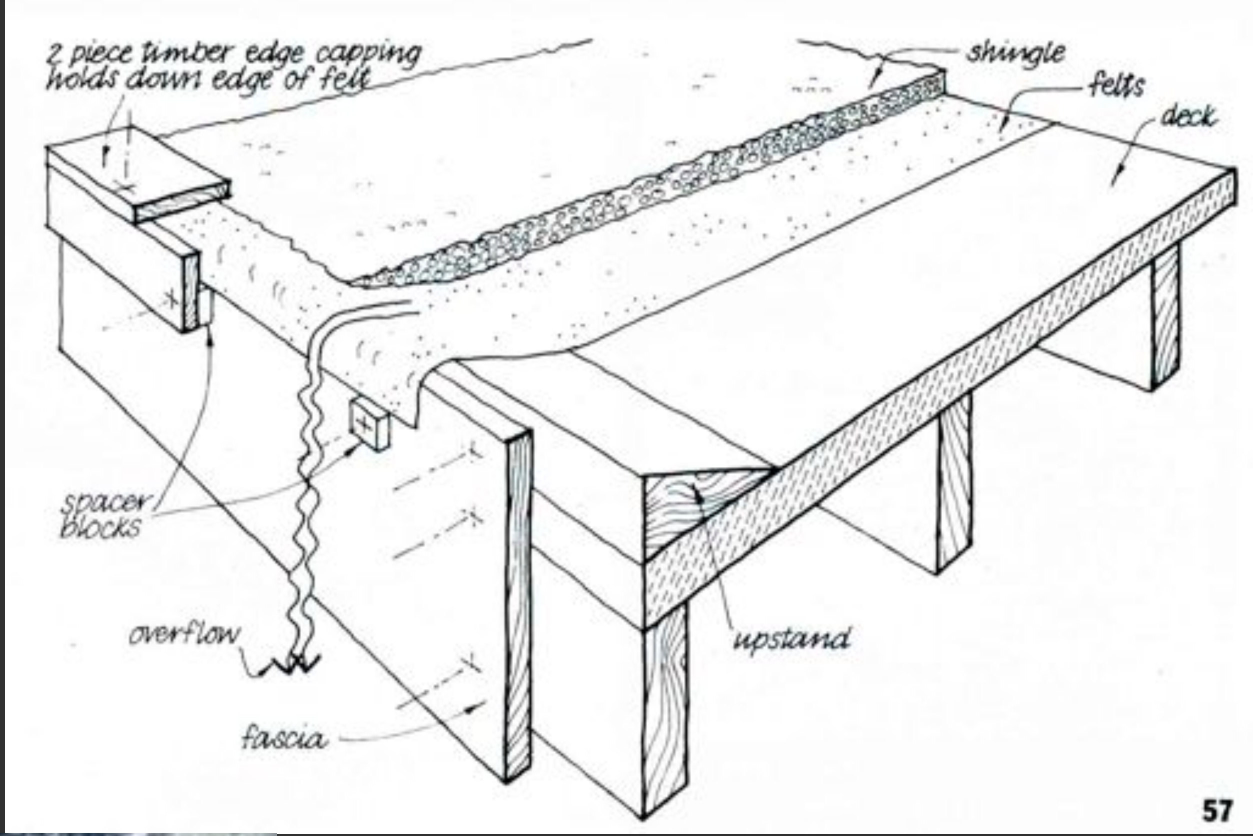
Wall insulation

First preference	Second preference	Third preference	Not recommended	Comments
Cellulose fibre Sheep's wool	Mineral wool Expanded polystyrene	Foamed glass	Polyurethane Extruded polystyrene	Avoid ozone depleting products

Flat roof coverings & fixing method

First preference	Second preference	Third preference	Not recommended	Comments
	EPDM TPO Modified bitumen felt.		PVC Zinc Lead	
Loose with plants	Loose with gravel	Mechanically fixed	Fully bonded to deck.	Allow for additional weight of ballasted roofs

Roof


2 piece timber edge capping holds down edge of felt
shingle
felts
deck
spacer blocks
overflow
upstand
fascia
57

No more PVC

timber windows
linoleum
polyethylene soil pipework
clay drainage
steel gutters
low smoke zero halogen cable

No more concrete

Timber

Reused timber can be high quality. Recycle waste

Reduce consumption, engineered timber

UK grown oak, chestnut, Douglas fir, larch. Certified if possible.

