MHA STRUCTURAL DESIGN

JOB	23072/51 Lamb's Conduit Street	DATE Feb-24	PAGE 1.1
TITLE	Introduction	BY MC	CHECKED RD

INTRODUCTION

These calculations are for the strengthening of part of the floor structure of flat 2,located on the second floor of 51 Lamb's Conduit Street.

The existing construction is a listed four-storey terraced house with load bearing masonry walls and timber floors. This note has been drafted following MHA's site visit on the 9th of January 2024. During the visit MHA viewed a limited amount of investigations to define the existing floor structure, with a particular focus on the living room and bedroom areas.

The existing timber joists are spanning parallel to Lamb's Conduit Steet, and trimmed by a bressummer along the stairs' edge. The central masony wall parallel to the facades is loadbearing and half brick thick. The existing floors was mostly covered with 18mm chipboards, with only limited areas still featuring the original timber boards.

The living room floor was found to slope towards the bressummer, with an approximate maximum defection of 50mm. The bedroom floor slopes towards the central partition and the central pier of the front façade. The maximum deflection measured was approximately 40mm.

None of the floor timber elements, joists and bressummer, meet in full the current design standards. The living room joists deflect excessively, but are sufficient for strength. The existing bressummer and bedroom joists are calculated to be overstressed and to deflect excessively. These conclusions were based on the assumption of timber being of C16 grade, which is conservative for the historic timber in good condition.

The proposed scope of the works is to strengthen the bressummer and bedroom joists to reduce the stresses to acceptable levels. Whilst the works will stiffen the floor, it will not meet full compliance in service(i.e. deflection and vibration).

REFERENCE TO STANDARDS:

BS EN 1991 EC0 : Actions on Structures
BS EN 1995 EC5: Design of Timber Structures
BS EN 1995 EC3: Design of Steel Structures

MHA STRUCTURAL DESIGN

JOB	23072/51 Lamb's Conduit Street	DATE Feb-24	PAGE 2.1
TITLE	Contents	BY MC	CHECKED RD

CONTENTS

MHA STRUCTURAL DESIGN

JOB	23072/51 Lamb's Conduit Street	DATE Feb-24	PAGE 3.1
TITLE	Load Allowance	BY MC	CHECKED RD

	Typical Floor	[KN/m2]	
		G	Q
	Laminated floor with soundproof layer	0.15	
	Timber joists + plywood + Insulation	0.30	
	Ceiling and Services	0.25	
	Imposed		1.50
	TOT	0.70	1.50
	Original partition	[KN/m2]	
		G	Q
	Lath and plaster on both sides	0.70	
	Studs and diagonals	0.10	
	Services	0.05	
	TOT	0.85	
	New partition	[KN/m2]	
		G	Q
	Plasterboard and skim on both sides	0.30	
	Studs and ply	0.15	
	Services	0.05	
	TOT	0.50	
	Stairs	[KN/m2]	
		G	Q
	Timber treads, rises and stringers	0.30	
	Ceiling and Services	0.20	
	Imposed		3.00
	TOT	0.50	3.00

MHA STRUCTURAL DESIGN

JOB	23072/51 Lamb's Conduit Street	DATE Feb-24	PAGE 4.1
TITLE	Existing Floor Check	BY MC	CHECKED RD

Check Living Room Joists - C16 195x63 @ 400 c/c

Partial factor for Imposed loads in long term combination ψ2 =			0.30			Span = L =		4.25 m
Partial factor for Imposed loads in vibration load combination =			0.10			Creep factor for Service Class 1: k def =		0.60
		Load	Spacing	Line Load		SLS load instantaneous =		0.88 KN/m
Dead Load = G =		0.70 KN/m2	0.40 m	0.3 KN/m		SLS load long term =		1.16 KN/m
Variable Load Roof = Q =		1.50 KN/m2		0.6 KN/m		SLS Vibration =		0.34 KN/m
						ULS load =		1.28 KN/m
				Depth joist = D=	195 mm	$I = BD^3/12$ =		3.9E+07 mm4
				Breadth Joist = B =	63 mm	$W = BD^2/6$ =		4.0E+05 mm3
						Elasticity modulus = Emean =		8400 N/mm2
Bending Resistance = fmk = 16	x Kmod = 0.8	x γmat = 1.3	x Ksys = 1.1	x Kdep = 1.0	x Kcrit = 1.0	= fmd =		10.83 N/mm2
Shear Resistance = fvk = 3.2	x Kmod = 0.8	x γmat = 1.3	x Ksys = 1.1		x Kcr = 1.00	= fvd =		2.17 N/mm2
Deflection								
						Deflection instantaneous = δ1 = 5/384 x [SLS instantaneous] x L^4 / EI =		11.43 mm
								<
						Maximum deflection instantaneous = δmax = L/333 =		12.76 mm
								CHECKED
Bending Moment								
						Mrd = W x fmd =		4.32 KNm
								>
						Muls = (ULS load) x L^2 /8 =		2.89 KNm
								CHECKED
Shear								
		Assuming	50 mm	x 63 mm tenon		Vrd = A x fvd /1.5 =		4.5 KN
								>
						Vuls = (ULS load) x L/2 =		2.72 KN

