D C Townend & Co Lt	Project 140 Reepham Road Norwich Description.. Conversion to Roof space	Date 22/09/23 EngrDCT Sht. 1 Job. No. 13085a

CALCULATIONS 13085a.odt

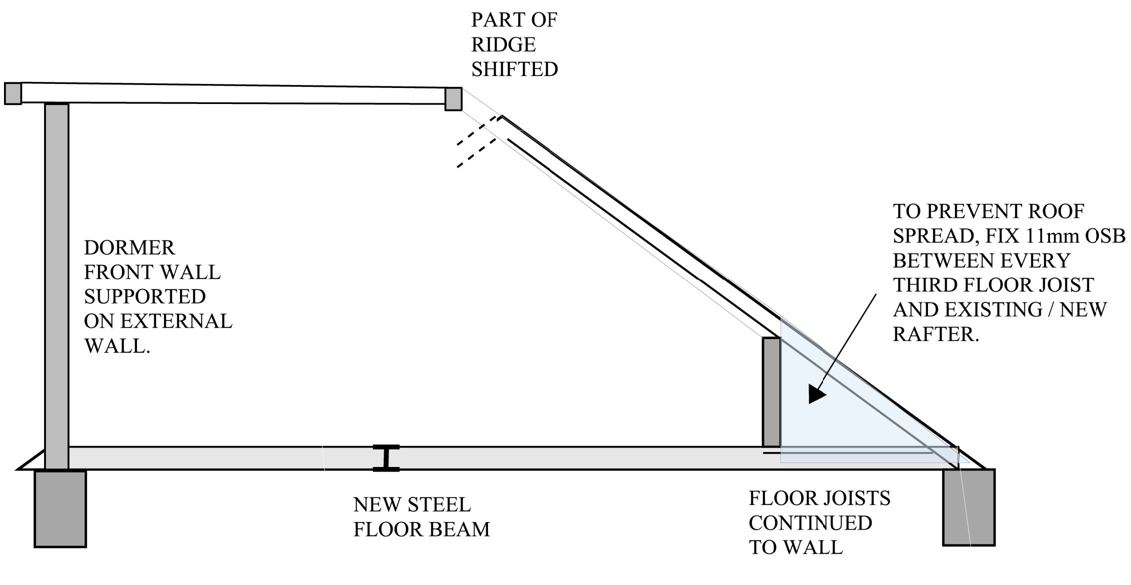
CALCULATIONS IN RESPECT OF PROPOSED CONVERSION TO ROOF SPACE AT 140 REEPHAM ROAD NORWICH

NOTE: The timbers used in the existing roof structure are mostly undersized and severe deformation has taken place. Rather then attempt to replace these, it is proposed to build a stiff timber and steel network using deep ply beams within the main part of the roof which will re-support the rafters and carry new floor joists. A steel beam will be provided at floor level, set within the floor depth carrying the floor joists between te flanges.

The new roof will project to one side in the form of a "gabled dormer" over an external wall. The existing front rafters will be "horizontally propped" by the flat roof and clad side slopes of the projection. For this to work, the dormer roof will need to act as a horizontal/inclined ply beams, with internal walls carrying the loads down to the floor. These will be clad in 11mm OSB and will be capable of transferring the loads down to floor level and passing them across to the feet of the opposite rafters.

The new structure will include "Ply Beams" replacing the short stud walls part way down the roof slopes. These deep timber beams will cantilever as well as span. Here, the support points are at random positions so a combination of these properties will be assumed. The floor joists will be suspended from the ply beams.

Many of the rafters will need to be replaced. Part of the ridge will be shifted and raided where the projection and main roof meet.



NEW STEEL FLOOR BEAM:

Much of the length will be laid on top of a ground floor wall. The beam may be jointed at 400mm from the corner.

Max free span = 4.3m eff.