Certified imported. FSC or PEFC.

Avoid Threatened species CITES eg Ramin

ZF chipboard, ply, MDF & OSB.

Hardboard, medium board, softboard & fibreboard use natural cellulose as binder. Cement & gypsum fibreboards have higher energy content.

Timber treatments

Avoid if possible

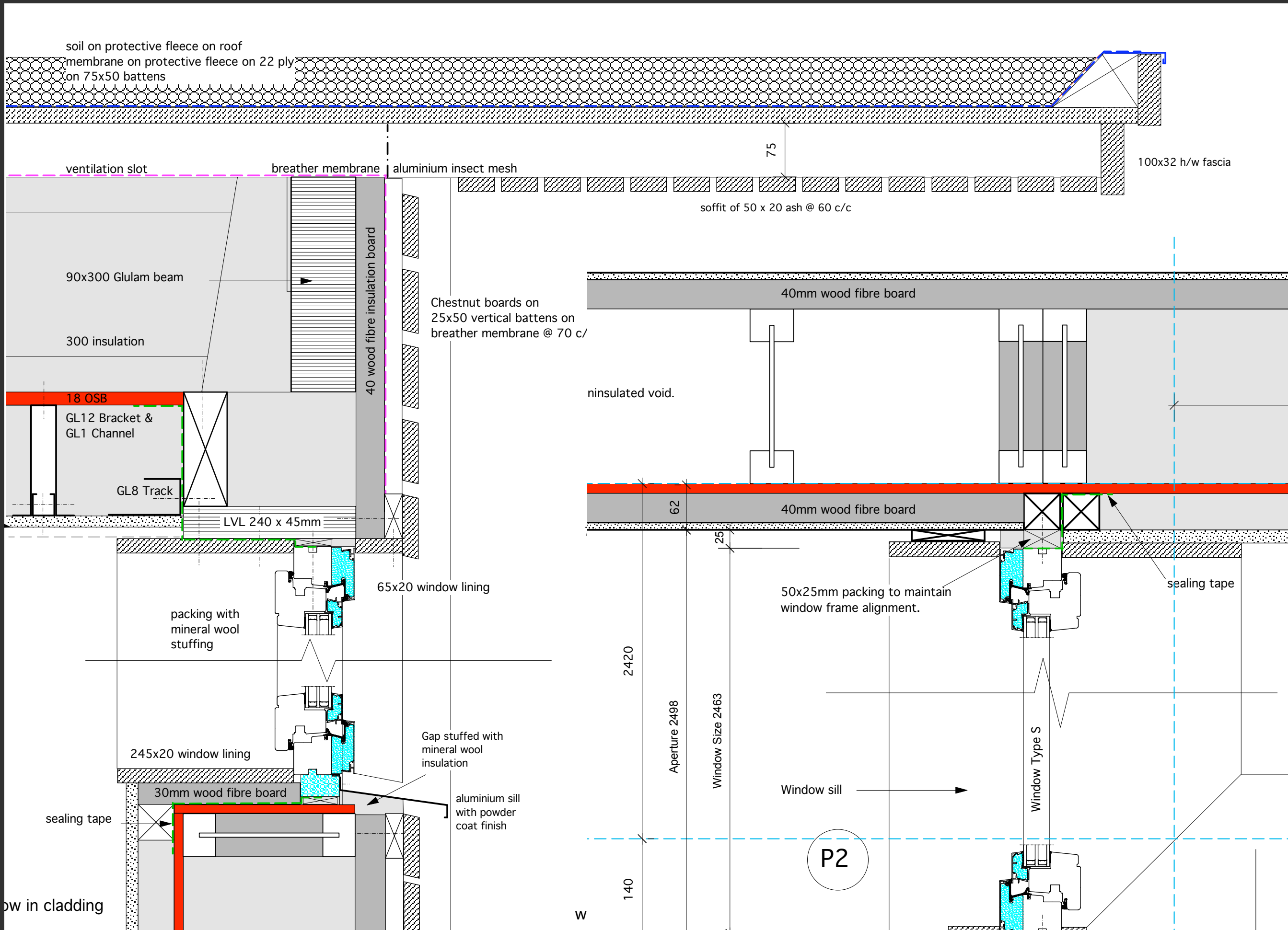
Specify durable or moderately durable species, avoid sapwood, design to shed water & ventilate.

