# **STEEL FOCUS #10** STRUCTURAL STEELWORK



# SHAPING UP NICELY

How 13,000 tonnes of structural steel put the curves into the City of London's new Walkie-Talkie tower

# DIVINE INTERVENTION

A biblical twist sets the University of Winchester's new teaching block on the right path

# SHAKY FOUNDATIONS

Are you missing the bigger picture when it comes to costing structural frames?

# **The talk** of the town

Rafael Viñoly's Walkie-Talkie tower is now flaring out over the London skyline, thanks to 13,000 tonnes of structural steel and 37 unique floor plates **Text by Pamela Buxton** 

oclaimed on its hoarding as "the building with more up top", Rafael Viñoly's 177m-high tower 20 Fenchurch Street is rapidly taking shape on London's skyline. Now almost fully clad, the 64,140sq m tower

is due for completion next year. The skyscraper's controversial, distinctively flared shape – less like its nickname Walkie-Talkie and more like a pint glass – has been realised with the use of 13.000 tonnes of structural steel provided by steelwork contractor William Hare.

With such a distinctive form, this building will always divide opinion as it joins the growing number of unconventional towers now jostling for attention in - criticised by some as over- City. whelming – respects the City's the contour of the river and the medieval streets".

ter. And at the very top, the joint south elevations and the convex developers Land Securities and curve on the east and west. Canary Wharf Group promise Creating and delivering the so-



# **FACETED STRUCTURE**

To create the flared shape the columns are faceted up to the 25th floor, after which the top of the flare is achieved with a cantilever, both of which simply delivered the desired profile. The angle of the columns is changed in a concealed, bespoke spigot connection welded to the top of each column during fabrication. This allowed the next column to be positioned at the correct angle to achieve the facet while avoiding the need for an external flange. The impact of the bolt head is minimised by the fire-protective covering. With such complex column geometry, the use of 3D project information was hugely important, according to steelwork contractor William Hare.



### **AERIAL PERSPECTIVE**

1 Gracechurch Street 2 Fenchurch Street 3 20 Fenchurch Street 4 Eastcheap

the capital's financial heartland. a publicly accessible sky garden lution to a tight 38-month time-Viñoly maintains that the design with spectacular views over the table was only possible, according to Canary Wharf Contractors The tower's form presented associate director Charlie Paul, historic character by "following a tough challenge for engineer with the use of what he terms 4D Halcrow Yolles and contractor BIM modelling - the fourth di-Canary Wharf Contractors since mension being time. This gives Commercially, the swelling each floorplate was a unique complete coordination of all asform makes sense, maximising shape and size due not only to the pects of design and construction the footprint by creating larger widening floor plates but also the using software compatible with floor plates as the views get bet- concave curve on the north and the Revit programme used by the design team, Sketchup Pro used by the contractor and Tekla used by the subcontractors.

> This real-time model allowed the contractor to fully coordinate the design team and specialist contractors so that they could anticipate any clashes and hiccups within the various interfaces during the construction programme and act accordingly to eliminate them. In this way, it also enabled those tendering to give a more accurate price, according to Paul.

"We had very little argument and debate with William Hare. The modelling we did allowed us to have a much closer relationip, ne adds.

Steel was the only viable choice for 20 Fenchurch Street's structure, lowering the weight of the building and allowing the engineers to use existing foundations on the site, according to Halcrow Yolles buildings team lead Jason Guneratne. It also met the requirement for long spans in order to maximise lettable office space.

The structure consists of 22 box columns arranged on a 9m grid around a central core. Columns were constructed from fabricated sections ranging from 525mm x 525mm square box sections with 100mm-thick plates to 525mm x 350mm I sections with 40mmthick plates at higher levels.





FRIDAY 26/07/2013 WWW BOONLINE COLIK

The wider floor plates or upper storeys maximise ettable space with views





West section: The steel frame cantilevers after the 25th floor. The upper three storeys are taken up with the sky garden.



accommodate services within the level 2 to 18m on the upper levels.

According to Guneratne, the geometric changes were the crux of the structural design challenge. Architectural aesthetics were the the building changes, it fundaalgorithm that automatically recalculated the positions of all the beams on every floor."

the ball of the

S ALL DO M DO M DO M DO

ALC: NOTE ALC: N

Bifurcating columns were initially considered in order to lifts. achieve the flaring shape but this would have taken up too much church Street will total £239 mi structure up to the 25th floor, with is 56% pre-let. the facets occurring first every six floors, then every four and finally every two on areas of high curvature as the tower neared its widest **PROJECT TEAM** "bulge" point on the 27th floor.

