JOINED UP LINKING
SCOTLAND'S BIGGEST ROAD SCHEME OPENED EIGHT MONTHS EARLY THIS MONTH, COMPLETING THE GLASGOW MOTORWAY BOX
Scotland’s biggest single road scheme opened on Tuesday this week, a heroic eight months early. The new 8km section of M74 completes the Glasgow motorway box connecting the M8 in the south west of the city to the existing M74 motorway in the south east. This special NCE report tells the project’s story.

Making Glasgow miles better

Introduction
By Jackie Whitelaw

Drivers in Glasgow should be feeling immediate benefits from the opening this week of the new section of M74 — the missing piece in the city’s motorway network.

The new road capacity and route options created by its construction should help relieve traffic jams on Glasgow’s roads, including the notorious Kingston bridge, which has for the last few years had the dubious honour of being the most congested crossing in the whole of the UK. And the promise is that this 8km long section of road, added to other planned public transport improvements, will transform travel in and through the city for the next 20 years, as well as launching the regeneration of old industrial land only 10 minutes from the city centre.

The £692M scheme has been funded by Transport Scotland, Glasgow City Council, South Lanarkshire and Renfrewshire Councils on an 88%/9%/2%/1% split. Its contractor is the Interlink M74 joint venture, a combination of four of the biggest businesses in Scottish construction — Morrison Construction, Balfour Beatty, Morgan Sindall and Sir Robert McAlpine.

Completion of the inner city motorway through contaminated former industrial land and alongside the West Coast Main Line railway, including a viaduct launch over the main line and a bridge lift using Europe’s largest mobile crane, would always be an achievement to celebrate. The fact that the project has come in eight months early and under budget is even more remarkable.

“This has been a fantastic job,” says Transport Scotland director of major transport infrastructure Ainslie McLaughlin. “It is a huge achievement for the whole team and a major testament to the abilities of the joint venture, which tackled some significant challenges so efficiently.”

Glasgow City Council head of M74 and engineer for the contract Ian Bruce, who has managed project delivery on behalf of the client partners, adds: “This project is essential for the economic vitality of the west of Scotland and the regeneration of the area services by the new route. The partnership working...
between all stakeholders throughout its delivery has been exemplary.”

Though construction went quickly, getting the job started was not quite so swift. Planning for the road began 46 years ago as part of the Highways Plan for Glasgow, when an extensive motorway network in the city was envisaged.

“There was a major review in the 1970s and a lot of the network was dropped, but there was always the intention to have a south link,” says engineer’s representative Steve McFadden, of Glasgow City Council.

“The oil crisis and changes in planning and transport policies meant that by the late 80s there were yet more revisions, particularly to the route. We picked one that would avoid residential areas and follow the West Coast Main Line through an old industrial area that was already falling into dereliction.”

Planning permission was secured in 1995, but a year later plans for the road came to a halt when the Scottish Executive, which took on responsibility for the Glasgow motorways, decided the scheme was not a priority, and that local authorities would have to fund it.

The authorities drew breath and submitted a revised scheme to the major national roads review of 1998 but it was again returned to the councils to fund.

Meanwhile, of course, congestion was building on the other routes, all of which had been designed with the expectation that the south link would be carrying some of the traffic. Gridlock at morning and evening peak rose to three hours each, and travel horror stories were starting to damage opportunities for economic growth in Glasgow and the neighbouring districts of Renfrewshire and South Lanarkshire.

The councils had another go at getting the go-ahead for the link, building the business case for economic regeneration. “Old businesses and industries along the route were disappearing, and derelict land was not being developed and was inaccessible. It was an area of high unemployment and ranked as one of the most deprived areas in the UK. Yet in 10 minutes you could be in the city centre,” says McFadden.

A fast link through the area with four junctions would open up the south side of Glasgow to development, improve access to the airport and at the same time free space on local roads that could be used to improve local transport and cycling options, he explains.

The regeneration argument won the day, and in 2001 the Scottish Executive agreed to take the route forward in partnership with the councils through Transport Scotland.

“We had a bit of a celebration then,” says McFadden, who has himself been working on promoting the road since the 1990s. “But then we had to deliver!

“When we signed the memorandum of understanding we had an ambitious programme that said the motorway would be open in 2008. The main milestone was to publish the statutory orders by March 2003, and we hit that. But then the problems started.

“The public inquiry took six months between 2003 and 2004,” he adds. “The main objectors were businesses along the route, but the business relocation team had identified who they were and new sites for them to move to. In the end we relocated over 95% of the businesses and almost all the jobs. BOC went 3km up the road for instance, others just 400m.”

That left Jam74 – a combination of pressure groups including Friends of the Earth Scotland – as the motorway’s opponent.

The Reporter at the end of the inquiry recommended against the scheme going ahead. But Scottish Ministers overturned his decision, disagreeing with the Reporter on the economic benefits of the scheme, and in March 2005 the M74 extension was given the go-ahead.