Consider borate implants or treatment.

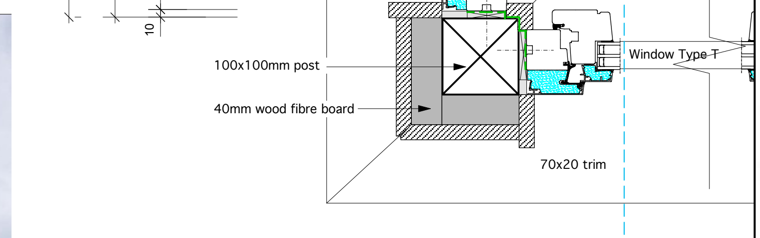
Water borne better than organic solvent based but cause swelling.

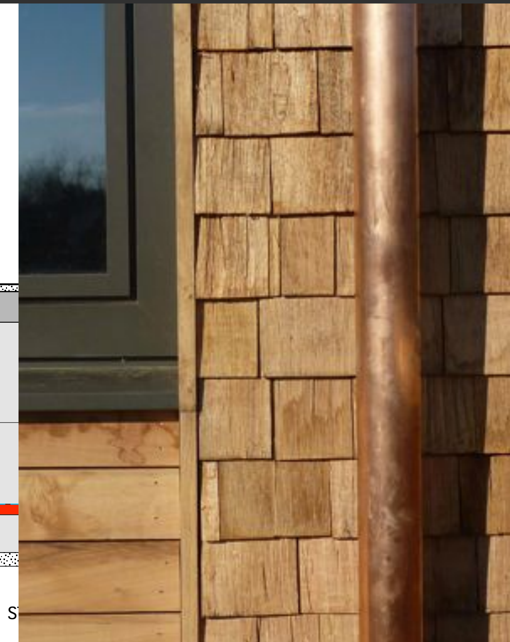
Avoid CCA.

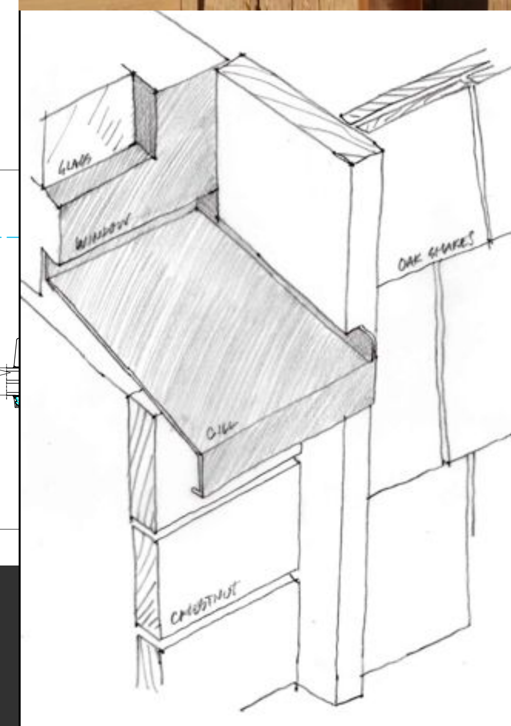
Ensure that surveys carried out by holders of Cert Timber Infestation Surveyors by Institute of Wood Sciences.



