Structural Calculations prepared by GKT Consulting

Glenn K Taylor I.Eng., I.M.I. Struct.E.
Incorporated Structural Engineer

[redacted]

Project : Review of Structural Works carried Out following Fire Damage at : The Kings Head P.H., Whitburn St., Bridgnorth. WV16 4QN.

Reference : GKT 2431

Dated: April 2024

LOADINGS - RESIDENTIAL

Sheeted Flat Roof

Roof W/Finish	0.05		
Insulation	0.05		
Decking/Purlins	0.50		
Services	0.15		
DL	0.75	1.4DL=	1.05
LL	0.75	1.6LL=	1.20
	1.50kN/m²		2.25kN/m²

Pitched Tiled Roof

Tiles/battens/rafters/trusses	0.85		

	Cos 45 degrees		
Dead on plan	1.20Kn/m2		
Ceiling Dead	0.25		
Rafter Imposed	0.75	1.4DL=	2.03
Ceiling Imposed	0.25	1.6LL=	1.60
	2.45kN/m²		3.63kN/m²

Glazed Roof~

Glazing/Rafters	0.50		
DL	0.50	1.4DL=	0.70
LL	0.75	1.6LL=	1.20
	1.25kN/m²		1.90kN/m²

Timber Flat Roof~

Roof W/Finish	0.05		
Insulation	0.05		
WBP Ply decking	0.15		
Joists	0.20		
Ceiling	0.20		
Services	0.15		
DL	0.80	1.4DL=	1.12
LL	0.75	1.6LL=	1.20
	1.55kN/m²		2.32kN/m

Walls~

100 Blockwork

100 Blockwork	1.50		
2xPlaster	0.50		
DL	2.00kN/m²	1.4DL=	2.80kN/m²

140 Blockwork

140 Blockwork	2.00		
2xPlaster	0.50		
DL	2.50kN/m²	1.4DL=	3.50kN/m²

210 Blockwork

210 Blockwork	2.80	
2xPlaster	0.50	
DL	3.30kN/m²	1.4DL= 4.62kN/m²

215 Brickwork

215mm Brickwork	4.60	
DL	4.60kN/m²	1.4DL= 6.44kN/m²

Cavity

102 Brick	2.25	
140 Blockwork	2.00	
1xPlaster	0.25	
DL	4.50kN/m²	1.4DL= 6.30kN/m²

Cavity

102 Brick	2.25	
100 Blockwork	1.50	
1xPlaster	0.25	
DL	4.00kN/m²	1.4DL= 5.60kN/m²

Solid Wall Brick (Existing)

215mm brick solid	4.50	
2 x plaster finishes	0.50	

	5.00Kn/M2	1.4DL = 7.00 kN/m2

Flooring~

Beam & Block

75 Screed/Insulation	1.70	
150 Beam and Block	2.30	
Partition wall allowance	1.00	
Ceiling/Services	0.50	
DL	5.50	1.4DL= 7.70
LL	1.50	1.6LL= 2.40
	7.00kN/m²	10.1kN/m²

150mm P.C.U.	3.00	
75mm Structural Topping	1.80	
Partition wall allowance	1.00	
Ceiling/Services	0.50	
DL	6.30	1.4DL= 8.82
LL	1.50	1.6LL= 2.40
	7.80kN/m²	11.22kN/m²

Timber Floor

Floor Joists	0.15	
22mm Plywood Decking	0.15	
Ceiling	0.20	
Stud Partitions	0.50	
DL	1.00	1.4DL= 1.40
LL	1.50	1.6LL= 2.40
	2.50kN/m²	3.80kN/m²

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JOB No. GKT 2431 DATE: April 2024 BY GKT SHEET No. S-01

CHECK FLAT ROOF TIMBERS OVER 2nd FLOOR BEDROOM (SPAN 3.30m)

@ 450c/c

LOAD / JOIST: $0.45 \times 1.55 kN/m^2 = 0.70 kN/m$ RUN

$\therefore$ B.M. $= 0.70 \times 3.3^2 / 8 = 0.95 kNm$

ON 50 x 170 TIMBERS:

$$f_b = \frac{0.95 \times 10^6 \times 6}{50 \times 170^2} = 3.94 N/mm^2 < 7.5 \times 1.1$$