Notes:

A new 18m plywood will be laid over the existing joists. A continuous line of full depth blocking will also be provided at midspan to improve the serviceability performance.

MHA STRUCTURAL DESIGN

JOB	23072/51 Lamb's Conduit Street	DATE Feb-24	PAGE 4.2
TITLE	Existing Floor Check	BY MC	CHECKED RD

Check Bressumer - C16 200x200

Partial factor for Imposed loads in long term combination ψ2 = 0.30
Partial factor for Imposed loads in vibration load combination = 0.10

Span = L = 5.00 m
Creep factor for Service Class 1: k def = 0.60

	Load	Spacing	*Line Load	
Dead Load = G =	0.70 KN/m2	2.13 m	4.0 KN/m	SLS load instantaneous = 7.23 KN/m
Variable Load Roof = Q =	1.50 KN/m2		3.2 KN/m	SLS load long term = 10.22 KN/m
				*[1]SLS Vibration = 1.36 KN/m
				ULS load = 10.23 KN/m

*3m x 0.85KN/m2 = 2.55KN/m added for partition above
*[1] Partition not considered in vibration

Depth bressummer = D= 200 mm
Breadth bressummer = B = 200 mm
I = $BD^3/12$ = 1.3E+08 mm4
W = $BD^2/6$ = 1.3E+06 mm3

Elasticity modulus = Emean = 8400 N/mm2

Bending Resistance = fmk = 16	x Kmod = 0.8	x γmat = 1.3	x Ksys = 1.0	x Kdep = 1.0	x Kcrit = 1.0	= fmd = 9.85 N/mm2
Shear Resistance = fvk = 3.2	x Kmod = 0.8	x γmat = 1.3	x Ksys = 1.0		x Kcr = 0.67	= fvd = 1.32 N/mm2

Deflection

Deflection instantaneous = δ1 = 5/384 x [SLS instantaneous] x L^4 / EI = 52.50 mm
>
Maximum deflection instantaneous = δmax = L/333 = 14.00 mm
EXCESSIVE DEFLECTION

Bending Moment

Mrd = W x fmd = 13.13 KNm
<
Muls = (ULS load) x L^2 /8 = 31.97 KNm
OVERSTRESSED

Shear

Vrd = A x fvd /1.5 = 35.2 KN
>
Vuls = (ULS load) x L/2 = 25.58 KN
CHECKED

Vibration

Mean frequency = 5.7 Hz
<
Min frequency = 8.0 Hz
LOW FREQUENCY

Notes:

1. It is likely that the bressummer is formed from hardwood, and would still be over-stressed by around 20%.

2. The bressummer requires strengthening to comply wih strength requirements, i.e. to be checked in bending and shear.

See next section for strengthening details.