soil on protective fleece on roof
membrane on protective fleece on 22 ply
on 75x50 battens
75
100x32 h/w fascia
ventilation slot
breather membrane
aluminium insect mesh
soffit of 50 x 20 ash @ 60 c/c
90x300 Glulam beam
300 insulation
40 wood fibre insulation board
Chestnut boards on
25x50 vertical battens on
breather membrane @ 70 c/
18 OSB
GL12 Bracket &
GL1 Channel
GL8 Track
LVL 240 x 45mm
65x20 window lining
packing with
mineral wool
stuffing
245x20 window lining
Gap stuffed with
mineral wool
insulation
30mm wood fibre board
aluminium sill
with powder
coat finish
sealing tape
ow in cladding
w
40mm wood fibre board
ninsulated void.
40mm wood fibre board
62
25
50x25mm packing to maintain
window frame alignment.
sealing tape
S
2420
Aperture 2498
Window Size 2463
Window Type S
Window sill
P2
140
10
100x100mm post
40mm wood fibre board
Window Type T
70x20 trim

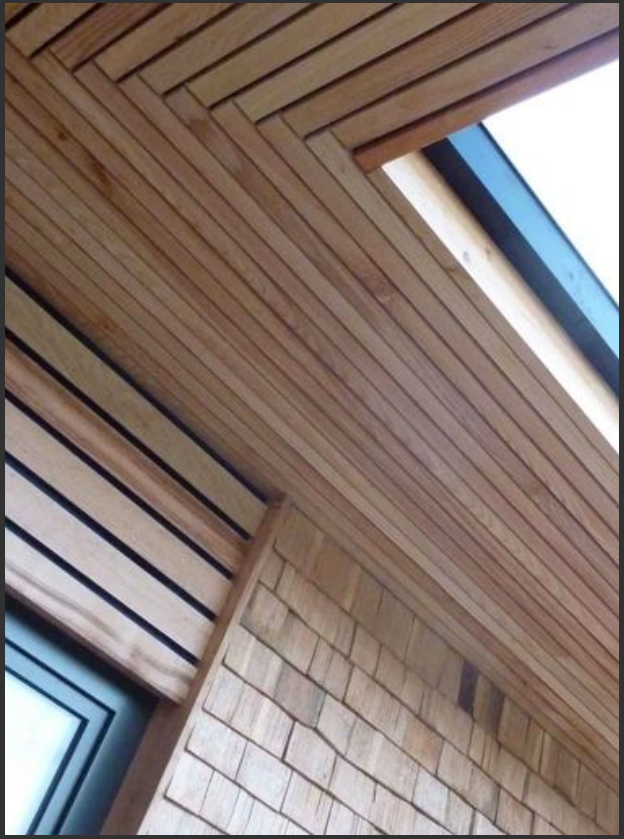






GLASS
WINDOW
OAK SHAKES
SILL
CHESTNUT




Stairs

£30,000 low energy house

3 bed, 2 bathroom house of 100 sq m
Self-built in 1996

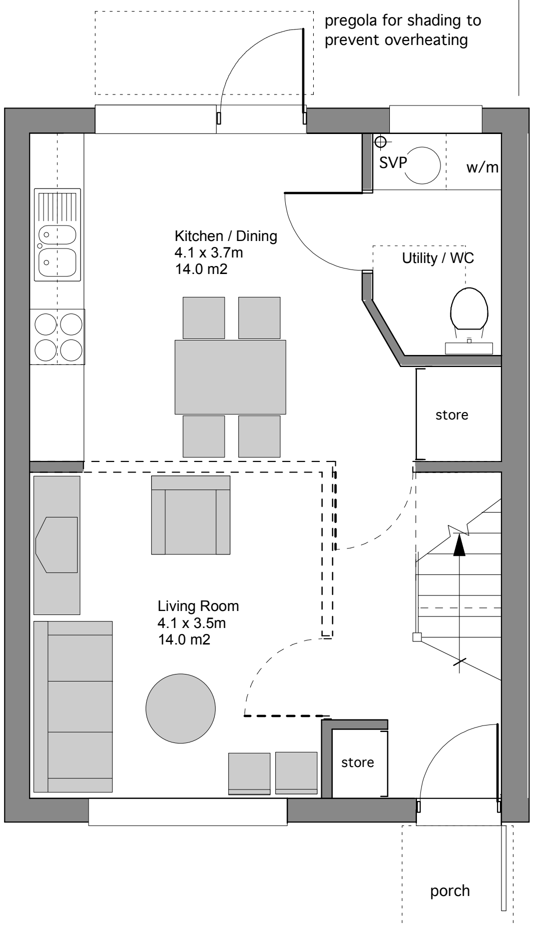
£45,000 passivhaus

Maximize self-build
Keep it simple

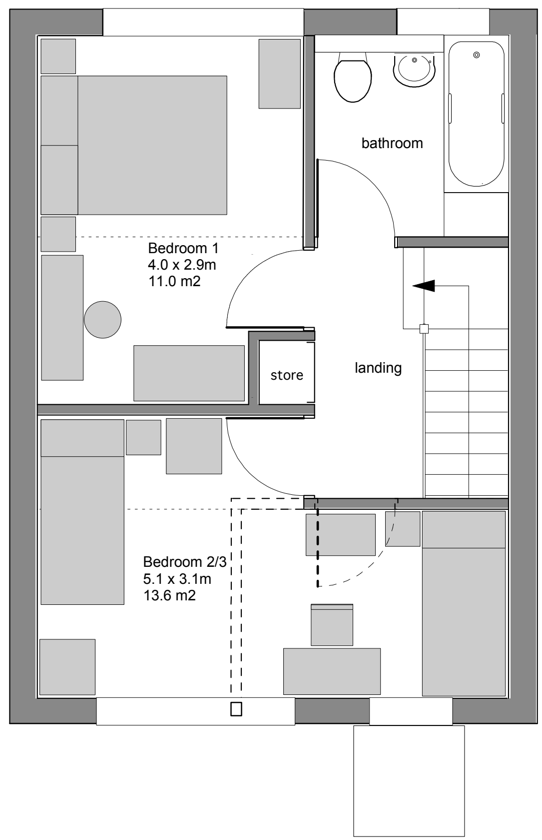
2/3 bed with utility 70 sq m
Passivhaus

Optional layouts
Adaptable

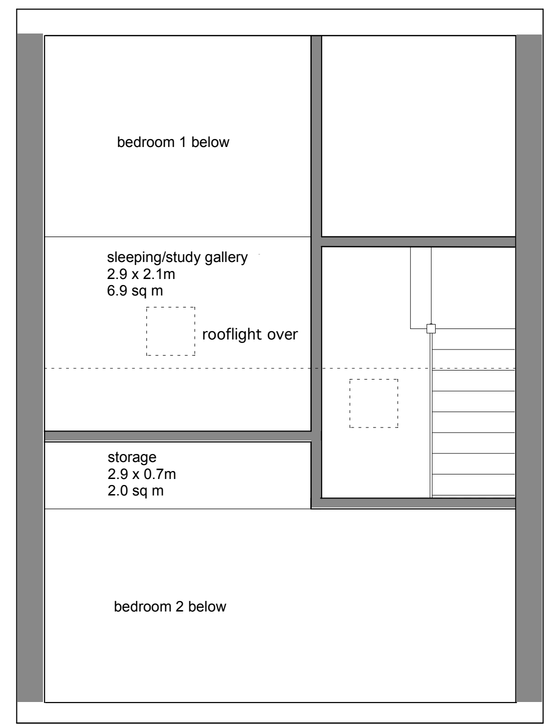
GROUND FLOOR



FIRST FLOOR



MEZZANINE



Conventional appearance
Tried & tested construction

Notes on construction

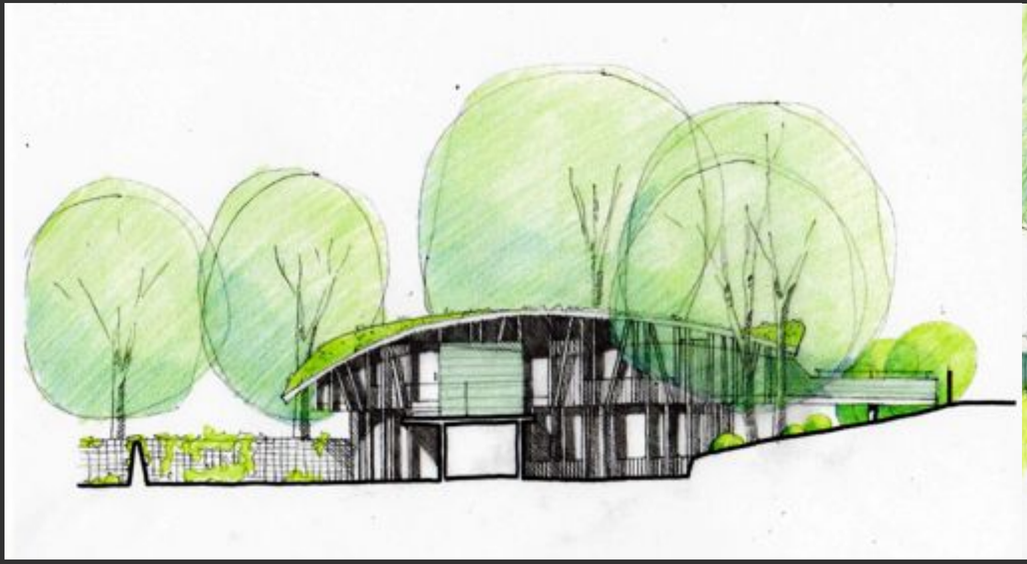
140mm timber frame with 50mm cross battens. High performance at low cost. But needs awareness from contractor!

UK timber frame industry limited ability to deliver high specification panels at the right cost.

Establishing trust with contractors is not always easy…but always necessary

Short cuts on specification are nearly always regretted later

Passivhaus in flood plain surrounded by AONB & SSSI



How to build a sustainable neighbourhood

2nd generation self-builder

CLT includes local authority who own the land and the local residents in adjoining Conservation area

Passivhaus standard, environmental improvements, shared facilities open to neighbours

Training and apprenticeships

Additional benefits of RUSS proposals

34 dwellings (not 16)