Two days later Friends of the Earth (FoE) put in an appeal. That had to be heard by the Court of Session, with the earliest date for a hearing July 2006.

After a wait of 15 months the M74 proponents saw FoE abandon its appeal on the second day of the case. Procurement could finally begin with Glasgow City Council acting as
Employer and providing the site supervision team.

"In hindsight that 15 month delay had a benefit because it gave us more time to relocate businesses, so when the contractor hit the ground there was a clear site for them," Bruce says.

The decision was taken to let the project as a single contract, and that drove the creation of a joint venture, explains Interlink project director David Welsh:

"The M74 is the largest civil engineering project of its generation. In terms of a single company being equipped to deliver, it was too much of a demand. The procurement arrangements have an extreme risk transfer and on top of that the job was hugely technically demanding. In terms of risk management it was best to share.

"We needed around 200 people to run the job and for one regional contractor to do that on its own would be too much. What would you do with people when the job finished?" he adds.

The risk transfer was detailed in a lump sum fixed price, not remeasured, design and build contract bespoke to Transport Scotland but based on the ICE 5th edition.

"The risk of unforeseen ground conditions was with us, and if we needed more land for the permanent works we had to go and get it and transfer it to the client; and every square metre had previous industrial use and contamination," Welsh says.

"Each of the four contractors was experienced with that and we knew how to price the risk."

From the client’s point of view, McFadden says: "We know we pay for that risk transfer but we get certainty of out-turn costs."

The client de-risked the job as much as possible – doing detailed site investigation and providing as much information as possible during the competitive dialogue, the chosen procurement method.

There was just the one bidder. In 2006 the construction industry had plenty of work, and Interlink was the only JV willing to man up for the job.

To test the pricing, the client commissioned an independent shadow bid. Interlink's bid was deemed good value for money and the construction contract was signed in March 2008 with serious construction starting in the August.

The completion date set under the contract was February 2012, but Interlink was always aiming to finish ahead of time. "We priced the job on a target end of August 2011," Welsh says.

And by opening in June the JV has even beaten its own stretching targets. "There were substantial overhead savings if we finished the project earlier," Welsh explains.

Now the motorway is open, Glasgow will see pollution levels fall as road congestion eases, McFadden promises.

"But economic regeneration is the big benefit," he says. Urban regeneration company Clyde Gateway has been set up to maximise opportunities from completion of the M74 missing link. It has a 20-year programme to deliver £1.5bn of private investment, 400,000m² of business space, 21,000 jobs and 10,000 new homes.

Deals are already being done. A business park is under construction at Fullarton Road; a planning application has been made for a retail site at Cambuslang; there are applications in for other sites; and masterplans are being prepared for developing adjacent areas.

"The M74 is a huge shop window for what the industry can do," says an enthusiastic McLaughlin. "We hear a lot about what goes wrong with big infrastructure, but what we can show here is that with the right team and expertise, we can deliver."
How to forge a winning crew

The M74 team
By Jackie Whitelaw

How do you turn staff from four separate contractors into a team? That was the important job facing Interlink project director David Welsh if he wanted to bring the huge, eye-catching M74 scheme in early and at a profit.

Fortunately, Welsh is highly experienced at pulling joint ventures together. He is a senior project director at Interlink partner Sir Robert McAlpine, and was called in to the post on the M74 because he had a vast amount of knowledge to share from his experience of being project manager or project director on eight major JV schemes around the UK. These included most of Scotland’s recent major road projects: the M77 southern orbital, the M6/M74, Luss bypass at Loch Lomond, the M74 Abington to Evanloot and the M8/M9 connection at Newbridge.

“I was a known face to the client,” he says with a smile, “but those joint ventures operated with varying degrees of success, so I arrived here with an awareness of the impact conflicting desires within the joint venture, and the client, could have on the success of the project.

“Really, really important was to establish an Interlink identity and for everyone to embrace it,” he adds. “The key was to have a fair distribution of representatives from each of the partners on the management board so everyone was in the know and information was accessible to all.

“And then there needed to be an even distribution of staff from each of the contractors on each of the main construction groups. If you have too many people from one company on structures or earthworks, for example, it becomes contractor A’s job and erodes the Interlink identity.

“We spent time, money and energy on creating the right mix, and held workshops to bring people together. We can only speculate whether if we had done less we would have got as far as we have done. The important thing was to deliver the M74 job. Rather go heavy on the number of workshops at the start than see things go wrong later.”

While a joint identity was vital to prevent any infighting in the JV, a bit of competition between different parts of the project was no bad thing. Welsh split the motorway’s construction into two teams under Graham Dickie in the east and Ian Reid in the west. “They were used to working sizeable jobs on their own, so we needed to give them their own patch,” he explains.

The two men were responsible for everything required to get their part of the road built, including, health and safety, commercial management, programme, environmental management and quality. The teams were supported by project-wide functions: Scott Chalmers as contractors lead, Derek Chambers as corporate social responsibility (CSR) and engineering director and Roger Reid on third party client liaison.

