EAST LONDON LINE REBORN

MAJOR PROJECT REPORT

27|05|10

LONDON’S NEW RAILWAY
PLANNING, DESIGN AND CONSTRUCTION OF A NEW 10KM RAIL ROUTE FOR LONDON OVERGROUND
This week the London Overground East London Line opened a full service from West Croydon in south London to Dalston in the north. In a remarkable achievement, the project has been delivered early. Jackie Whitelaw reports.

One day after the opening of the core route of the London Overground East London Line last month, passengers were wandering around wide-eyed, taking in the wonder of the capital’s newest rail route. Londoners who know the detail of the Underground better than their bank pin numbers were cooling considerably to themselves while looking at a map of the route which revealed a whole new circuit board of travel possibilities. As the first section of ELL opened they could go from Dalston in Hackney on a disused North London Line. In a remarkable achievement, the project has been delivered early.

From the start, we stressed to everyone that this job is about delivering an operational railway – infrastructure, rolling stock and power systems, 3.5km of new track, an operational control centre, depot; and 44 four car trains – 20 for the East London Line and 24 for the North London Line. This week the London Overground East London Line opened a full service from West Croydon to Dalston Junction via Peckham Rye and Wandsworth Road and links to the Underground Clapham Junction to Willesden Junction Line.

The capital will have an outer orbital metro railway under the banner of London Overground, interconnecting along the way with its Underground lines and serving 20 of its 33 boroughs, and commuters will have opportunities aplenty to avoid central bottlenecks when they are trying to cross the city. The key to creating this will have been a £1bn Transport for London investment in infra-structure and new rolling-stock. This has reinvigorated and expanded the old East London Line Tube line, reusing Victorian infrastructure and introducing some new modern landmarks along the way. There are going to be huge benefits in terms of regeneration and new jobs for some of the less developed parts of the City, rail-deprived Hackney will at last have a metro, and east and southeast London will acquire some life changing infrastructure.

Around 3m passengers are expected to be using the route every year by 2011, rising to a projected 3m by 2016. “The really good part of this job,” says London Rail chief executive Howard Smith, under whom the project is managed, “is that we are changing the face of London and the way we think of and use London in a permanent way. It is really dramatic.”

There has been a plan to upgrade the East London Underground Line that ran from Shoreditch to New Cross Gate since 1979. London Underground had the idea to take a railway into Hackney on a disused viaduct that had once carried the North London Overground Line from Broad Street Station, which had disappeared under the Broadgate development in 1986. It got Transport & Works Act (TWA) powers for the scheme, which was then expanded again when it was realised the railway could interconnect with the North London Line. Another Transport & Works Act was acquired, and as the project by that stage had effectively become part of Overground rather than Underground rail, it was passed to the newly formed Strategic Rail Authority (SRA) to manage.

ELL plans languished there without a champion. But over at Transport for London it did have its backers – Smith and his managing director Ian Brown. It was a good decision. The TWA powers they fought for, and won the division in particular. And when the Olympics came along, which finally tipped the balance and we could get on with building the project,” Smith says.

Peter Richards was brought in from the SRA to run the job as infrastructure director for the now dubbed London Overground, along with Mike Stubbs as engineering director, and they got stuck into design. There had been a brief flirtation with funding the route through private finance. “But the ELL is a grey asset,” Smith says. “There is a lot of old infrastructure it would have been difficult to box up for PFI, and a PFI takes time to put together.”

With the 2012 Olympics fast approaching, it was decided to go for a design and build option.

It was a good decision. The scheme, built by a Balfour Beatty Carillion joint venture (BBCJV), opened early on 23 May. BBCJV won the contract in October 2006, started design immediately, and then started the major structures in 2007. It got onto the tunnel and south sections of the site when the old East London Underground was closed in December 2007 and handed over in late January 2008.

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“This from the start, we stressed to everyone that this job is about delivering an operational railway – infrastructure, rolling stock and operations,” says Richards. “We have managed to bring together these aspects and given the responsibility for managing the interface between the different infrastructure and main works structures and rail systems to Balfour Beatty Carillion as our main works contractor. “That is why we went for a single NEC3 design and build main works contract. “It has meant that BBCJV has managed the interfaces, and all the responsibility has rested with one party to get on and do the whole thing.”