Mix of residents reflects the population as a whole

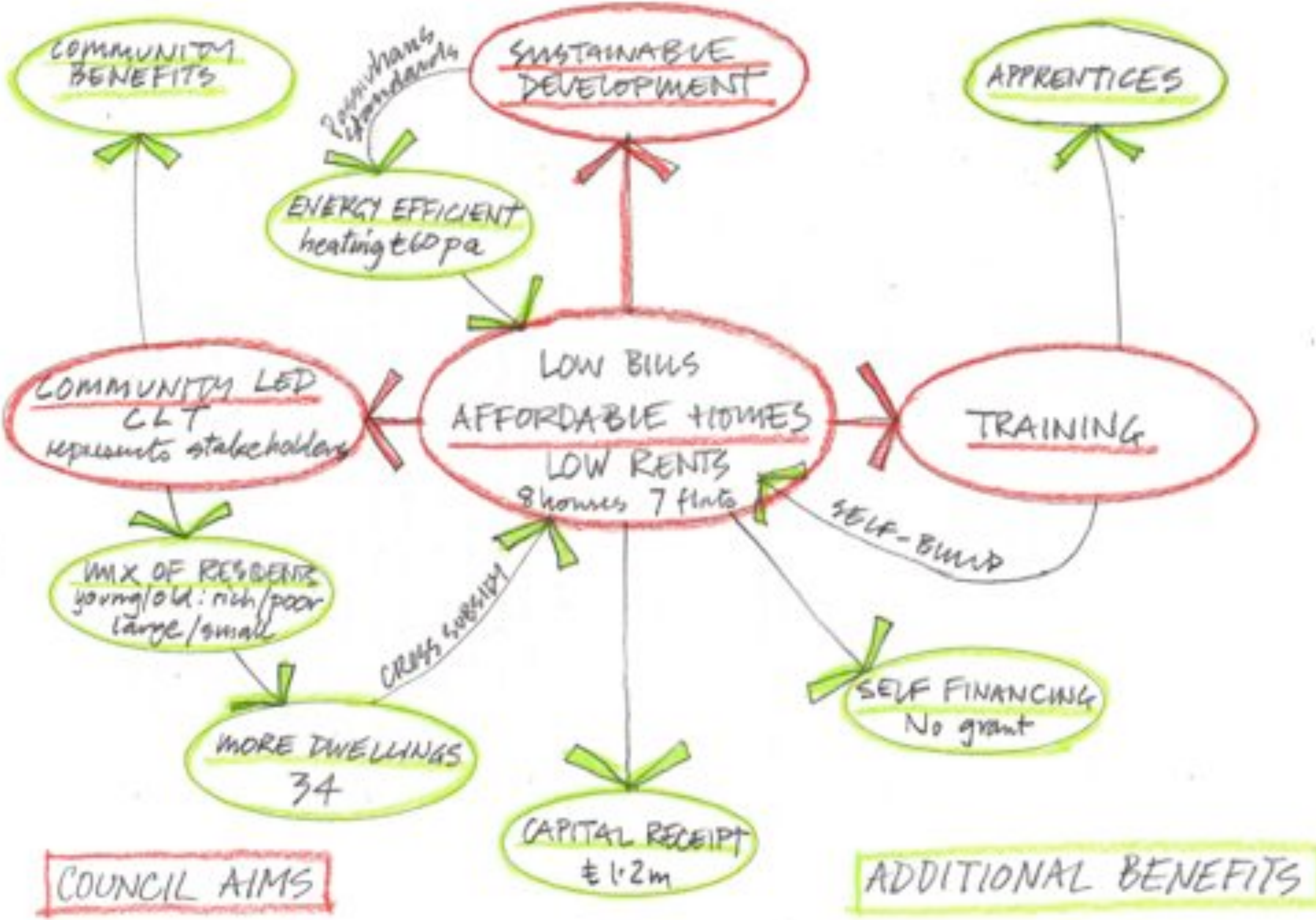
High level of self-build and cross subsidy from homes for shared ownership makes the development self-financing so limited grant can be invested elsewhere

Council will receive ongoing revenue for investment in similar schemes

Design prioritizes adaptability to ensure long useful life

Residents will develop the design and have a stake in the future

Integrated into neighbourhood


COMMUNITY BENEFITS
SUSTAINABLE DEVELOPMENT
APPRENTICES
Passivhaus standards
ENERGY EFFICIENT
heating £60 pa
LOW BILLS
AFFORDABLE HOMES
LOW RENTS
8 houses 7 flats
COMMUNITY LED
CLT
represents stakeholders
TRAINING
SELF-BUILD
MIX OF RESIDENTS
young/old : rich/poor
large/small
CROSS SUBSIDY
SELF FINANCING
No grant
MORE DWELLINGS
34
CAPITAL RECEIPT
£1.2m
COUNCIL AIMS
ADDITIONAL BENEFITS

The mix

Homes for social rent -

- Flats for people under-occupying council houses
- Large houses for families in overcrowded accommodation

Co-housing scheme of 2 & 3 bed flats for over 50's

Shared ownership houses for families unable to buy

Shared houses for young people at affordable rents

Residents hall and kitchen

Under construction in Walthamstow

The TREE HOUSE

Vote at

http://thesundaytimes.co.uk/bha

JON
BROOME
ARCHITECTS