However, the maximum beam span that could be tolerated was Architect 20m. So from level 25, the struc- Rafael Viñoly Architects ture's flare was created using a cantilever to give the final 4m on Adamson Associates the north and south faces beyond the column line. On the east and west sides, the columns remain in **Contractor** the facade, which is triple-glazed with panelised aluminium cladding and vertical louvres.

Each beam was kept to a In order to avoid using the three 600mm depth whatever the tower cranes needed to erect the span, except at the uppermost structure during the worst of the levels where they were increased winter weather, Canary Wharf to 1,150mm. All are fixed to the Contractors asked William Hare concrete core using embedment to deliver the steel installation in plates. Most are fabricated plate just 36 weeks from May 2012 to girders with web penetrations to January 2013, rather than 41, by working on accelerated hours for beam depth. Typical floor beam 17 weeks. This included the instalspans range from about 11m at lation of the approximately 8,500 major structural members that made up the steel frame.

Having installed the vertical cladding, the contractors are now building the sky garden. main driver. When the shape of When complete in April 2014, the Breeam "Excellent" building will mentally changes every beam a contain 61,000sq m of offices up to little bit. So we formulated an the 34th floor as well as 1,200sq m of ground floor retail, plus the sky garden, which is intended to be a public space with bars and restaurants served by its own dedicated

Development costs for 20 Fenspace within the plan. Instead, lion. So far, with completion still a the solution was to facet the steel year away, office accommodation

Developers Land Securities, Canary Wharf Group Executive architect Structural and facade engineer Halcrow Yolles Canary Wharf Contractors Steelwork contractor William Hare



The steel frame is made up of approximately 8,500 major structural members.



# **SKY GARDEN**

The sky garden is a 50m x 60m, double-height glazed space at the top of the tower with clear spans and a giant full-height window on the north and south elevations.

The original intention had been to use a spaceframe construction but thi was changed to a more economical and faster-to erect portal frame with 34 structural fins spanning east to west, including wo central zum s 1,200mm deep. Each is fixed by William Hare into a base connection — a concealed steel "shoebox" typically 750mm x 400mm x 100mm deep. This takes the horizontal forces into the steel structure and accommodates the transition from the aluminium fins running up the side of the tower into the steel roof structure. Mitre connections on the four corner fins are also accommodated in more heavily loaded "shoeboxes".

# FRIDAY 26/07/2013 **14 STEEL FOCUS UNIVERSITY OF WINCHESTER**



# **Thirty pieces** ofsilver

Design Engine's new teaching block for the University of Winchester is dominated by a steel-and-timber portico inspired by Christian symbols

**Text by Pamela Buxton** 

steel portico and dis- in 2005. Building.

to the former King Alfred teaching and the theatre, which the practice further teaching studios. college's campus, following its re-refurbished in 2003.

ith its 12m-high then the University of Winchester ing space, the university decided for the building to create a suit-

to redevelop an inadequate 1920s tinctive Christian- Design Engine has worked ex- arts block in front of the library new piazza, which has become an inspired artwork, tensively on the campus, which to provide eight flexible teachthere's no missing occupies a steeply sloping site on ing rooms for up to 600 students. the University of Winchester's the outskirts of the city. The St Design Engine's eventual solution new Learning and Teaching Alphege building, which was of- also creates a linking block to the ficially opened in January, helps to adjacent 1970s St Edburga build-Designed by local practice De- form a new public space bounded ing, which has been reclad and to what would be an important sign Engine, the St Alphege build- by the University Centre – com- given a lightweight, steel-framed ing is the latest facility to be added pleted by the practice in 2007 – rooftop extension containing two

As well as providing the acincarnation as first University Faced with an urgent need for commodation the university re-College Winchester in 2004 and improved and additional teach- quired, the architects were keen diose steel atrium also facilitates

ably impressive presence on the important outside social space on the campus.