Loading = Floor 4m x 2kN/m = 8kN/m

Moment = WL2/8 = 18kNm

I reqd = 2.232 x 8 x 18 x 4.3 = 1382

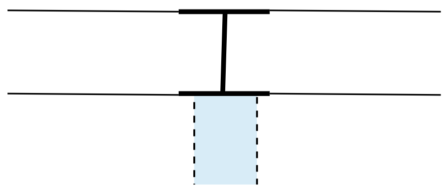
Assume 152 x 152 x 30kg. UC

L/ry = 0.7 x 4300/38= 80 D/T = 17

Pbc = 150N/mm2 fbc = M/Z = 81N/mm2

I prov = 1748

Max deflection = 9mm OK



Use 152 x 152 x 30kg. UC

NEW FLOOR JOISTS:

The new floor joists will be set at proposed new ceiling level. The short joists to one side of the steel beam will carry some load from the ply beam/short stud wall.

Max span = 3.5m

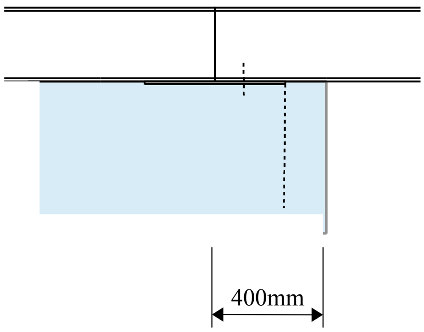
Max Loading = 0.4m x 2kN/m2 = 0.8N/m

Moment = $wL^2/8$ *=* $0.8 \times 3.5^2/8$ *= 1.3kNm.*

EI reqd. = $4.34 \times 0.8 \times 3.5^3$ *= 149*

USE 50 x 150 C24 FLOOR JOISTS AT 400c/c

CONNECTION IN THE STEEL BEAM AT THE WALL CORNER:



WELD 300 x 150 x 8 MS PLATE TO THE BOTTOM OF THE BEAM ON THE WALL, STRADDLING THE BUTT JOINT AND DRILL 2 no 14 DIA HOLES IN THE OTHER END FOR M12 BOLTS THROUGH THE FLANGE OF THE SECOND BEAM

NEW RAFTERS:

Some of the rafters will be extended in length because of the shifted ridge. The rafters will carry both bending moment and axial load due to the removed roof slope.

Max span = 3.0m [on plan]

Max Loading = 0.4m x 1.2kN/m2 = 0.48kN/m

Moment = $wL^2/8 = 0.48 \times 3^2/10 = 0.5$ *kNm.*

Max axial load = [3 x 0.4 x 1.2]/sin 30 = 3.3kN

Assume rafters 50 x 150 C16 @ 400c/c
A = 7500mm2
Z = 187500mm4

Use equation:

$$\frac{\Upsilon_m a//}{\Psi_m\ adm// \left[1 - \frac{1.5\lambda_c a//}{X_e} \times k_{12}\right]} + \frac{\lambda_c a//}{\eta_c\ adm//}\ \boxed{?}\ 1$$