When Richards set up the job he wanted to create momentum, so he formed an integrated client team to manage the job and drive its progress. This included himself, Parsons Brinckerhoff’s Ashok Kothari as head of programme management and designers from Mott MacDonald as technical adviser to the project.

Refurbishment work along the route on some of the older structures like the Kingsland Viaduct was let as enabling works contracts to Murphy and Taylor Woodrow (now Vinci Construction). “Refurbishment is risky and it was prudent to do some of that first before we let the bigger contracts,” Richards says.

“And then, as a client team, we worked very hard towards letting the main works contract to programme.”

“We have built ourselves a team,” said. “We have created the foundation for the project and the whole project is coming in.”

“We are changing the face of London and the way we think of and use London in a permanent way. It is really dramatic,” said Howard Smith, London Rail
Collaboration between client, contractor and supply chain was crucial as the construction project developed in scope, writes Jackie Whitelaw.

**MANAGING THE TEAMS**

**BBCJV project director**, Mike Casebourne has had to manage 640 professional staff, and 600 designers off site in the offices of Scott Wilson and Tony Gee and other designers.

He is also responsible for 2,500 operations on site at peak and up to 1,000 people engaged in the offline manufacture of all the steelwork for the job throughout the UK. At peak, the project was spending £150M every four weeks or £1.5M a day.

The job was divided into four construction sections under the control of four of BBCJV senior project managers: northern cities under Andy Swaff; southern and central cities under Paul Barracan; rail systems under Elliott Young and the depot under Howard Williams. These were supported by design, commercial and administrative managers within their teams and reporting also to their department directors.

**COMMUNITY RELATIONS**

Community relations were a vital part of successful delivery of the East London Line with full time community relations managers working for London Overground and BBCJV.

The usual issues of working hours, noise and dust had to be dealt with at the start of the project – at Dalston and Dalston New Cross Gate where there were most sensitivities.

“We were particularly pleased about getting the route into service early as it will have its separate structures and rail systems,” says Casebourne.

“It was a requirement driven contract – for example to design for three minute headways between trains:

“There were 6,000 requirements and about two thirds of them were changed or modified as we all got on with the job,” says Balfour Beatty Carillon engineer Andy Nettleton.

“Without strong management of a resilient, responsive design organisation we would never have achieved so much in such a short time.”

The key to pinning down the scope was gaining access to the old Underground section of the route between Shoreditch and New Cross Gate.

“We pushed to get London Underground to agree to the route closed as early as possible,” says Parsons Brinckerhoff head of programme management Aashok Kothari. “We agreed to shut down the line in December 2007 although it had originally wanted to keep it open until the following April. There was a slight delay in the depot being ready but this was found, if not, then as much cash was saved on each operation as possible so there was some to spare when needed.

That approach required close collaboration between the client team, BBCJV and its supply chain throughout the works.

“The closely cooperative nature of the job has been vital,” says Balfour Beatty Carillon project director Mike Casebourne. “It is one of complete openness; no secrets, shared decisions and facing and solving problems together.”

Richards agrees: “We have some very dedicated people on this project. There is a collaborative, positive culture which has all helped towards getting the job out the door on time and on budget.

Actually the railway is two months ahead of schedule. The original opening date set at the start of the job in 2004 was 30 June 2010. The full network opened on 23 May to coincide with the start of the job in 2004 was 30 June 2010. The full network opened on 23 May to coincide with the start of the job. The final job is coming in at £700M or thereabouts after new non-contractual milestones to hit, worked out with Parsons Brinckerhoff.

“Also in December 2008 we had a number of the new structures, track, and operational systems complete to start test train running so it was either one or two months earlier on 5 October 09, and we did,” says Stuart. “And from that date we ran up to six of the new trains every day for four months during which time we finished the new station buildings behind the platforms; our track gives a very smooth ride to 33kV high voltage signalling systems worked fault free.

In November 2009 we gave a date of 17 January 2010 to be ready for trial operations and on that very date we started the week long process of handover to London Underground for final site trial operations,” adds Casebourne. “In fact by the time of the handover of the tunnel stations was completed and the customer information systems were finished. Now customers are on board and everything is working reliably.