OK IN BENDING

$$\delta_{TOTAL} = \frac{5 \times 0.7 \times 3300^4 \times 12}{384 \times 10800 \times 50 \times 170^3} = 4.9mm$$

OK DEFLECTION

$\therefore$ MIN SIZE 50 x 170 TIMBERS @ 450c/c ACCEPTABLE
& DOUBLED UP TO TRIM APERTURE + SUPPORT ROOFLIGHT

CHECK PURLIN OVER 2nd FLOOR MANAGERS OFFICE

MAX S.W ROOF = 1.7m on PLAN. (SPAN 4.7m)

$\therefore w = 1.7 \times 2.2 kN/m^2 = 3.74 kN/m$ RUN

B.M. $= 3.74 \times 4.7^2 / 8 = 10.32 kNm$

$\therefore \delta$ ON EXIST 100 x 175 PURLIN TIMBER =

$$\frac{5 \times 3.74 \times 4700^4 \times 12}{384 \times 7500 \times 100 \times 175^3} = 77mm > CHECK\ 311 \text{ (EXCESSIVE)}$$

INSTALL 2 x 75 x 220 C24 SECTION.

$\therefore f_b = \frac{10.32 \times 10^6 \times 6}{150 \times 220^2} = 8.52 N/mm^2 < 7.5 \times 1.1 \times 1.25$

$\therefore$ OK IN BENDING.

$$\delta_{TOTAL} = \frac{5 \times 3.74 \times 4700^4 \times 12}{384 \times 10800 \times 150 \times 220^3} = 16.5mm = \frac{SPAN}{285}$$

$\therefore$ ACCEPTABLE δ.

$\therefore$ UPGRADE EXISTING DEFECTIVE PURLIN WITH
2 x 75 x 220 C24 TIMBERS BOLTED @ 600c/c

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JOB No. GKT 2431 DATE: APRIL 2024 BY GKT SHEET No. S-02

CHECK REPLACEMENT TIMBER 2nd FLOOR JOISTS + MULTI PLY BEAMS.

(a) ABOVE REAR OFFICE AREA. (SPAN 2.50m)

CHECK 50×195 C24 SECTION @ 400c/c INSTALLED

∠ LOAD / JOIST = 0.4 × 2.5kN/m² = 1.0kN/m RUN

∠ B.M. = 1 × 2.5² / 8 = 0.78kNm

∴ $f_b = \frac{0.78 \times 10^6 \times 6}{50 \times 195^2} = 2.47 N/mm^2$ OK BENDING

$\delta_{TOTAL} = \frac{5 \times 1.0 \times 2500^4 \times 12}{384 \times 10800 \times 50 \times 195^3} = 1.52mm$

OK TOTAL DEFLECTION

∠ PROVIDED 50×195 C24 TIMBERS @ 400c/c ACCEPTABLE

(b) CHECK TWIN JOIST INTERMEDIATE FLOOR BEAM (SPAN 3.3m)

INSTALLED 2× 50×195 C24 TIMBERS

UDL = 2.5 × 2.5kN/m² = 6.25kN/m RUN

∠ B.M. = 6.25 × 3.3² / 8 = 8.50kNm

∴ $f_b = \frac{8.50 \times 10^6 \times 6}{100 \times 195^2} = 13.4 N/mm^2$ EXCESSIVE IN BENDING

$\delta_{TOTAL} = \frac{5 \times 6.25 \times 3300^4 \times 12}{384 \times 10800 \times 100 \times 195^3} = 14.4mm$

EITHER UPGRADE WITH ADDITIONAL 50×195 C24 TIMBER

∴ f_b = 8.93 N/mm² < 7.5 × 1.1 × 1.25 (10.3 N/mm²)

δ = 9.6mm < 3300 × 0.003 ∴ OK DEFLECTION

EITHER INTRODUCE ADDITIONAL 50×195 TIMBER TO EXISTING SECTION OR 152×152×23 UC STEEL STRENGTHENING BEAM

Structural Calculations prepared by GKT Consulting

JOB No. GKT 2431 DATE: APRIL 2024 BY GKT SHEET No. S-03.