Where $\Upsilon_m a// = M/Z = 2.4N/mm2$

$\eta_c\ adm// = 7.5 \times 1.25 = 9.4N/mm2$

$\lambda_c\ a// = P/A = 0.5N/mm2$

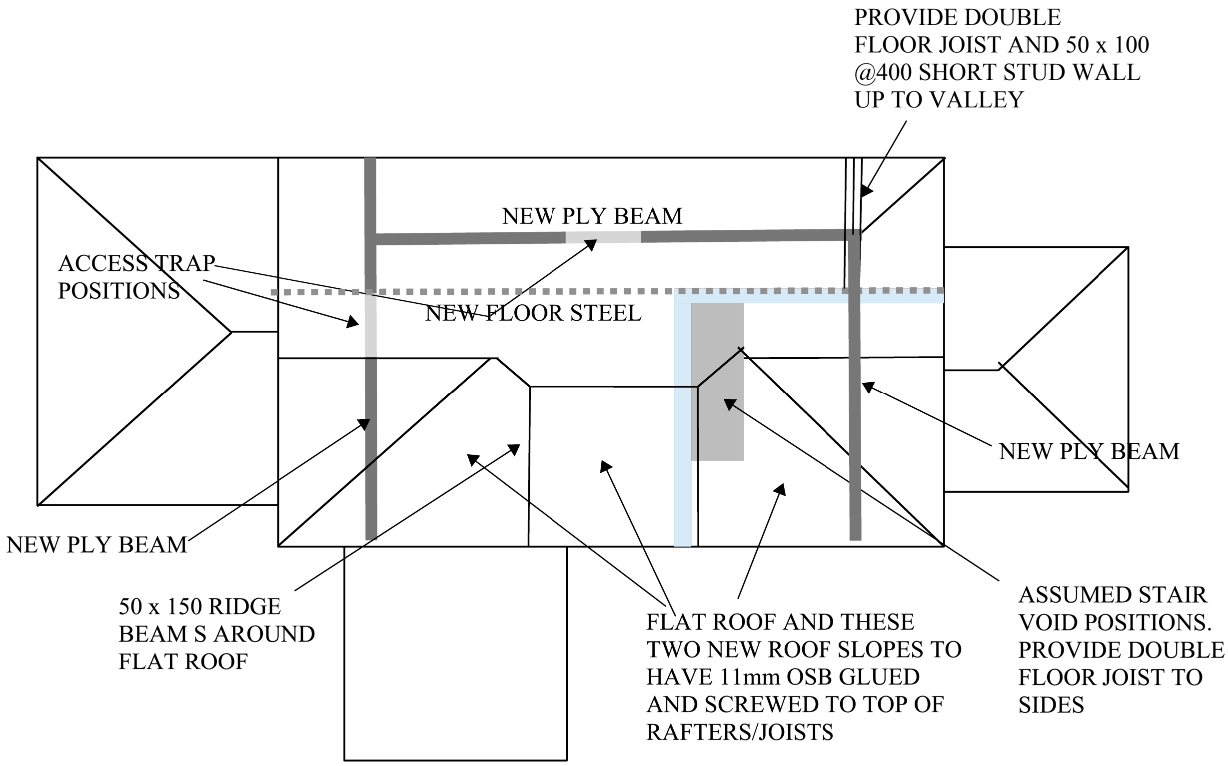
$\eta_c\ adm// = 6.8\ N/mm2$

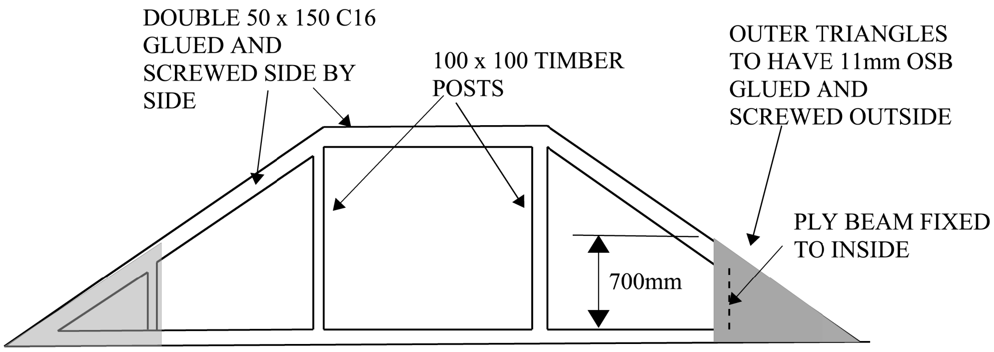
$X_{e=}\ \Upsilon^2 E/[L/i]^2 = 10$

$K_{12} = 0.552$

$$\frac{2.3N/mm2}{9.4N/mm2[1 - \{[1.5x0.82/10]x0.552\}]} + \frac{0.5N/mm2}{6.8 N/mm2} = 0.5 \text{ OK}$$