"My worry was that a teaching building wouldn't have a frontage with some element of closure public space," says Design Engine director Richard Jobson. "So we developed the idea of a large **SITE SECTION** oversailing roof with an opportunity for an artwork." The gran-



1 St Alphege building2 Link building3 St Edburga building4 University Centre5 Piazza6 Theatre7 D 7 Dvtch 8 Library



2 St Alphege building

5 St Edburga building

1 Library	
4 Link building	

3 Double-height first floor 6 Rooftop extension

Edburga.

In association with The British **Constructional Steelwork** Association and Tata Steel TATA STEEL



FRIDAY 26/07/2013 WWW.BDONI TNF.CO.UK

pedestrian flow through to the green space alongside, known as the Dytch, Jobson adds

Another important factor was the nature of the adjacent St Edburga building, which has floorto-ceiling heights of just 2.3m. Ideally, the architects would have wanted to provide level floor plates to ease the transition between the two buildings, but this was problematic because of the desire to provide higher teaching spaces in the new accommodation. The practice therefore opted to make the ground floor of teaching studios double height (4.5m) so that the first floor could align with the new upper storey of St

Steel was the only viable option for the primary structure, according to engineer Heyne Tillett Steel, because of the intense time pressure to complete the St Alphege building before the 2012 autumn term (the St Edburga phase completed early this year). As a result, the programme was accelerated, with the design detailed and procured at speed in order to finish in time. In total, steelwork contractor Snashall Steel Fabrications Co supplied 300 tonnes of steel.

The building is constructed with a steel superstructure with composite beams, highly insulated rainscreen cladding and blockwork walls. The 12m-span precast concrete planks provide thermal mass and use integral water pipes as part of an active cooling and heating strategy.

On the south side of the building, the recessed elevation is overhung by a 1.5m-wide colonnade of large brise-soleil blades. The

# **'My worry was** that a teaching building wouldn't have a frontage with some element of closure to what would be an important public space'

colonnade's eight steel columns are syncopated with alternate balanced with a pattern of timber slats that the architects derived ously, says Jobson, the pattern is Christ surrounded by the apos- Snashall Steel Fabrications Co

broken so that students don't feel as if they are imprisoned inside. "It's a repetitive pattern that you break with an alternative pattern but also a certain account of freedom," he adds.

The glazed link between the St Alphege and St Edburga buildings contains the main entrance and is dominated by a purple "scissor" steel staircase which leads to teaching floors, as well as a mezzanine with computer and ing, with a full-height window side elevation desk space.

5m from the edge beams on each connections through the linking landing, with hollow section building to a new rear courtyard. stringers further stiffened by a welded steel plate balustrade. to achieve a Breeam rating of This solution avoids the intru- "Excellent". The entire project, sion of support structure into the including the adjacent building's circulation space. Instead, each steel-framed upper floor, cost a half landing is supported only by total of just  $\pm 3.8$  million at a rate the staircases going up and down of £2,150 per sq m. "There's a lot of from it. The curved staircase has a building, and a lot of complexity," randomised pattern of circles cut says Jobson. into the plate balustrade.

But it's the portico that steals the show. This provides a frame **PROJECT TEAM** for the artwork, designed by the Client University of Winchester wide and narrow gaps; these are architects in consultation with Architect Design Engine vice-chancellor Professor Joy Main contractor Carter. She wanted a piece that Geoffrey Osborne from an overlapping "golden would reinforce the relationship Structural engineer rectangle" proportioning system. of the university with its Christian Heyne Tillett Steel Rather than running continu- heritage. The work represents Steelwork contractor

tles, denoted by suspended steel **Clockwise** boxes, with the exception of a rust- from main ing weathering steel element that **image**: represents Judas. These are linked that also repeats. It has a rigour by 30 polished rods in reference artwork uses to the 30 pieces of silver that was suspended the price of Judas' betrayal. Two Douglas fir timbers form a cross. to represent Other elements include thin vertical strips of larch, which symbolise the population of the college.

The architects have made the most of views through the buildopening onto the portico from the Structural The staircase is cantilevered lower teaching level, and visual

The new building is designed

The portico steel boxes the apostles: Two layers of larch brisesoleil help to animate the steel model.