East London Line running when that project goes ahead.

“One of the things I am most proud of here is that the scope increased very significantly yet our design, construction and commissioning period increased by only five months,” says Stuart.

“We had to design, construct, test and deliver an operational railway”

Mike Casebourne, BBCJV

Team work: The close cooperation culture of the job has been vital to successful construction of complex projects like Dalston Junction station

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**SAFETY**

The London Overground East London Line scheme has had an excellent safety record over the duration of the project.

The site has twice recorded an accident free year under the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (Riddor) 1995.

This was achieved in December 2008 and again in November 2009.

The job hit over 1.5M continuous Riddor free hours, and the current accident frequency ratio of reportable accidents to 100,000 man hours worked is an excellent 0.2, a performance which recently landed a coveted Rospa Gold Award.

“We have had a really big push on the safety culture on this project,” says health and safety advisor Mike Nettleton.

“We have focused on the coordinators and supervisors and put in place incentive like group of the month winning a fleece each,” he adds.

**NEW CIVIL ENGINEER 27.05.10 | www.nce.co.uk 27.05.10 NEW CIVIL ENGINEER**
Dalston Junction station is a massive, complex structure that has been designed to support multi-storey developments and to accommodate the potential Crossrail 2 line, as Margo Cole discovers. And Adrian Greeman focuses on the array of civil engineering work in the northern section linking the Victorian Kingsland Viaduct to the old East London Line at Whitechapel.

**DALSTON JUNCTION**

In theory, building a new four-track four-platform station at Dalston Junction could have been fairly straightforward.

Admittedly, space was very tight, but the new line runs through an existing cutout, so surely it wouldn’t have been too much of a challenge to build a roof slab over a section of the tracks and put a station building on top — wouldn’t it?

The reality is not quite so simple. The area taken up by the railway line as it runs through the heart of Dalston is prime development land and an important area within Hackney’s regeneration plans. As a result, a slab had to be built over the tracks not only to support the station building but also the loads from a series of apartment blocks of up to 17 storeys that are set to be constructed on top.

Within weeks of work starting, what had once appeared to be a generously-proportioned, open cutting had become a highly congested construction site, with over 30 pieces of major plant involved in excavation and pile installation, as the London Overground East London Line team set about building a 250m long by 40m wide podium slab and its supports.

The loads from the proposed apartment blocks will go into foundation piles. Once the beams were in place, the diaphragm plates were welded in situ, the voids between the plates were filled with grout and then reinforcement cages placed in and around the beams to tie them into the podium slab before the concrete was poured. In all, there is 1,000t of structural steelwork in the new station, most of it in these massive beams.

The downstand beams span between walls and columns that sit on pile caps up to 2m deep, the largest of which takes up an area of 3.6m². Beneath the pile caps are heavily reinforced bored concrete bearing piles, most of which are 600mm or 750mm in diameter, and sunk to a depth of 26m. However, at one end of the site, provision has been made for the possibility of the second Crossrail line passing diagonally beneath the East London Line.

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For Dalston Kingsland Guy Anstiss recalls: “In some places there’s an awesome amount of reinforcing steel. One section of beam has over 100 H40 bars at the top and bottom of the downstand beam, and multiple links,” he says. This gives a total of 2,350kg of reinforcement per linear metre in some locations.

However, in 19 beams, even this heavily reinforced concrete was unable to support the anticipated point loads from the apartment building which are expected to be up to 7,000kN. Here, steel I-beams have been used as part of the permanent reinforcement, with pairs of I-beams joined top and bottom with diaphragm plates.

These pairs of beams weigh up to 90t each, and span up to 35m. They sit on specially designed bearings supplied by Freysinet that weigh up to 35t and are capable of handling the uplift and the rotation that could be caused by such heavy point loads. Once the beams were in place, the diaphragm plates were welded in situ, the voids between the plates were filled with grout and then reinforcement cages placed in and around the beams to tie them into the podium slab before the concrete was poured. In all, there is 1,000t of structural steelwork in the new station, most of it in these massive beams.

