

### RAILWAY BRIDGE REFERENCES

CLIENT, COUNTRY	PROJECT	SCOPE OF SERVICES	YEAR (S)
THE BOMBELA CONSORTIUM AND VELA VKE; THE SECTION DETAILED DESIGNER	GAUTRAIN HSR VIADUCT SECTION DESIGN SERVICES	<p>GAUTRAIN IS AN 80 KM DOUBLE TRACK HIGH SPEED RAILWAY SYSTEM IN SOUTH AFRICA THAT WILL LINK PRETORIA STATION AND JOHANNESBURG PARK STATION TO THE OR TAMBO INTERNATIONAL AIRPORT.</p> <p>THE SERVICES INCLUDES PRELIMINARY AND DETAIL DESIGN OF THE FIVE VIADUCTS; PERFORMING SPECIALIZED ROLLING STOCK CALCULATIONS AND PROVIDING CONSULTING SERVICES SUPPORT FOR PRECAST CONCRETE SEGMENTAL CONSTRUCTION.</p> <p>THE PRECAST CONCRETE BOX SEGMENTS ARE ALL 10.1 M WIDE AND 3.5 M DEEP IN CROSS SECTION; AND THE FIVE VIADUCT SPANS AND LENGTHS ARE:</p> <ul style="list-style-type: none"> <li>- V01 5 SPANS, 230 M LONG</li> <li>- V03 13 SPANS, 638 M LONG</li> <li>- V11 5 SPANS, 230 M LONG</li> <li>- V13 10 SPANS, 444 M LONG</li> <li>- V14 15 SPANS, 638 M LONG</li> </ul>	2006-ONGOING
TAIWAN HIGH SPEED RAIL CORPORATION	INDEPENDENT CHECKING ENGINEER AND INDEPENDENT SITE ENGINEER SERVICES	<p>5 HSR DESIGN CONSTRUCT CONTRACTORS USED 9 LAUNCHERS TO CONSTRUCT 138 KM OF VIADUCT BY THE FULL SPAN LAUNCHING METHOD (FSLM). THE PRECAST SPAN LENGTHS WERE EITHER 25 OR 35 M AND WEIGHED BETWEEN 600 AND 900 TONNES.</p> <p>11 HSR DESIGN CONSTRUCT CONTRACTORS BUILT 44 KM OF PRESTRESSED CONCRETE VIADUCTS BY THE FULL SUPPORT METHOD.</p> <p>9 HSR DESIGN CONSTRUCT CONTRACTORS BUILT 75 KM OF PRESTRESSED CONCRETE VIADUCTS BY THE ADVANCING SHORING METHOD.</p> <p>10 HSR DESIGN CONSTRUCT CONTRACTORS BUILT 8.5 KM OF PRESTRESSED CONCRETE VIADUCTS BY THE BALANCED CANTILEVER METHOD.</p>	1999-2007
INDIAN RAILWAYS, INDIA	CHENAB ARCH BRIDGE, INDIAN RAILWAY NETWORK	<p>CHENAB BRIDGE ERECTION USED 26,000 TONS OF STEEL AND WAS THE LARGEST STEEL ARCH BUILT IN INDIA, WITH A 480 M LONG AND 130 M HIGH ARCH SPAN. THE BRIDGE HAS A TWO RIB ARCH; MADE FROM LARGE STEEL TRUSSES; WHILE THE CHORDS ARE SEALED STEEL BOXES, FILLED WITH CONCRETE TO ASSIST IN CONTROLLING WIND INDUCED FORCES.</p> <p>DESIGN SERVICES WERE PROVIDED FOR A SET OF TRAVELLER EQUIPMENT, USED FOR THE ERECTION OF BRIDGE STEEL SEGMENTS WHICH FORM THE SUPERSTRUCTURE PIERS, THE ARCH SPAN AND THE TYPICAL BRIDGE DECK SPANS OF 48 M.</p> <p>THE TRAVELLER EQUIPMENT USED FOR THE ERECTION OF THE STEEL SEGMENTS BEING 34 M IN LENGTH AND 16 M IN HEIGHT.</p>	2005-2006