But as east and west teams battled it out to be the best at everything, Welsh made sure that good ideas were shared at management meetings.

From his previous experience Welsh knew the pitfalls to avoid. “One was the risk of cliques being formed or one part of the job belonging to one partner rather than Interlink,” he says. “Another thing to watch for is any subcontract arrangements one party in a JV might have. There is potential for a competing agenda.

“I was extremely keen in this joint venture that we try not to subcontract directly with JV partner companies. On a big job like this we obviously had to, but we were alert, managed the process and dealt with things in a proper subcontract manner. Otherwise there is always the risk of a misalignment of objectives.”

Welsh says good, honest, open collaboration at all levels makes joint ventures work well, as does confronting any issues early rather than allowing them to fester. On the M74 these approaches worked not just for Interlink but for the client and third parties as well.

“It is important to bring contractors, client and third parties together, in the workshops and on site, talking directly so misunderstandings can be resolved,” Welsh says. “At the start we had a road map of issue resolution which started at the bottom level and then, if it couldn’t be resolved, it passed to a project review board.”

“There were 133 utility diversions on this scheme. All the relevant stakeholders were in the team. All the diversions were delivered to programme. We got everyone involved so they felt part of the success of the M74 rather than an obstruction to it.”

Glasgow City Council’s decision to bring Network Rail into the team given the critical nature of bridge launches over its tracks and all the work going on alongside them was also vital. Likewise, the client was thinking “it’s not the contractor’s problem, it’s our problem” when any issues arose.

“One of the things I have attempted to do is get the contractor’s deliverables – like value and programme, and the client’s deliverables – like local employment, to have the same priority for everyone. I am not sure that in general we contractors do that,” says Welsh. “The eye opener has been the payback. The client did not divorce itself from the job, and for a relatively modest investment we have had a huge contribution back from the client team.”
A short link that solves a big problem

Design and Construction
By Margo Cole

The 8km route of the M74 Completion scheme crosses mainly brownfield and industrial sites, but this is by no means a derelict area: much of the route, especially at the west end, is intertwined with Glasgow’s busy road, rail and underground railway system.

"Overall the biggest challenge of this job is that you’re smack in the middle of a huge city," says Interlink construction manager Allan Scott. "You’re dealing with restricted access points, and there are limitations on the side streets that affect the routes you can take with your materials."

The urban nature of the job affected the design and construction methodology. Although one third of the 8km route is made up of structures, the remainder includes some major cuttings and embankments. "If this was a green field site we would obviously try to have a cut and fill balance," explains Mark Connelly, project manager with the Jacobs/Atkins joint venture, the contractor’s designer. "But that’s not possible, because we would be moving material through an urban area all the time."

With such a constrained and narrow route corridor, scope for value engineering was limited, but a long tender period did allow for some elements to be reconsidered. Major design changes included the Auchenshuggle bridge over the Clyde,…
which was redesigned to avoid construction in the river itself, and the Fullarton underpass, which was changed from a multi-span bridge to two single span structures. Some of the retaining walls in the original design were also taken out by incorporating black bales, a form of residue from colliery spoil that can be used as embankment fill, and gives enough stability to enable the side slopes to be steeper than the standard 1:3 design. There are 14 structures on the length of the new road, with 60% of the route on the west side made up of over and underbridges. On the east side there is a more equal split between structures, roads and earthworks. The structures are described in detail on the following pages.

**M74-M8 Link Bridges**

A key critical path element was to get the new link between the existing M8 and the M74 constructed as early as possible. This consists of two separate structures, one for the eastbound and one for westbound traffic.

The westbound link bridge is a three span structure supported at each end by reinforced concrete abutments and by two pairs of V-shaped reinforced concrete piers. The deck is made up of precast concrete beams and an insitu concrete deck.

Larger and more complex is the eastbound link bridge, which crosses both carriageways of the M8 and Camoustie Street. The four span bridge is supported at each end by reinforced concrete abutments and at three intermediate locations by V-shaped reinforced concrete columns. The superstructure is made up of steel box girder beams with a concrete deck.

“We built an access ramp from the street surfaces onto the central reserve,” says Interlink structures manager John MacArthur. This allowed the contractor to install the bored concrete piles that support the central columns during day shifts, with the motorway running as normal alongside the work site. Only a few night shifts were required to install the piles nearest to the eastbound lane.

Concrete for the pile caps and columns was brought in on the access ramp, so the entire substructure was constructed in one section at a time. The main piles were set in the ground and poured in one day. This consisted of two separate columns; the bigger column was the access ramp, so the entire substructure was built with only minimal disruption to M8 traffic.

Motorway closures were needed to lift in the curved steel bridge beams,
Each built in four sections and welded together. “It was all done in night shifts, and we worked our way across the M8 with a full closure of each carriageway in turn,” explains MacArthur. “In the mornings the motorway reopened and there would be another beam over the road.”