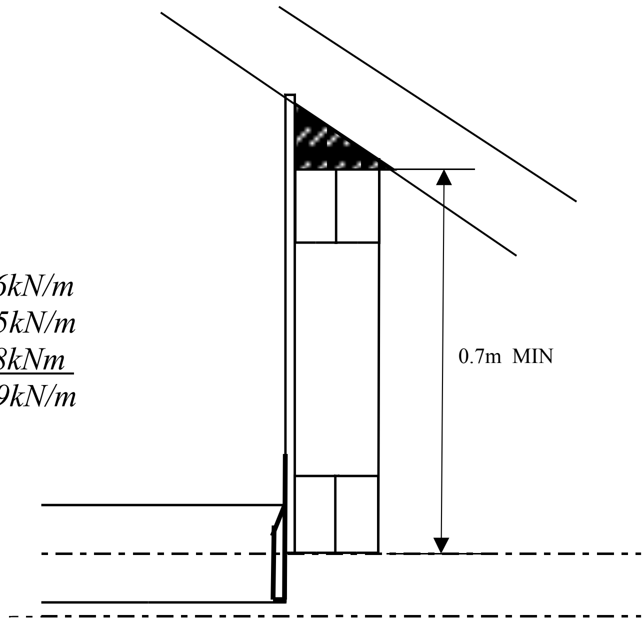
USE 50 x 150 C16 RAFTERS AT 400 C/C





GLAZED GABLE

PLY BEAMS:



Max free span = 5.7m .

Loading

Roof 3m2 x 1.2kN/m	*= 3.6kN/m*
S/W = 1m x 0.5kN/m2	*= 0.5kN/m*
Floor load 2.4m x 2kN/m2	*= 4.8kNm*
	8.9kN/m

Bending moment = wL2/8 = ***36kNm.***

PROPERTIES OF 0.7m DEEP x 111m BEAM:
[with double 50 x 150 top & bottom & 11mm OSB one side]
ASSUME ET = EP = 6600
[HOMOGENOUS METHOD]

$I = 111 \times 700^3/12 - 100 \times 400^3/12 = 2.6E9$

$EI = 1.75E13$

$Z = I/y = 6.3E6$

MAX STRESS

= M/Z = 36E6 / 6.3E6 = ***5.7N/mm2***

Allowable = 7.5N/mm2 x 1.25 = ***9.37N/mm2***

MAX BENDING DEFLECTION:

$5WL^3/384EI$

$= 5 \times 50730N \times 5700^3/384 \times 1.75E13 = 7mm$

MAX SHEAR DEFLECTION:

$$8v = \frac{M_0}{GwAw}$$ *[Roarks simplified formula]*

Where:

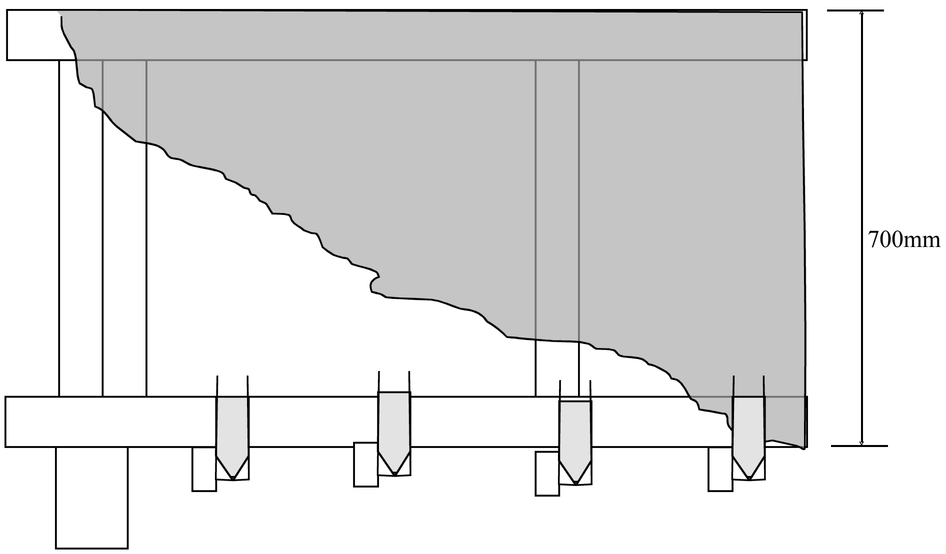
Mo = moment at midspan = 36E6 kNm

Gw = modulus of rigidity of webs = 650N/mm2

Aw = area of the webs 700 x 11mm = 7700mm2

8v = 7mm Total deflection ***= 14mm OK***

PROVIDE 700mm DEEP PLY BEAM FROM DOUBLE 50 x 150 C24 GLUED SIDE BY SIDE AT TOP AND BOTTOM WITH STUDS FROM SINGLE 75 x 100 C24 AT 1200mm CENTRES CLAD ON ONE SIDE USING 11mm THICK OSB. GLUE TO SOFTWOOD CARCASS USING WATERPROOF PVA ADHESIVE AND PROVIDE 70mm SCREWS AT 150mm CENTRES ALONG EVERY SOFTWOOD MEMBER.