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Guy Anstiss, BBCIV
Catalyst: The station at Dalston Junction is expected to trigger regeneration

“Wanted 750mm diameter piles, but when we decided to keep the bridge, the question was ‘how do we get the rigs in?’” says Anstiss. “Then we had to grout under pressure to replace the bentonite, and at the same time install the 1.8m long reinforcement cages.”

Now that Dalston Junction station is complete, much of the massive civil engineering work required for the station to open was completed.

“Tight spot: Hoxton station was snugly fitted under Kingsland viaduct”

“We established a truck route out of the Bishopsgate Goods Yard using a Bailey bridge”

The new station at Hoxton is built inside an existing set of rail arches, with the concourse constructed by punching through the brick piers.

To create this space, ground engineering specialist Barry first installed low headroom mini-piles either side of each existing pier, and the beam was cantilevered on top. Holes were then drilled through the brickwork, and needle beams threaded through the top of the pier, and jacked off the ground beam to support the arch roof while the material below was removed to form the required space.

New columns and a lintel beam were then grouted in place to form a portal frame within the pier.
DALSTON & NORTHERN STRUCTURES

EAST LONDON LINE: DALSTON & NORTHERN STRUCTURES

Shoreditch Station was sited. This was where the original side, swinging around towards part of the cutting which reshaping the gradient and shape” says Swift. Giving them a slightly arched the depth varies at centre span of mainly 6m high columns above ground.

The new Shoreditch station is set in the length of the old goods yard, along much of a new viaduct which carries the track through the yard space and out across Brick Lane. This Bishopsgate viaduct carries the line off a new concrete elevated way, some 50m or so above ground.

The viaduct comprises pairs of mainly 6m high columns which are mainly circular or elliptical in cross section. They carry a large 3m deep edge beam on either side. “In fact the depth varies at centre span giving them a slightly arched shape” says Swift. The beams form the platforms and are connected by a concrete slab which forms the deep trackwork trough between them. Span between are 21m to 23m long apart from an extra long 34m span across the street at the station entrance.

Concerting for these beams was reasonably complicated since they required a mass of heavy 840 bar reinforcement, up to five layers thick, which meant care was needed in placing the concrete. “We used limpet vibrators on the formwork which gave us issues of noise and vibration to manage, since this is a busy area with a lot of residential property around,” says Swift.

Clusters of five bored piles support each end of a series of single pile caps at wide as the viaduct on which sit each pair of the columns that support the viaduct above. One cluster was bored very close to London Underground Central Line tunnels and monitoring equipment was set up to give early warning of possible distress. Fortunately there was none. Piles are as much as 30m deep under the station section and around 22m deep elsewhere. They were driven into London clay on which much of the site rests. “The clay rises from the Brick Lane end somewhat as you approach Shoreditch,” says Swift. There is trenched gravel beneath and for the longer piles that meant using a “wet pile” system to bore them, with polymer support, into water saturated gravel.

Piles were “substantial” says Swift, between 1.2moom and 1.5m diameter. The larger diameter was used to achieve a shorter pile in a few places, allowing the pile end to remain in clay and avoiding the need for the polymer. Bachey Solerancho was subcontractor for the piling.

The longer piles carry the heavier loads in the central part of the viaduct where the 200m length of the new Shoreditch station is located. The entire station at rail level is enclosed in a precast concrete box, creating a kind of “funnel in the air”. The box tube comes in two widths, 2m high panels are bolted to each side of these before an insitu top deck is formed and poured. There were challenges on the longer GE19 bridge to the east of the station site. This was fabricated and assembled by Fairfield Mabey. The assembly of the Warren truss bridge which carries the new railway on a 85m span over the six Liverpool Street main lines, went well. It was fully assembled on temporary falsework on the track alignment in the space which became the approach ramp, and push launched into place.

It was powered over using a multi-axle transporter provided by Abnormal Load Equipment” says Swift. A 3000 long nose section was added for the launching at the front end and the ALE transporter sat at the rear end. “It was a balancing exercise to keep the nose up” says Swift, “so we concentrated the back end deck and added more weight, leaving the front deck to be done later. The launching was done with the strand jacks between the permanent concrete abutments being used as the launch fulcrum, and the ALE transporter at the rear end.”