# PORTICO

A 12m-high galvanised-steel frame creates a suitably impressive portico. Steelwork contractor Snashall Steel created two 850mm-wide and 200mm-thick corner fine using steel "ladders" clad in powder-coated aluminium panels. These are of different heights to accommodate the sloping site. "The architect wanted to see fins, so

we used a double column arrangement to support the weight of the artwork structure, says Heyne Tillett Steel project engineer Andrew Blasdale. "The ladder arrangeme gives fixing positions to the cladding and provides nominal interconnecting restraint to the two columns in their weaker direction.

The frame contains an oculus - originally intended to be positioned above a reflecting pool — which throws a circle of light onto the ground and backlights the artwork. Due to the cost and programme constraints on the project, Snashall Steel decided to use four corner beams at 45 degrees to provide an octagon. This was then finished off with plywood to create the curve.



# **ROOFTOP EXTENSION**

One of the trickiest aspects of the project was creating the lightweight steel-framed storey on top of the St Edburga building. Although the skeleton portal frame was fairly standard, the challenge was getting the setting out right because the base building wasn't quite square, according to Snashall Steel technical director Blair Thomas. "The whole thing sat on top of the existing structure and fixed into the masonry," he says, adding that this was achieved using chemical anchors.

The existing roof finishes and toppings were removed and the original brick piers were tied into the new steel columns.

# Putting frames onafirm footing

Accurate costing from the outset is essential to choosing the right structural frame Text by Pamela Buxton Illustration by Nick Lowndes

choice of structural framing later date. material, with under a quarter feeling that steel frames were expensive.

But as steel frames have accounted for 70% of all non- Recent cost trends domestic framed multi-storey According to the Department for buildings over the last 10 years, Business, Innovation and Skills this perception of steel is not (BIS), prices for both structural borne out in reality. So what can steel and steel reinforcement be done to ensure that costing is (and therefore concrete frame) accurate both at the early stages fell steeply from the second half of the design process when the of 2008 due to over capacity after frame is chosen, and during de- the fall in demand caused by the tailed design stages?

rying out ongoing research into of that year until the present (see constructional steelwork prices, chart below). Output fell by alaccurate costing can be challeng- most 35% by early 2010 compared ing to achieve unless project-spe- with March 2008. cific cost drivers are understood.

choice and configuration are often years shows an initial fall in rates without the benefit of fully de- ity returning by the end of 2011 veloped information," says G&T and continuing through to 2013. associate Rachel Oldham. "None- However, in the six months after the second half of the year. theless, it is important to review July 2012, the material price of alternative solutions and the im- fabricated structural steel fell by Getting the price right

200

150

100

PRICES OF COMMON STRUCTURAL MATERIALS 2008-13

Concrete

reinforcing bars

n a recent industry survey two frame and associated elements, thirds of architects identified since it can be costly and difficult cost as the main driver in the to change the frame choice at a

"Otherwise, it may lead to a project proceeding with a design olution that is not optimised.'

economic crisis. They then con-According to Gardiner & tinued to fall during 2009 before Theobald (G&T), which is car-generally stabilising from the end

cific factors on the design of the December 2012 were 2.7% lower rent pricing, G&T advises that

Fabricated

structural steel

NAROS SEPOS NAROS SEPOS NARIO SEPIS NARI' SEPIS NARI'S SEPIS NAR'S

than December 2011, this was those doing the costing should G&T's analysis of steel frame generally not reflected in tender speak to the supply chain to find "Decisions on frame material tender prices over the last five prices for fabricated structural out the reality of current steel steel. With small rises in the cost costs. When given a typical cost made early in the design process in 2008 and 2009, with stabil- of raw materials in 2013, some range for different frame types, firming of the price of fabricated G&T suggests that, rather than structural steel is also expected in using the highest rate of a range, it

# plications of project and site-spe- about 1.2%. While steel prices in To get an accurate picture of cur-

Cement Concrete Precast

is best to instead interrogate and understand what those rates buy, and also how the standard rates can be adapted to suit projectspecific needs.

Those analysing costs need to consider the key cost drivers that Function. sector and buildbetween different building types. An industrial building, for exam- gramme costs. 40kg/m<sup>2</sup> GIFA (gross internal floorarea)compared with 90kg/m<sup>2</sup> GIFA for a long-spanning city- BCIS LOCATION FACTORS\* centre office building due to the shed supporting a much lower load compared to the office frame. Variations in floor-to-floor height also need to be accommodated in a cost matrix. Discussion of design principles with the engineer and architect is essential to clarify this.