The beams were lifted into position followed by the permanent soffit shutter panels for the deck. “Once they were over and sealed up, we could work over the carriageway,” says MacArthur. “The deck pours were done over the live M8.”

**PORT EGLINTON VIADUCT**

At 750m the Port Eglinton viaduct is the largest structure on the project. It carries the M74 over surface streets and rail lines, including the West Coast Main Line, the Glasgow–Paisley, City Union and Cathcart Circle rail lines, Eglington Street and Pollokshaws Road.

The 12-span bridge has reinforced concrete abutments at each end, and 11 intermediate piers consisting of circular reinforced concrete columns that support steel box girder beams topped with an insitu concrete deck. For much of its length the steel box girders were lifted into position using a 1,200t crane positioned at street level, but a 200m section over the Cathcart Circle, West Coast Main Line and Eglington Street was built by “launching” the assembled bridge sections over the roads and rail lines. Each launch section weighed 4,200t and included the concrete deck above the railways so that no possessions were required for deck construction.

“At an early stage in the design process it was going to be launched, but originally there was going to be an intermediate support,” says Interlink structures manager Keith McLean. “During the bidding process the designers came up with the idea of extending the launch [by 50m], which saved building a permanent support on the side slope of the railway cutting.”

The structure’s piers are between 1,800mm and 2,400mm in diameter, some of which were installed within just a few metres of the subsurface railway lines and required full length casings. The larger piles are needed at the west end of the structure and the 1,800mm and 2,400mm piles were installed at the north end.

“At some stages of the launch it was only supported at two points” says Interlink construction manager, Cleveland Bridge

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**NCE in partnership with Interlink M74 JV**
launch section supports, where the beams are deeper and loads are greater.

Along its length, the beams are all around 5.5m in width but vary in depth from 2.5m to 4.5m depending on the loads being carried. Most of the structure is made up of four lines of box girders, but there are six at the west end, where the main structure links in to slip roads.

“The [5.5m] box girders were too wide to transport as whole boxes, so they were fabricated off site as a complete box, split along the longitudinal centreline for delivery and welded back together on site,” explains Steve Osborne, project manager for steelwork subcontractor Cleveland Bridge. The company fabricated and erected 16,000t of steelwork for the viaduct, of which half went into the two launch sections, each of which carries one carriageway. A further 1,000t of temporary steelwork was needed to assemble and support the beams during the launch, including intermediate props and trestles.

“Supporting the box girders, which are in a position that supports the launch nose as it approached each pier, so that it could sit on top of the temporary support. The launch nose girder was 30m long and weighed 100t,” Osborne adds. “The maximum launch cantilever over the West Coast Main Line was 90m, which produced a 900mm deflection. We had to develop a scheme to take out this deflection so that it could land on a support trestle on the other side of the railway. We thought about using a crane to lift up the nose, but because of the size of the crane needed in the street, it didn’t work logistically.”

Instead, Cleveland Bridge developed the pivot system consisting of two lifting struts that engaged the launch nose on a skew as it arrived at the trestle and then lifted it using the forward launch pulling force, which forced it into the vertical position.

“Most launches are generally straight, but this went round a plan curve which made guiding it a challenge,” says Osborne. “At some stages of the launch it was only supported at two points, so there were some quite heavy loads to cater for in the support system.”

The “launch” involved pulling the structure into position using strand wires anchored at the tail and head through two 418t capacity strand jacks. “One pulls the strand from the tail end while the other releases it to the head,” explains Osborne. “It’s a system that can be controlled very carefully, and can be reversed if necessary. We could move it a millimetre and then stop it.”

The launches were carried out under night-time rail and road possessions. Once the structure was in position it was aligned and levelled with large jacks, the permanent bearings were levelled and grouted, and the structure

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**LOCATOR**

**SCOTLAND**

GLASGOW

River Clyde

M8

M77

M74

River Clyde

M8

M74

44m

44m

90m

8km

14

Single span structure

Number of box girder lines

in length the M74 extension is the final piece of Glasgow’s major road network, linking with the M8

major structures ...

the M74 extension is intertwined with Glasgow’s busy road and rail networks

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was de-jacked onto the permanent bearings.

It took three years in total to complete the Port Eglinton viaduct substructure and superstructure.

**CATHCART ROAD OVERBRIDGE**

The two-span Cathcart Road overbridge, which carries Cathcart Road over the new M74, is the only structure on the route to be built using top down construction.

Services in the existing road were diverted, and a temporary realignment of Cathcart Road was constructed to the east of the existing road. Once traffic has been diverted on to this, reinforced concrete piles were installed to form both the foundations and the piers for the west half of the new bridge.

The in situ deck was cast onto these piles, using the existing ground to support the deck until it gained strength. Traffic was then diverted onto the west half of the deck and the same process followed for the east section.