CHECK TIMBER 2ND FLOOR JOISTS OVER W.C BLOCK
100 x 220 TIMBER @ 400c/c - SPAN 4.2M

UDL / JOIST = 0.4 x 2.5 KN/m² = 1.0 KN/M RUN

∴ B.M. = 1.0 x 4.2² / 8 = 2.2 KNm

∴ $f_b = \frac{2.2 \times 10^6 \times 6}{100 \times 220^2} = 2.72 N/mm^2 < 7.5 \times 1.1$

OK BENDING

$\delta_{TOTAL} = \frac{5 \times 2.20 \times 4200^4 \times 12}{384 \times 10800 \times 100 \times 220^3} = 9.7mm$

OK TOTAL DEFLECTION

∴ EXT 100 x 220 DP C24 JOISTS @ 400c/c ACCEPTABLE

CHECK SUPPORT BEAM TO WC JOISTS + LEAN TO ROOF
(SPAN 3.20M)

UDL: 2.1m x ROOF x 2.5 KN/m² = 5.25 KN/M
0.8m LEAN TO x 2.2 KN/m² = 1.76 KN/M
7.01 KN/M RUN

∴ B.M.: 7.01 x 7.2² / 8 = 8.97 KNm

∴ $f_b = \frac{8.97 \times 10^6 \times 6}{100 \times 220^2} = 11.12 N/mm^2 > 10.32.$

$\delta_{TOTAL} = \frac{5 \times 7.01 \times 3200^4 \times 12}{384 \times 7500 \times 100 \times 220^3} = 14.3mm \geq 14$

SAY OK DEFLECTION

∴ INSTALLED 100 x 220 DP C24 TIMBER BEAM
ACCEPTABLE

Structural Calculations prepared by GKT Consulting

JOB No. GKT 2431 DATE: APRIL 2024 BY GKT SHEET No. 5-04

CHECK REPLACEMENT FLOOR JOISTS (1ST FLOOR) ABOVE KITCHEN AND UTILITY AREAS (DUE TO FIRE)

(a) FLOOR JOISTS INSTALLED - 50 × 220 @ 400c/c (MAX SPAN 3m)

∴ LOAD / JOIST = 0.4 × 2.50kN/m² = 1.0kN/m RUN

∴ B.M. = $1 \times 3.0^2 / 8$ = 1.13kNm

$f_b = \frac{1.13 \times 10^6 \times 6}{50 \times 220^2}$ = 2.8N/mm² OK IN BENDING

$\delta_{TOTAL} = \frac{5 \times 1.0 \times 3000^4 \times 12}{384 \times 10800 \times 50 \times 220^3}$ = 2.2mm

OK TOTAL DEFLECTION

∴ PROVIDED 50 × 220 JOISTS @ 400c/c OK

(b) CHECK INTERMEDIATE MULTI JOIST TRIMMER SUPPORT 5 ply 50 × 220 - SPAN 2.7m

UDL = 2.5m S.W FLOOR × 2.50kN/m² = 6.25kN/m RUN

∴ B.M. = $6.25 \times \frac{2.7^2}{8}$ = 5.70kNm

$f_b = \frac{5.70 \times 10^6 \times 6}{250 \times 220^2}$ = 2.82N/mm² OK BENDING

$\delta_{TOTAL} = \frac{5 \times 6.25 \times 2700^4 \times 12}{384 \times 10800 \times 250 \times 220^3}$ = 1.8mm

OK TOTAL DEFLECTION

∴ 5 ply - × 50 × 220 TIMBER INTERMEDIATE FLOOR SUPPORTING BEAM OVER RECOMMENDED KITCHEN ACCEPTABLE.

P.L TO PRIMARY OAK BEAM - SPAN 4.8m

= $6.25 \times \frac{2.7}{2} + 1m$ = 11.6kN.

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JOB No. GKT 2431 DATE: APRIL 2024 BY GKT SHEET No. S-05.

CHECK INTERNAL 275 x 275 OAK BEAM INSTALLED ACROSS KITCHEN AREA TO SUPPORT INTERMEDIATE MULTI PLY TIMBER (SPAN 4.8m)

$\therefore$ B.M = $\frac{11.6 \times 4.8}{4}$ = 13.92kNm

$\therefore f_b = \frac{13.92 \times 10^6 \times 6}{275 \times 275^2} = 4.1 N/mm^2 < 9.0$

OK BENDING

CHECK SHEARING RESISTANCE - (FINE) = REDUCED SECTION = 235 x 255 DEEP

$\therefore f_{b\ SHEARING} = \frac{13.92 \times 10^6 \times 6}{235 \times 255^2} = 5.47 N/mm^2 < 9.0$

$\delta_{TOTAL} = \frac{13.92 \times 10^3 \times 4800^3 \times 12}{48 \times 6500 \times 275 \times 275^3} = 10.35mm <$
0.003×4800

$\therefore$ OK TOTAL DEFLECTION

$\therefore$ 275 x 275 PRIMARY OAK BEAM ACCEPTABLE

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JOB No. GKT 2431	DATE: APRIL 2024	BY GKT	SHEET No. 5-06.