MHA STRUCTURAL DESIGN

JOB	23072/51 Lamb's Conduit Street	DATE Feb-24	PAGE 4.3
TITLE	Existing Floor Check	BY MC	CHECKED RD

Joists Bedroom - C16 195x63 @ 400 c/c

Partial factor for Imposed loads in long term combination ψ2 =			0.30				Span = L =	6.50 m
Partial factor for Imposed loads in vibration load combination =			0.10				Creep factor for Service Class 1: k def =	0.60
		Load	Spacing	Line Load			SLS load instantaneous =	0.88 KN/m
	Dead Load = G =	0.70 KN/m2	0.40 m	0.3 KN/m			SLS load long term =	1.16 KN/m
	Variable Load Roof = Q =	1.50 KN/m2		0.6 KN/m			SLS Vibration =	0.34 KN/m
							ULS load =	1.28 KN/m
		Load						
	Partition load =	0.60 KN			Depth joist = D=	195 mm	$I = BD^3/12$ =	3.9E+07 mm4
					Breadth Joist = B =	63 mm	$W = BD^2/6$ =	4.0E+05 mm3
							Elasticity modulus = Emean =	8400 N/mm2
Bending Resistance = fmk = 16	x Kmod = 0.8	x γmat = 1.3	x Ksys = 1.1	x Kdep = 1.0		x Kcrit = 1.0	= fmd =	10.83 N/mm2
Shear Resistance = fvk = 3.2	x Kmod = 0.8	x γmat = 1.3	x Ksys = 1.1			x Kcr = 0.67	= fvd =	1.45 N/mm2

Deflection

Deflection instantaneous = δ1 = 5/384 x [SLS instantaneous] x L^4 / EI = 62.55 mm

>

Maximum deflection instantaneous = δmax = L/333 = 14.00 mm

EXCESSIVE DEFLECTION

Bending Moment

Mrd = W x fmd = 4.32 KNm

<

Increased by point load -> Muls = (ULS load) x L^2 /8 = 8.00 KNm

OVERSTRESSED

Shear

Vrd = A x fvd /1.5 = 11.9 KN

>

Increased by point load -> Vuls = (ULS load) x L/2 = 4.65 KN

CHECKED

Vibration

E plywood =	8100	Plywood Thk =	18.0 mm	Kstrut =	0.97	EI,b =	7.9E+10 mm4
E ceiling =	2000	Plasterboard Thk =	0.0 mm			Kdist =	0.30
		Scheme =	Simply Supported			L eq =	6500
		Type of joists =	Solid Timber			K amp =	1.05
		Continuous blocking line?	Yes				
						winst,q =	5.5 mm
							>
						a =	1.06 mm
							LOW FREQUENCY
						Mean frequency =	3.7 Hz
							<
						Min frequency =	8.0 Hz
							LOW FREQUENCY

Notes:

1. A new 18m plywood and two continuous lines of full depth blocking will be provided to improve the serviceability performance.
2. Every joist will be doubled with a 195x47C24 timber.

MHA STRUCTURAL DESIGN

JOB	23072/51 Lamb's Conduit Street	DATE Feb-24	PAGE 5.1
TITLE	Proposed Floor Strengthening	BY MC	CHECKED RD

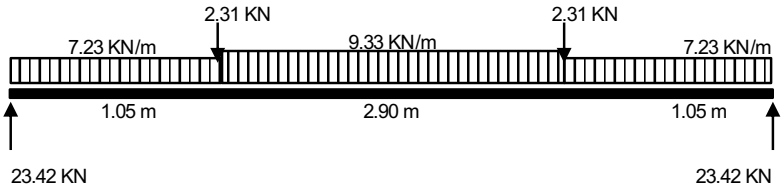
Strengthening Bressummer - PFC 200x 90 + Bressummer

Span = L = 5.00 m

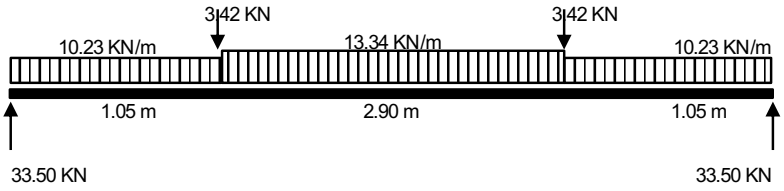
		Load	T. width	*Line Load		
Floor Load						
	Dead Load = G =	0.70 KN/m2	2.13 m	1.5 KN/m	SLS load =	4.68 KN/m
	Variable Load = Q =	1.50 KN/m2		3.2 KN/m	ULS load =	6.79 KN/m
Partition Load		Load	Height	Line Load		
	Dead Load = G =	0.85 KN/m2	3.00 m	2.55 KN/m	SLS load =	2.55 KN/m
					ULS load =	3.44 KN/m
Stairs		Load	T. width	Line Load		
	Dead Load = G =	0.50 KN/m2	0.60 m	0.30 KN/m	SLS load =	2.10 KN/m
	Variable Load = Q =	3.00 KN/m2		1.80 KN/m	ULS load =	3.11 KN/m
Landing		Load	T. area	Point Load		
	Dead Load = G =	0.50 KN/m2	0.66 m2	0.33 KN	SLS load =	2.31 KN
	Variable Load = Q =	3.00 KN/m2		1.98 KN	ULS load =	3.42 KN

The strengthening beam is designed to take the bending moment for the whole load currently on the bressummer.