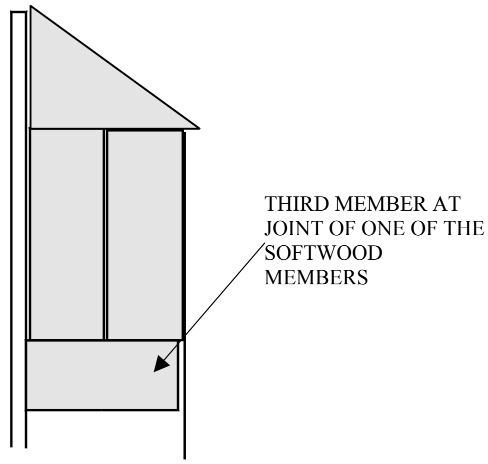


Ply Beams are an efficient way of spanning large distances and are constructed from relatively small sized sections.

The construction needs to be carried out with precision and a few basic principles need to be adopted for to ensure success:

The top and bottom softwood members need to be effectively continuous from end to end. Since sections of this length may be *inconvenient, joints may be provided. Joint positions should not coincide. Where joints do occur in one of the two members side by side, a third splice member of size 900 long x 75 x 100 should be laid flat on the main longitudinal timbers and glued and screwed to them and the ply in a similar fashion to the other main members.*

The top of the beam should support the rafters using shaped packers or short studs which should be securely fixed to them.

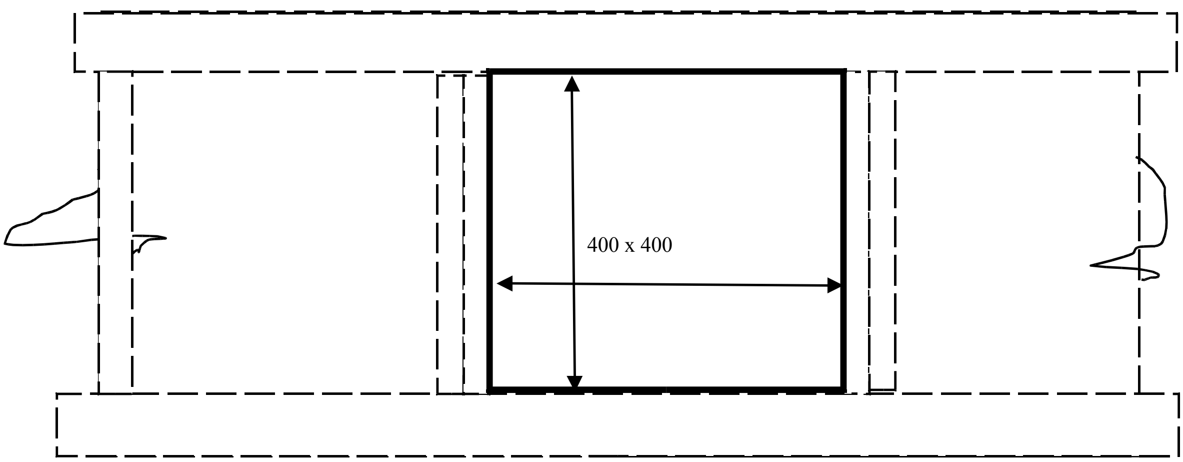


ACCESS HOLES THROUGH PLY BEAM.

NOTE: In accordance with the Timber Designers Manual [1st edition], an opening where no shear is likely, may extend the free height of the ply [the distance between upper and lower chords].

PROVIDE OPENING AS SHOWN BELOW:

NOTE- OPENING MUST BE WHERE SHOWN ON THE PLAN



CALCULATIONS *13085a.odt*

DETAIL OF TAPERED END OF BEAM WHERE REQUIRED