CHECK TWIN STEELS INSTALLED OVER UTILITY & DISABLED WC FACILITIES TO SUPPORT RE CONSTRUCTED REAR WALL OVER:- MAX SPAN 3.0M

INSTALL 2x 152x152x30kg/m UC STEELS (BOLTED)

∴ UDL LOADING

2.1m FLAT ROOF x 1.55kN/m² = 3.25kN/m
1m EXT ROOF x 2.2kN/m² = 2.20kN/m
2.75m FRAME + BLOCK x 3.0kN/m² = 8.25kN/m
BEAMS S.WT = 0.6kN/m
14.3kN/m RUN

∴ B.M MAX PER BEAM

$14.30 \times 3^2 / 8 \div 2 = 8.05$ kNm

PL TO RECEIVING BEAM (NEW WALL OVER)

$= \frac{14.3 \times 3}{2} = 21.5$ kN.

CHECK TWIN 152x152x30kg/m UC STEELS (UNRESTRAINED)

∴ $\frac{L}{r_y} = \frac{3000}{38.3} = 78.3$ $\frac{D}{T} = 16.7$

∴ $p_{bc} = 158$ N/mm²

∴ $f_{bc} = \frac{8.05 \times 10^6}{222 \times 10^3} = 36.3$ N/mm² < 158

∴ OK IN BENDING

δ TOTAL $\frac{5 \times 14.30 \times 3000^4}{384 \times 2.1 \times 10^5 \times 1748 \times 10^4} = 4.1$ mm

OK TOTAL DEFLECTION

∴ DIRECT BEARING = 440x215 7N/mm² BLOCK PIER (f_k - 5.4N/mm²)

ULTIMATE BEARING = $\frac{1.5 \times 14.3 \times 3}{2} = 32.2$ kN.

CAPACITY 215 BEARING

$\frac{5.4}{3.5} \times \frac{215 \times 300}{10^3} = 99.5$ kN > 32.2kN

OK BEARING

∴ TWIN 152x152x30kg/m UC STEELS ACCEPTABLE

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JOB No. GKT 2431 DATE: APRIL 2024 BY GKT SHEET No. S-07

CHECK 'RELIGIN' SUPPORT STEEL BEAM (ADJACENT ONE FRAME BEAM TO REAR GARDEN EXTENSION (COURTYARD AREA) - SPAN 3.50M

BEAM MEASURED ON SITE - 254 x 146 x 37 UB

∴ UDL LOADING:

1M FLAT ROOF x 1.55 kN/m²	= 1.55 kN/m RUN
1.5M FLOOR x 2.5 kN/m²	= 3.75 kN/m RUN
2.75 + 2.75 HALVED	
= FRAME x 3.0 kN/m²	= 11.02 kN/m RUN
BEAM S.WT	= 0.38 kN/m RUN
	16.70 kN/m RUN

+ P.L 21.5kN @ 1M

∴ B.M. MAX = $\frac{16.7 \times 3.5^2}{8} + \frac{21.5 \times 1 \times 2.5}{3.5}$

∴ Σ B.M = 40.93 kNm

∴ EQUIV UDL = $\frac{8 \times 40.93}{3.5^2}$ = 26.7 kN/m RUN

∴ CHECK 254 x 146 x 37 kg/m INSTALLED.

$\frac{l}{ry} = \frac{3500}{34.8}$ = 100.6 $\frac{D}{T}$ = 27.6 ∴ pbc = 132 N/mm²

∴ $f_{bc} = \frac{40.93 \times 10^6}{433 \times 10^3}$ = 94.5 N/mm² < 132

∴ OK IN BENDING

$\delta_{TOTAL} = \frac{5 \times 26.7 \times 3500^4}{384 \times 2.1 \times 10^5 \times 5537 \times 10^4}$ = 4.5 MM

OK TOTAL DEFLECTION

∴ 254 x 146 x 37 UB SUPPORT BEAM INSTALLED SATISFACTORY

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JOB No. GKT 2431 DATE: APRIL 2024 BY GKT SHEET No. S-08.