SLS



ULS



Full Bending Moment (only on PFC)

C1 factor for eqiuivalent moment from SCI P360: 1.13

Mrd for Le = 5.00m = From Blue Book = 44.10 KNm

* Assuming no torsional restraint by the floor and plywood

>

Muls = 43.55 KNm

CHECKED

Shear (resisted by bressummer)

Shear Resistance = fvk = 3.2 x Kmod = 0.8 x γmat = 1.3 x Ksys = 1.0 x Kcr = 0.67 = fvd = 1.32 N/mm2

Depth bressummer = D= 200 mm Breadth bressummer = B = 200 mm Vrd = DB x fvd /1.5 = 35.2 KN

>

Vuls = ULS Reaction Bressummer and PFC = 33.50 KN

The PFC will bear into the masonry wall and wil be encased in concrete

MHA STRUCTURAL DESIGN

JOB	23072/51 Lamb's Conduit Street	DATE Feb-24	PAGE 5.2
TITLE	Proposed Floor Strengthening	BY MC	CHECKED RD

Strengthening Joists Bedroom - C16 195x63 + C24 195x47 @ 400 c/c

Partial factor for Imposed loads in long term combination ψ2 = 0.30
Partial factor for Imposed loads in vibration load combination = 0.10

Span = L = 6.50 m
Creep factor for Service Class 1: k def = 0.60

	Load	Spacing	Line Load
Dead Load = G =	0.70 KN/m2	0.40 m	0.3 KN/m
Variable Load Roof = Q =	1.50 KN/m2		0.6 KN/m

SLS load instantaneous = 0.88 KN/m
SLS load long term = 1.16 KN/m
SLS Vibration = 0.34 KN/m
ULS load = 1.28 KN/m

Partition load: Load =0.5KN/m2 x 3m x 0.4m =0.60 KN

Depth joist = D= 195 mm
Breadth Joist = B = 63 mm
$I = BD^3/12$ = 3.9E+07 mm4
$W = BD^2/6$ = 4.0E+05 mm3
Elasticity modulus = Emean = 8400 N/mm2

Depth C24 joist = D= 195 mm
Breadth C24 Joist = B = 47 mm
$I = BD^3/12$ = 2.9E+07 mm4
$W = BD^2/6$ = 3.0E+05 mm3
Elasticity modulus C24 = Emean = 11000 N/mm2

Equivalent C16 properties: Ieq = E_{C24} / E_{C16} x I = 3.8E+07 mm4
Weq = C_{24} / C_{16} x I = 4.5E+05 mm3

I final = I existing + I strengthening = 7.7E+07 mm4
W final = W existing + W strengthening = 8.5E+05 mm4

Bending Resistance = fmk = 16	x Kmod = 0.8	x γmat = 1.3	x Ksys = 1.1	x Kdep = 1.0	x Kcrit = 1.0	= fmd = 10.83 N/mm2
Shear Resistance = fvk = 3.2	x Kmod = 0.8	x γmat = 1.3	x Ksys = 1.1		x Kcr = 0.67	= fvd = 1.45 N/mm2

Bending Moment

Mrd = W x fmd = 9.16 KNm
>
Increased by point load -> Muls = (ULS load) x L^2 /8 + Puls x L/4= 8.07 KNm
CHECKED

Shear

Vrd = A x fvd /1.5 = 11.9 KN
>
Increased by point load -> Vuls = (ULS load) x L/2 + Puls = 4.56 KN

Notes:

1. Each joist is to be doubled with a 195x47 C24 grade timber.

2. A new 18m plywood will be laid over the existing joists. A continuoud line of full depth blocking will also be provided at midspan to improve the serviceability performance.

3. The proposed works are improving the performance in service of the floor joists, even if not complying with latest recommended limits.