**POLMADIE ROAD UNDERBRIDGE**

A new four-span bridge carries the M74 over Polmadie Road, while a section of the road below has been widened to create a new “full diamond” motorway junction with on and off slip roads in both directions. The bridge has reinforced concrete abutments, three sets of circular reinforced concrete piers and a deck consisting of prestressed precast concrete beams and an in situ concrete slab.

**GLASGOW ROAD UNDERBRIDGE**

The Glasgow Road underbridge takes both carriageways of the M74 over Glasgow Road. It has three spans, and is supported by reinforced concrete abutments and circular reinforced concrete columns. The deck consists of prestressed precast concrete beams and an in situ reinforced concrete slab.

**RUTHERGLEN STATION UNDERBRIDGE**

Three sets of railway lines converge at Rutherglen station to create a triangle of land bordered on three sides by railway lines. A four-span bridge carries the new M74 over two of these lines, as well as a section of the station platform.

The structure was originally designed as a two-span bridge, but was optioneered at an early stage, and the four-span design won out. “The two-span option would have been pretty unmanageable – we would have been putting in so many temporary foundations,” says McLean.

The bridge is supported at each end by reinforced concrete abutments and has three intermediate concrete piers, two of which are within the triangle. The superstructure consists of steel box girder beams with an in situ concrete deck.

The piers are supported by 30m deep piles, which were redesigned from large diameter auger (LDA) to continuous flight auger (CFA) following the experience of construction at Port Eglinton, where almost the entire length of the LDA bores had to be cased. With many of the 900mm diameter piles for Rutherglen sitting alongside the railway lines, CFA offered a quicker alternative to full casings.

When it came to constructing the piers, the lower sections could be built outside possession, but the upper top sections required possessions as the contractor had to lift shutters into place.

Interlink’s solution to building this complex structure so close to the railway lines was to make use of the 5,000 sq m of space within the triangle itself, installing a temporary at-grade crossing to get access into the triangle, and using the space to fabricate and erect the steel bridge girders.

Two girders were delivered every night while the railway overhead lines were isolated, and parked in the triangle ready to be offloaded during the day shift. “The girders were too wide to transport as whole box girders, so we built each girder as a box in the factory and then split them down their length,” explains Osborne.

The L-shaped halves were offloaded onto assembly stillages, and the bottom flanges welded together to create the 5.5m wide open boxes. Girders could only be delivered in lengths up to a maximum of 32m, but they needed to be up to 60m long for the bridge spans, so not only were the two halves welded together lengthwise, they were also joined end to end.

It took five days to assemble and weld each of the 27 full length box girders.
girders, which were then paired up for
the lifts.
Value engineering resulted in the
permanent pier-top plinths being
re-designed to suit a temporary works
scheme that could support and pre-set
each girder from the concrete column
tops during different erection stages.
For offloading and assembly the
contractor used a 250t crawler crane
with a short 24m boom that could be
positioned to work failsafe during the
daytime without affecting the working
rail lines. A 1,200t crane was used for
all the beam lifts, which were done
under possession continuously over 16
nights.
The geometry of the steel girders is
extremely complex: they are
trapezoidal open top girders that are
curved in both plan and elevation with
the new road pavement has been
laid by a joint venture of tarmac
and Aggregate Industries, and
involved 240,000t of asphalt, of
which about 10% is in the surfacing.
The sub-base is a 200mm deep
cement bound granular material,
which was been grooved to induce
cracking. On top of this are two
asphalt base course layers, 100mm
and 125mm thick respectively, and a
60mm binder course topped with a
35mm layer of thin surfacing. For the
surface course, each contractor laid
its own proprietary thin surfacing
bound with polymer modified
binder from Nynas. The surface
course was laid at the very end of
the job to reduce the risk of damage
from construction equipment. Each
carriageway is 15m wide, made up
of three running lanes and a hard
shoulder; and the surfacing was laid
in four passes with the joints
between them designed to sit under
each lane’s white lines. On top of the
structures the pavement design
varies, but all have a minimum
depth of 120mm, made up of 20mm
red sand carpet, a 65mm binder
course and a 35mm surface course.

“The two-span option
would have been pretty
unmanageable”
Keith McLean,
structures manager, Interlink

Steelwork for the four largest
structures on the route was
supplied, fabricated and erected
by Cleveland Bridge, which was
awarded the subcontract in
November 2008.
All steel for the permanent works
was fabricated at the firm’s
Darlington facility, as was the
2,000t of temporary steelwork.
A total of 21,500t of weathering
grade steel plate was delivered to
the fabrication facility over the
course of a year, with 3,000t
arriving every month at the peak.
Thicknesses ranged from 10mm
to 100mm. In addition, there are
180,000 tension control bolts in the
steelwork, and 300,000
shear studs welded to the top
flanges for the composite decks.
Cleveland Bridge fabricated 245
girders, with each taking between
three and four weeks to fabricate.
Design development and value
engineering were carried out with
the M74’s designer Jacobs/Atkins,
resulting in savings that included
reducing weld sizes, revising
internal frame corner joints,
reorganising internal bracing and
providing a central longitudinal
joint so that wide girders could
be transported and assembled
more easily.