Form, site conditions and complexity of structure Complex

structural solutions, irregular grids and the inclusion of nonstandard sections will increase overall frame rates due to higher fabrication costs and more complex connection details

Location, logistics and access Costs should be adjusted according to geographic location. Indices from building cost information provider BCIS currently show City of London at 120

with Belfast the lowest at 66 (see below). impact on structural steel frames: Site-specific factors are also important – for example, citydeliveries, which can affect pro-

ple, could have a frame weight of **Programme, risk, and pro**curement route Single-stage

Location	BCIS index	BCIS index Location	
City of London	120	Leeds	93
Nottingham	93	Newcastle	89
Birmingham	100	Glasgow	108
Manchester	96	Belfast	66
Liverpool	92	Cardiff	98

procurement routes are increasingly common compared to the previously dominant twostage approach. This generally leads to more competitive tender prices.

## Current costs

G&T has compiled current costs for two key building types: Low-rise and short-span buildings, typically two to four storeys with a regular structural grid of 6-9m for largely column-free space and floor-to-floor heights of 3.75-4m. Average steel fram ing height Average steel frame centre sites can be restricted weight is about 50-60kg/m<sup>2</sup> weights will vary considerably in terms of working hours and including fittings. Due to the low-rise nature of the building, fire protection of 30-60 minutes would be considered standard.

## \* As at 13 June 2013

is mixed mode.



**BREAKDOWN OF FRAME COSTS** 

FRIDAY 26/07/2013 WWW.BDONLINE.CO.UK

> aw materials )-40% Fabrication 30-40% Construction 10-15%

Fire protection

Engineering

Transport

### INDICATIVE COST RANGES

ТҮРЕ	GIFA rate (£) BCIS index 100	GIFA rate (£) City of London
Frame: low-rise, short spans, repetitive grid/sections, easy access (see Building 1)	75-100/m <sup>2</sup>	90-120/m <sup>2</sup>
Frame: high-rise, long spans, easy access, repetitive grid (see Building 2)	125-150/m <sup>2</sup>	140-170/m <sup>2</sup>
Frame: high-rise, long spans, complex access, irregular grid, complex elements	145-170/m <sup>2</sup>	165-190/m <sup>2</sup>
Floor: metal decking and lightweight concrete topping	40-58/m <sup>2</sup>	45-65/m <sup>2</sup>
Floor: precast concrete composite floor and topping	45-60/m <sup>2</sup>	50-70/m <sup>2</sup>
Fire protection (60-minute resistance)	7-14/m <sup>2</sup>	8-16/m <sup>2</sup>
Portal frames: low eaves (6-8m)	45-65/m <sup>2</sup>	55-75/m <sup>2</sup>
Portal frames: high eaves (10-13m)	55-75/m <sup>2</sup>	65-90/m <sup>2</sup>

buildings, typically 10-15 storeys plus basements. These often require longer structural grid spans, increasing frame weight, and may require cellular beams for the distribution of services. Use of regular column grids may be hampered by irregular citycentre sites or the requirements of mixed-use schemes. This contributes to higher average weights of steel frames of 65-85kg/m<sup>2</sup> including fittings. Buildings over 15 storeys are likely to have a higher proportion of complex elements and non-standard sections, and the rate range can be 15-20% higher than the top of the standard range.

Costs include allowances for concrete costs and have been developed from cost models of the building types. For both, the fabricated plate girders or trusses average weight of the structural frame is given. Within this range, it is important to confirm anticipated frame weights, variables and fire protection with the design team, and also each key cost driver in turn.

To use the table above, choose the frame type that most closely relates to the project, add the floor type and fire protection required can be considered suitable for

**High-rise and longer span** the structural works would have commenced in the first quarter of 2013. After this point, there should be allowance for inflation.

# During detailed design

As the design develops, a more detailed costing of the structural steel frame on a per tonne basis can be made. This requires drawings from the structural engineer on frame configuration, cores and shear walls, columns and beams, section sizes and types, floor construction details and the strategy or integration of mechanical and electrical services.

The nature of the main members, secondary members, fittings and connections should all be considered. Each structural product, whether rolled I-section, structural hollow sections, will have its own costs depending on the differing fabrication and erection requirements. As popular sections may be manufactured up to four times more often than less common sections, it may be less costly to use heavier options that are more readily available.