CHECK LOADING TO TWIN STEEL SUPPORTING RECONSTRUCTED FRAME / REAR WALL OVER KITCHEN (2-STOREY) — SPAN 5M

(U.D. LOADING) (A)

1.7 + 0.6 FLAT ROOF × 1.5 kN/m² = 3.60 kN/m

HIC FLOOR (SPANS TO BEAM)

5.7M FRAME WALL × 3.0 kN/m² = 16.50 kN/m

BEAM S.W.T = 0.6 kN/m

20.7 kN/m

USE (B) + (FLOOR P.L TO ONE PRIMARY BEAM

∴ ΣB.M. = 20.7 × 5²/8 = 64.68 kNm

∴ USING 2 × 152 × 152 × 30 kg/m UKC BEAMS

∴ f_{bc} = 180 N/mm²

∴ f_{bc} per BEAM = $\frac{64.68 \times 0.5}{222 \times 10^3}$ = 145.7 N/mm² < 180

∴ OK IN BENDING

δ TOTAL (BEAM) = 20.7 × 0.5 = 10.35 kN/m

∴ δ TOTAL = $\frac{5 \times 10.35 \times 5000^4}{384 \times 2.1 \times 10^5 \times 1748 \times 10^4}$ = 22.9mm < $\frac{\text{SPAN}}{220}$

∴ AT LEAST TWICE OF LOAD FROM IMPOSED LOADING. SUPERIMPOSED DEFLECTION < $\frac{\text{SPAN}}{360}$ ∴ OK AS FOR IMPOSED LOAD DEFLECTION

∴ P.L TO NEW RECLAIMED BEAM OVER KITCHEN

= $\frac{20.7 \times 5}{2}$ = 51.75 kN

∴ TWIN 152 × 152 × 30 kg/m UC STEEL BEAMS BOLTED TOGETHER IS GOOD ACCEPTABLE

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JOB No. GKT 2431 DATE: APRIL 2024 BY GKT SHEET No. S-09

CHECK ADDITIONAL 254×146×37 kg/m UB INSTALLED ACROSS KITCHEN TO SUPPORT TWIN BEAMS + PRIMARY OAK FLOOR BEAM. (SPAN 3.5m)

UDL = $\frac{2.5m}{2}$ FLOOR × 2.5 kN/m² + 3.5 kN/m RW

+ CPL OAK BEAM : 5.8 kN CPL

+ PLUS OWN WT = 51.75 kN @ 1m IN.

∴ Σ B.M.'s

$\frac{3.5 \times 3.5^2}{8} + \frac{5.8 \times 3.5}{4} + \frac{51.75 \times 1 \times 2.5}{3.5} = 47.4 kNm$

∴ EQUIVALENT UDL = $\frac{8 \times 47.4}{3.5^2} = 30.95 kN/m RW$

∴ CHECK 254×146×37 UB INSTALLED

$\frac{L}{y} = \frac{3500}{34.8} = 100.6$ $\frac{D}{T} = 27.6$ ∴ $p_{bc} = 132 N/mm^2$

∴ $f_{bc} = \frac{47.4 \times 10^6}{433 \times 10^3} = 109 N/mm^2 < 132$

∴ OK BENDING

BEAM δ's = $\frac{5 \times 30.95 \times 3500^4}{384 \times 2.1 \times 10^5 \times 5537 \times 10^4} = 5.2mm$

OK TOTAL DEFLECTION

∴ ULTIMATE REACTION:

$1.45 \times \frac{51.75 \times 2.5}{3.5} + \left(\frac{3.5 \times 3.5}{2} + \frac{5.8}{2}\right)$

∴ UL REACTION = 46kN

CAPACITY 215mm BLOCK PIER - f_u = 7 kN/m² PLUS (= 5.4 kN/m²)

= $\frac{5.4}{3.5} \times \frac{215 \times 146}{10^3} = 48.4 kN$ > 46.

∴ BEARING OK

∴ 254×146×37 UB INSTALLED ACCEPTABLE