Pavement

The new road pavement has been
laid by a joint venture of Tarmac
and Aggregate Industries, and
involved 240,000t of asphalt, of
which about 10% is in the surfacing.

Cleveland Bridge

NCE in partnership with Interlink M74 JV
pre-cambers, and are rotated to form a cross-fall. The deck consists of GRP permanent formwork and an insitu reinforced concrete slab, which was poured during night-time possessions.

FARMELOAN ROAD UNDERBRIDGE
The three-span Farmeloan Road underbridge carries the M74 over the existing Farmeloan Road. It has reinforced concrete abutments and two sets of circular reinforced concrete columns. The bridge deck is made up of prestressed precast concrete beams and an insitu reinforced concrete slab.

CAMBUSLANG ROAD UNDERBRIDGE
The Cambuslang Road underbridge carries both carriageways of the M74 over the existing Cambuslang Road, and the road beneath the bridge has been widened to build a new “full diamond” motorway junction with on and off slip roads in both directions. The four-span bridge is supported at each end by reinforced concrete abutments and with circular reinforced concrete columns at three intermediate locations. The superstructure consists of prestressed precast concrete beams and a cast insitu concrete deck.

AUCHENSHUGGLE BRIDGE
Auchenshuggle bridge is the only point where the new motorway crosses the River Clyde. Its original design consisted of a three-span structure with abutments set back from the water and two intermediate piers in the river adjacent to the banks, giving it a relatively short centre span and two 50m-long backspans. At tender stage Interlink proposed an alternative single span design that offered considerable benefits — including eliminating the river piers.

“We reduced the total span to 90m, but more significantly we eliminated the requirement to work in the river, which is not something we would do unless really necessary,” says Interlink structures agent Ross Glendinning.

The single span option brought its own challenges: reducing the total span resulted in a far longer river span and heavier deck beams. “The steel is spanning 90m, which is really pushing the design to the stage where it becomes uneconomical,” says Glendinning.

Interlink’s preliminary designs...
assumed the deck could be built using six girders, each weighing around 250t, and the JV believed they could be lifted into position from either side of the river by the 1,200t crane previously used at Rutherglen and Port Eglinton. But detailed design showed that seven beams would be needed, not six, and they would be heavier than first envisaged. The deck was redesigned to include microsila in the slab, making it slightly lighter, but the girders were still weighing in at between 270t and 320t, depending on their length, which varies from 83.3m to 91.5m. Interlink calculated that, to lift loads of this size over the reach required would require a crane with “superlift” – a large counterweight to balance the heavy load. Superlift is stacked on a tray that hangs from the back of the crane, and needs a lot of space on the ground for loading and unloading.

Only one side of the river – the east side – had enough space for this, so the only solution was to find a crane capable of lifting all of the beams from one side. The answer was Europe’s largest mobile crane, which has a capacity of 2,000t and a maximum boom length of 170m.

It arrived on site on 82 articulated trucks, and required a 275t “slave crane” just to piece it together. For the Auchenshuggle lifts it was configured with a 98m long main boom, a 48m back boom and 350t of back ballast, with a 98m long main boom, a 48m back boom and 350t of back ballast, augmented by 900t of superlift when the beams were picked up.

The weathering steel bridge beams arrived from Cleveland Bridge’s Darlington works in five sections, each weighing around 60t. They are open box plate girders with a maximum flange thickness of 70mm. Most were bolted together on site, with the exception of the outer beams, which were welded for aesthetic purposes. The bottom flange of the beams is curved, with a maximum depth at each end of 4.2m.

Over a one week period in June 2010, one beam was lifted into position every 24 hours in a process that began by moving the girder on four self-propelled modular trailers (SPMTs) from its fabrication position by the next survey the health and safety awareness of the plant operators was off the scale, ” says Gardner. “We have set very good standards,” he says.

Big design changes – like the decision to lift in the bridge at Auchenshuggle rather than construct a bridge pier in a river – have helped. But so too have the concerted efforts to impose a highly healthy and safety conscious culture. “[Project director] David Welsh said the aim should be to go away from here as better people than we arrived,” says CSR and engineering director Derek Chambers. “We adopted Ballour Beatty’s “Zero Harm” health and safety strategy, with things like a mandatory glove policy. But we tried to take in the best ideas from all four Interlink contractors and fed those ideas back to the parents too.”

One of the biggest impacts on behaviour was created by an event for all M74 personnel held at Hampden Park, where the company was addressed by former site worker Jason Anker who broke his back in a fall from a 3m high ladder on another project, bringing home to everyone how they could be affected by a simple accident. It had a noticeable effect on behaviours, Gardner says.