To calculate the costs of the structural frames, each of the different components will have a and adjust the total GIFA rate us- rate per tonne applied and then ing the BCIS index. These rates totalled. This will include all elements of the cost of the profile cost planning of projects where from raw material to erection.



As the pie chart above shows, raw materials make up only 30-40% of total frame costs, with fabrication the same again, followed by construction, fire protection, engineering and transport. As a rule, 20 hours of fabrication time is roughly equivalent in cost to 1 tonne of raw material.

With construction typically accounting for 10-15%, it is worth considering the extent of

Separate cost allowances are repetition and connection type as these can significantly impact on frame costs.

### Case studies

The costs for the two typical office buildings below were developed by G&T, Peter Brett Associates and Mace Group and updated quarterly. Embodied carbon was discussed in the last Steel Focus (3 May 2013).

For further information go to www.steelconstruction.info/ Cost comparison study

beams and slab with in-situ

columns. The overall floor-

to-floor height for the steel

for the concrete option. All

costs more than 3% less

than the concrete option

on a whole building basis

and more than 8% less in

steel option's lower floor-

to-floor height reduces the

envelope cost by about 5%.

Substructure costs are also

less, due to a lighter frame

options would require 20

weeks for substructure and

around slab construction.

For the frame and floor, the

steel option would take 16

weeks, and the concrete 28.

weight and a lower roof cost.

Mace estimates that both

terms of frame and floor. The

option is 4.18m, and 4.375m

costs are at Q2 2013 prices, based on the City of London.

The steel composite option

# **CASE STUDY 2: CITY-CENTRE OFFICE BUILDING**



This is an eight-storey citycentre office with a GIFA of about 16,500m<sup>2</sup>. The design is L-shaped with a central core, internal secondary escape stair and doubleheight reception. The clear floor-to-ceiling height is 3m, with a structural grid of 7.5m x 15m. Curtain walling is in 1.5m-wide, storevheight panels with solar control fins. Solid areas are lined with cold-rolled metal studwork, insulation and plasterboard. There is fourpipe fan-coil air-conditioning and no natural ventilation

The study compares two structural systems: a steel frame with cellular composite beams and composite slab and 60-minute fire resistance; and a concrete option using post-tensioned band

## BUILDING 2 COST MODEL (PER M<sup>2</sup> GIFA)

Substructure £56 £60 Frame and upper floors £194 £210 Total building £1,861 £1,922

# **CASE STUDY 1: BUSINESS PARK OFFICE BUILDING**

This is a low-rise building in an out-of-town location, with a GIFA of about 3,200m<sup>2</sup>. It has an 18m-wide, rectangular floor plate and a floor-to-ceiling height of 2.8m. There is one central core and two lifts. The envelope has a brick outer skin and the window allowance is 35% of the facade. Ventilation

Peter Brett Associates set a structural grid of 7.5m x 9m for four frame types: steel composite beams and composite slab; steel frame and precast concrete slabs; reinforced concrete flat slab: and in-situ concrete frame with post-tensioned slab. For all options, the foundations are unreinforced mass concrete pads. Core construction is steel crossbraced framing with blockwork infill for the steel options, and concrete shear walls for the concrete. For the roof, the steel frames have a lightweight steel deck and the concrete structures continue

the concrete slab construction of the lower floors. Floor-tofloor heights for steel options include an 80mm service zone below the metal deck and a 600mm service zone beneath the concrete slab

Costs are at Q2 2013 prices based on the City of London, and exclude fees, VAT, project contingency and fixtures.

The steel composite option has the lowest cost in terms of frame and upper floors, and in total. The reinforced concrete option has the highest frame, upper floor and overall costs, with the frame and floors over 10% higher than the steel composite option, and total building costs about 6% higher. The post-tensioned option has a slightly lower frame and floor cost than the steel and precast option, but the latter costs less overall due to lower roof costs and a shorter programme. On average, both steel options can be built 5% faster than the concrete alternatives.



### BUILDING 1 COST MODEL (PER M<sup>2</sup> GIFA)

ТҮРЕ	Steel composite	Steel and precast concrete slabs	Reinforced concrete flat slab	Post-tensioned concrete flat slab
Substructure	£52	£55	£67	£62
Frame and upper floors	£140	£151	£153	£150
Total building	£1,535	£1,561	£1,628	£1,610