West of Shoreditch Station, the line crosses Shoreditch High Street on a 35m span bowstring arch bridge fabricated by Fairfield Mabey partly within the Bishopsgate Goodsyard site. There, the firm welded the curving steel beams to form the bow and set the vertical hangers. A critical part of the job was a major crane lift for the completed 350t bowstring arch bridge, using the 1,200t Sarens crane on a May weekend in 2008.

“The lift only took a couple of hours but 12 months of preparation were needed beforehand” says Swift, not least because the busy crane is much sought after. “We also had to coordinate all the emergency services, local authorities, and others for a road closure,” Swift adds. The site needed proper preparation for the crane which arrived on some forty trucks and took several days to assemble. Ground had to be properly cleared, and an area piled to support the crane. The viaduct continues west of Shoreditch High Street with the Holywell viaduct, curving sharply to take the line back across the street as it links north to the existing Victorian brick viaduct further on. Five 20m spans were needed, built close alongside a listed and untouched building on Shoreditch High Street, running within 350m of it at one point.

This part of the work was preceded by significant archaeological investigation within the Holywell Yard. The Museum of London was delighted by the discovery of the remains of an old monastery, including footings and columns, various burial sites, plates and knives.

“The station enclosure is really a permanent crash deck to keep trains running while work is done later by the developer” Andy Swift, BBCIV

“GE19: The bridge was launched over using a multi-axle transporter. It was a balancing exercise to keep the nose up” Andy Swift, BBCIV

Shoreditch High Street: A 35m span bow arch bridge is lifted into place

New link: The line runs on a mixture of new and refurbished viaduct from Dalston to Shoreditch
Negotiating existing tunnels, contracts and Victorian structures was all in a day’s work for the East London Line team as it worked to construct and renovate the railway. This section of the project also involved work to ensure the new structures did not interfere with planned works for the Crossrail line which crosses the route. Adrian Greeman reports.

**Tunnels & Tracks**

The biggest civil engineering challenges were at Whitechapel and Wapping as part of the need to provide the under-ground stations with secondary means of escape (SMIs).

**Whitechapel**

At Whitechapel, a relatively simple steel truss bridge sufficed for the SME, with lattice towers on the platforms and steel staircases to link to an emergency street level exit. But on either side of the Whitechapel Station, two large excavations will be required for the planned Crossrail station which will sit above the Crossrail tunnels but below the ELL. The two subterranean Crossrail concourses will be linked by a pedestrian underpass beneath the ELL tracks, and it made sense to build the under rail structural elements during the ELL works. The ELL team also found itself involved in some other advance works for the Crossrail team. Crossrail has almost no space to find space it has prepared for a major bridging structure to be built over a 70m length of the Whitechapel cutting.

This “crash deck” work platform will need to support major equipment and heavy plant and demands correspondingly hefty foundations, explains BBCJV engineering manager for central and southern sections Andy Bradshaw. “The struts date from the days when steam trains ran on this section of the line,” says Bradshaw. It dates from 1830, when the ELL was opened as the London and Blackwall Railway (L&BR), and continued to work until early in the 20th century. The ELL team installed for Crossrail the new platform, and a spiral staircase but at the other end there was no obvious second escape route. “We used hefty 460mm diameter tubular steel struts as temporary support until the piles were cast,” says Bradshaw. “The struts were later reused for excavation support elsewhere on the project.” Circular voids had to be left in the piles for later sinking of the piles needed to support the Crossrail work platform.

To avoid the need for a new grade crossing over the Old Kent Road, the Crossrail team planned to avoid building an under rail structural element. Two contiguous piled walls some 5m apart across the tracks were also cast to form the walls of the future Crossrail station connecting passage. A thickened section of the track bed makes a roof slab for this pedestrian tunnel which will be excavated, when needed by Crossrail, without disrupting the ELL.

The cost of “several millions” has been met by the Crossrail project. Wapping At Wapping station the main entrance uses the Brunel tunnel shaft to accommodate two lifts and a spiral staircase but the other end there was no obvious second escape route. “There was a brick lined smoke shaft however, about 1m across” says Bradshaw. It dates from the days when steam trains ran underground which they did until early in the 20th century. Either side of this 16m deep vent, it was decided to sink shafts in which steel staircases could be built, linked to the platforms by cross passages at the base that were created by breaking through the thinner infills between the retaining wall buttresses. The original plan to form a rectangular box shaft with big 1100mm secant piles did not work within the overall construction programme. A value engi...
Excavation through what had been thought to be London Clay instead turned out to be rotten timbers, possibly from some long-forgotten wharf.