Health and safety climate surveys helped highlight where the risks might be. “Our first survey revealed that plant operators were not connected into health and safety. We came up with an action plan that included involving them in more briefings and toolbox talks, and by the next survey the health and safety awareness of the plant operators was off the scale,” says Gardner.

Hand arm vibration syndrome (HAVS) emerged as one of the biggest risks on the job, so the decision was taken to purchase Reactec measuring and monitoring tools. “Everyone wanting to use a jackhammer, breaking tool, scabbler or concrete drill picked up a monitor,” Gardner says.

“They could monitor their own exposure and stop before they were exposed to risk. It cost us around £18,000, but when you think of the damage that can occur from hand arm vibration, and the cost of a single HAVS claim – up to £30,000 – it was money well spent.” Reactec, with Interlink’s support, was awarded a Scottish Construction Centre certificate for Innovation and Best Practice.
Clearing the way forward

Ground Engineering
By Margo Cole

One of the biggest challenges on the project has been dealing with the site’s ground conditions, which include chemical contamination and old mine workings.

Although there is a consistent alluvium stratum running throughout the job, the depth to bedrock varies considerably. Glasgow’s industrial heritage in the area includes iron works, coal mines and clay pits, which have left a legacy of heavy contamination, including chromium from a former chemical works.

Residue from chromium ore processing was historically used to infill clay pits. It is highly toxic and can pose a risk to public health. As the contamination extended to a depth of 15m, Interlink’s strategy was to cap rather than remove it. However, some material was treated on site, at a “soil hospital”, where five full time environmental experts and a specialist subcontractor dealt with 86,000t of contaminants that, along with the ore, were mined from tunnels running throughout the job, with a consistent alluvium stratum running throughout the job.

Maps and drawings from the 19th century helped to identify where the mine workings had been, and the contractor pre-probed to work out the locations of the voids. All the structures on site have piled foundations, and a variety of piling techniques have been used, including precast concrete driven piles, large diameter auger (LDA) piles, segmental cast LDA piles, stone column piling, insitu concrete column piling and continuous flight auger (CFA) piling.

At tender stage the solution was to take the chromium off site, but the only hazardous waste site that could deal with it was in Middlesbrough,” explains Interlink environmental manager John Logan. “So we entered into dialogue with SEPA [Scottish Environment Protection Agency] and devised a method of treating the material and recycling it on site.”

Another legacy of Glasgow’s industrial past was a series of mine workings, mainly in two sections between Cambusbarrang and Fullarton, and between Polmadie and Cathcart, where seams up to 2m thick are prevalent at depths of 30m to 40m below ground. Before the main construction work started, 11 months and £18.9M was spent on these seams with a cement/PFA grout mixture, with subcontractors Consolidated Drilling and Cementation Skanska/Keller drilling more than 800km of bores and installing 57,000t of grout.

“We devised a method of treating the material and recycling it on site”
John Logan, environmental manager, Interlink

As the pozzolans stabilise the leachate potential and work well with the chromium,” explains Logan. Good quality Class 2 fill material was found in local borrow pits, and over 2.5Mt of other fill was imported, much of it from the demolition of the local Hoover factory and Gorbals flats.

Embankments have either 1:2 or 1:3 side slopes, with clay cores and blaes shoulders and geogrid reinforcement at foundation level. Up to 700mm of settlement was expected in underlying ground, which was taken out using band drains and surcharging. The maximum surcharging period was 14 months. At Cambusbarrang modified paper pulp was used in constructing the 300m long embankment’s foundations.

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Driving for a shared goal

Stakeholder Engagement
By Margo Cole

Almost every activity on the M74 construction schedule has had an impact on third parties.

“The corridor follows the existing West Coast Main Line for about two thirds of its length, and eventually crosses it and local suburban lines as well,” says Interlink project consultation and liaison manager Roger Reid. “Also, with the urban setting, you are crossing arterial routes into the city, and all have public utilities in them. You end up with a wide spectrum of interfaces who all have their own interests at heart.”

Rather than seeing this as a problem, however, Reid says it was the “recipe for success” on the project, as a philosophy of integration was adopted, with third parties brought on board at an early stage. “I think the secret was close contact and good communications, which enabled us to develop trust,” says Reid. “When we did have some challenging situations, we all knew each other, which helped when it came to sorting it out.”

Rail interfaces were seen as crucial, as “stopping the West Coast Main Line was one of the worst things that could have happened”, according to Interlink rail proposal manager John Hooper, whose job was to manage the relationship between the construction team and rail operators.

The solution was to have two members of Network Rail’s asset protection team embedded within the M74 project team for two years, paid for by the client. One of them, construction manager Brian Prentice, says: “Our preferred option was to work hand in hand with the contractor on a daily basis, developing methodologies that minimised the risk of disruption to rail operations.”

Prentice says he was welcomed as part of the team, and the contractor was “very open and honest about what they were trying to do”. However, there were still “many challenging debates as to methodology. The team had to sometimes think outside the box when facing either critical intrusive construction activities such as piling works very close to the operational line, or construction methods that I personally had limited experience of, such as the bridge launch.”

Community Relations
Interlink CSR and engineering director Derek Chambers has always understood the importance of engaging local communities with the scheme, with a recent charity fundraising event underlining this fact. Because of the significance of the project and its high media profile, he had special authority to make sure the construction was understood by the community and was sympathetic to their concerns.

Rail interfaces have also been helping drive an agenda of local employment, which resulted in over 70% of the 850 workers who worked on the project at its peak coming from the local area. And through the M74 Employability Partnership 20 young people who have struggled to find local employment were taken on, 12 of whom will complete modern apprenticeships this summer as civil engineering operatives, steel fixers or joiners.

Meanwhile public relations manager Ewen Macdonell has orchestrated exhibitions, leafleted affected communities, responded to helpline queries and taken the story of the project into local schools. “When we started this project not everyone was in favour, and many were apprehensive about the construction,” says Macdonell. “The other day one of our long term objectors came and shook my hand and said he’s decided to reassess his perception of construction projects. That was very rewarding.”

“We all had the same objective: to look after the safety of the travelling public and the workforce.”
Ian Balmer, Interlink

A notorious stumbling block on major projects can be the interface with utility companies carrying out service diversions, but that was also overcome on the M74 through close liaison with the main players.

Interlink utilities manager John Cuthbertson says the company organised monthly meetings with key people from the utility companies. “They bought into the programme and met it,” he adds. “The big driver for me was ensuring the utilities didn’t hold up the programme.”

Cuthbertson and his team challenged every diversion that had been identified, and managed to reorganise work to avoid some. Even so, there were 123 separate service diversions on the project, the longest lasting 16 weeks. There were also 379 different traffic management schemes, all of which had to be agreed with the client, the police and the relevant highway authority, which could be Glasgow City Council, South Lanarkshire Council or Amey. Transport Scotland’s trunk road managing agent.

“Initially it was all about getting to know each other, but ultimately it became team working,” says Interlink traffic management manager and security adviser Ian Balmer. “We all had the same objective: to look after the safety of the travelling public and the workforce.”

Among the traffic management schemes Balmer’s team implemented was a series of overnight closures of the eastbound carriageway of the M8 so bridge beams could be positioned. “The construction team was under pressure to get each of these lifts done in one night, but Amey trusted what we were telling them,” says Balmer.

The trust between the two parties eventually resulted in Amey doing routine maintenance under cover of the M74 possessions, and allowing Interlink to piggy-back on closures they had already planned, reducing the number of carriageway closures.
M74 Completion Key Participants

Clients
Transport Scotland
Glasgow City Council
South Lanarkshire Council
Renfrewshire Council

Appointed Agent
Glasgow City Council

Employer
Glasgow City Council

Main Contractor
Interlink M74 JV
Morrison Construction
Balfour Beatty
Morgan Sindall
Sir Robert McAlpine

Designer (for Interlink M74 JV)
Jacobs Atkins Joint Venture

Design Checker (for Interlink M74 JV)
Halcrow

Road Safety Auditor
Stewart Paton Associates

Key Subcontractors (to Interlink M74 JV)

Structural Steelwork
Cleveland Bridge UK

Surfacing
Tarmac/Aggregate Industries JV

Piling
Bachy Stent JV
Morgan Sindall Piling Ltd

Mineworks Grouting
Cementation/Skanska Keller JV
Consolidate

Vibrostone Columns
Keller Ltd

Landscaping
Land Engineering Ltd

Safety Fencing
George Walker

Concrete Barrier
SIAC

Noise Barriers
Holgate Highways and Infrastructure

Sign Ganties
Britons Fabrication
Merson Signs
Fox Construction

Traffic Management
Contralflow
Central Traffic Management
Soil Treatment
ERS

Road Lighting
Southern Electrical Contracting Ltd

Motorway Communications
Pegasus Power and Communications Ltd

Road Markings
Markon

Traffic Signs
Dee Organ
TRL Signs

Bridge Waterproofing
Stirling Lloyd
Chemcem

Bridge Expansion Joints
USL Ltd
Ekspan

Boundary Fencing
Dartfield Fencing
Lechkin Fencing

Pumping Station
Northern Tunnelling and Ferrier Pumps

Project Design Team (Scheme Development)
Glasgow City Council
Jacobs
SIAS Ltd
Faber Maunsell/Mason Evans
ERM

Awards

Health and Safety
• British Safety Council | International Safety Award 2009
• British Safety Council | International Safety Award 2010
• British Safety Council | International Safety Award 2011
• RoSPA | Gold Award 2011
• Scottish Construction Centre | Demonstration Project Innovation Award for use of HAVS procedures

Environmental
• Chartered Institution of Waste Management | Sustainable Construction and Demolition Project of the Year Award
• Green Apple Award

Sustainability
• CEEQUAL | "Excellent" Standard

Community
• Considerate Constructors | Gold Award

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