**NEW CROSS GATE DEPOT**

The new ELL depot sits on old sidings which for some years had become a local authority site for impounded cars. Says Mark Walker of BBCJV who supervised the depot construction: "The depot is dominated by the four-track, four-crate, four-train rolling stock maintenance facility and its three stores of offices all housed in a huge 90m by 40m by 12m high rectangular steel framed steel clad building. Inside the depot are three raised tracks enabling clear access below the trains. The fourth track is equipped with synchronized jacks capable of lifting a whole train in one minute for the purpose of bogie changing.

Another 90m building, split longitudinally into two, has one track dedicated to a twin-headed wagon and a second in the other half committed to heavy cleaning and painting. It also has a blast and fire proofed top floor dedicated to an operational control and signaling centre which allows signals 10 minutes notice of any track or rail system in the event of a fire."

Renewing bridges, providing for connections to the mainline and future London Overground connections and a flyover at New Cross were big challenges.

**NEW CIVIL ENGINEER | 27.05.10 | www.nce.co.uk**
The most complex part of the operation to build the four track crossing was placing the main 1,200t Warren truss for the 75m span. “Fortunately there was some unused Network Rail land alongside the mainline tracks where our subcontractor Fairfield Mabey could assemble the bridge,” says Bradshaw.

To get it into position needed a 56 hour possession, booked long in advance.

“We used multi-axle self-powered transporter units for the move. The truss was jacked at finished height onto trestles on the back of the transporter units and then moved southwards some 60m. Then one end of the truss was slewed across in a 60m long arc while the south end took a shorter 20m long path” says Bradshaw.

The construction yard embankment area was previously surfaced with a 300mm thick layer of recycled demolition aggregate to improve its load bearing capacity for the move.

To prepare the four mainline tracks for the heavy loadings of the bridge and its transporter units, various bespoke level crossing options were considered. But they would have been expensive, not only because a lot would have been needed but they would have had to be tailored to fit irregular track and sleeper spacings.

Instead, a simpler solution was found. By removing the third rails that provide traction power for trains in Network Rail’s Southern Region and protecting the running rails with steel channel sections, it was possible to build up a load bearing platform using conventional ballast. This meant it was unnecessary to keep the temporary fill and the existing line ballast separate. Any surplus would simply form part of the railway afterwards.

“Big move: Four multi-axle transporters move the 1,200t Warren truss for the New Cross Gate flyover into position”

“Covering up: Temporary fill cover the track during the flyover move”

“Sound solution: Rubber “boots” under the track damp down vibration”

“Truss: Last minute adjustments”

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“On the new viaducts and in the tunnel, the East London Line sees the first application of the Sonneville boot system of slab track.

For new viaducts and tunnels, slab track was installed, using the Sonneville system of concrete blocks to support either end of the sleeper, all embedded in a concrete slab. Each independent block sits on a neoprene pad inside a rubber “boot” which dampens vibrations; and the blocks can be extracted and the boot renewed easily when necessary. Noise suppression was the key factor on viaducts particularly as they run through crowded areas of the city, but reduced maintenance was the prime reason for the choice in the tunnels, where only night-time access is possible.

“We had two variants of slab, the basic one and in some places the mass spring system,” says BBCJV’s Steve Bradley who was track construction manager for three years of the project. The difference lies in the concrete surround for the blocks. Mostly this is just mass concrete poured around the booted blocks that are carefully positioned by hanging them from the precisely positioned rails that have been placed inside a basic concrete trough. But for additional noise suppression on viaducts, the trough is lined with an additional absorbent membrane and the concrete track slab poured around it has to be reinforced to handle the additional movement created by the addition of the membrane.

The boot system is complex to install, since each sleeper end is independent and must be accurate for rail inclination, gradient, gauge, alignment and more, before fixing in concrete. It is the first application in the UK. Drivers have already informally declared the line the smoothest they have experienced.

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