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KUNG SHI CONTRACTORS, TAIWAN	TAIPEI RAPID TRANSIT SYSTEM, NEIHU LINE	<p>THE NEIHU LINE IS MOSTLY ELEVATED AND COMPRISES OF PRECAST SEGMENTAL BALANCED CANTILEVER VIADUCTS AND 25 M LONG FULL SPAN PRECAST U GIRDERS PLACED SIDE BY SIDE.</p> <p>PRECAST SEGMENTAL EQUIPMENT WAS DESIGNED FOR A 1 KM LENGTH OF VIADUCT. THE SEGMENTS BEING 9.3 M WIDE WITH A VARYING DEPTH OF 3.6 - 1.6 M. THE SERVICES INCLUDED:</p> <ul style="list-style-type: none"> <li>- PRECAST PIER CAP MOULD DESIGN</li> <li>- PRECAST SEGMENTAL MOULD DESIGN</li> <li>- EQUIPMENT DESIGN FOR SEGMENTAL CANTILEVER ERECTION</li> <li>- DESIGN OF THE ERECTION EQUIPMENT FOR THE FULL SPAN PRECAST U GIRDERS</li> </ul>	2004-2006
HOCHTIEF / BALLAST NEDAM / PAN ASIA; JOINT VENTURE	TAIWAN HIGH SPEED RAIL, CONTRACT C 250, DESIGN UNIT 03.04	<p>SERVICES WERE PROVIDED TO THE HBP JOINT VENTURE FOR THE DESIGN OF ONE SET OF 110 M LONG MSS; MOVABLE SCAFFOLDING SYSTEM EQUIPMENT USED FOR THE ADVANCING SHORING METHOD FOR THE CAST IN PLACE CONCRETING OF 18 x 45 M SPANS OVER A TOTAL LENGTH OF 810 M.</p>	2001-2003
HOCHTIEF / BALLAST NEDAM / PAN ASIA; JOINT VENTURE	TAIWAN HIGH SPEED RAIL, CONTRACT C 250, DESIGN UNIT 09.01	<p>SERVICES WERE PROVIDED FOR THE DETAIL DESIGN AND CONSTRUCTION SUPPORT FOR THE 3 SPAN, PRESTRESSED CONCRETE HIGH SPEED RAILWAY BRIDGE IN DU 09.01. THE BRIDGE WAS BUILT BY THE BALANCED CANTILEVER METHOD.</p> <p>SERVICES INCLUDED:</p> <ul style="list-style-type: none"> <li>- PRELIMINARY DESIGN</li> <li>- DETAILED DESIGN</li> <li>- CONTRACTORS CONSULTANT</li> <li>- EQUIPMENT DESIGN</li> </ul>	2001-2003
HOCHTIEF / BALLAST NEDAM / PAN ASIA; JOINT VENTURE	TAIWAN HIGH SPEED RAIL, CONTRACT C 250, DESIGN UNIT 09.05	<p>SERVICES WERE PROVIDED FOR THE DETAILED DESIGN AND CONSTRUCTION SUPPORT FOR THE THREE SPAN PRESTRESSED CONCRETE HIGH SPEED RAIL BRIDGES IN DU 09.05.</p> <p>THE PRESTRESSED CONCRETE BOX GIRDETS WERE DESIGNED TO BE CONSTRUCTED BY THE BALANCED CANTILEVER METHOD.</p> <p>SERVICES INCLUDED:</p> <ul style="list-style-type: none"> <li>- PRELIMINARY DESIGN</li> <li>- DETAILED DESIGN</li> <li>- CONTRACTORS CONSULTANT</li> <li>- EQUIPMENT DESIGN</li> </ul>	2001-2003
HOCHTIEF / BALLAST NEDAM / PAN ASIA; JOINT VENTURE	TAIWAN HIGH SPEED RAIL, CONTRACT C 250, WARREN TRUSS BRIDGE, DESIGN UNIT 12.03	<p>SERVICES WERE PROVIDED TO THE JOINT VENTURE FOR THE PRELIMINARY AND DETAIL DEIGN OF THE HSR WARREN TRUSS STEEL BRIDGE.</p> <p>THE DU 12.03 TRUSS BRIDGE HAD SPANS ARRANGED AS 61 M + 70 M + 60 M AND CONSISTED OF TWO PARALLEL STEEL TRUSSES JOINED BY CROSS BEAMS WITH A CONCRETE, COMPOSITE SLAB AS A BASE FOR THE TRACK.</p>	2001-2003



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HOCHTIEF / BALLAST NEDAM / PAN ASIA; JOINT VENTURE	TAIWAN HIGH SPEED RAIL, CONTRACT C 250, LAUNCHED BRIDGES, DESIGN UNITS 13.02, 13.05 AND 13.08	SERVICES WERE PROVIDED TO THE JOINT VENTURE FOR THE DESIGN AND ERECTION OF 3 OF THE HSR WARREN TRUSS BRIDGES; JUST SOUTH OF TAICHUNG STATION. THE THREE BRIDGES WERE FOR THE MAINLINE RAIL SOUTH AND NORTH BOUND; AND THE BRANCH LINE TO WURIH DEPOT. THE PARALLEL BRIDGES CROSS THE NORTH - SOUTH FREEWAY, THE FAZI RIVER AND PROVINCIAL HIGHWAY NO. 1. EACH BRIDGE CONSISTED OF CONTINUOUS SPANS 150 + 120 + 140 M; 441 M IN LENGTH, AND THE TOTAL WEIGHT FOR ALL THREE OF THE BRIDGES WAS 24,000 TONS.	2001-2003
HOCHTIEF / BALLAST NEDAM / PAN ASIA; JOINT VENTURE	TAIWAN HIGH SPEED RAIL, CONTRACT C 250, DESIGN UNIT 14.05	SERVICES WERE PROVIDED FOR THE DETAIL DESIGN AND THE CONSTRUCTION SUPPORT FOR THE MULTIPLE SPAN, PRESTRESSED CONCRETE HIGH SPEED RAIL BRIDGE IN DU 14.05. THE PRESTRESSED CONCRETE BOX GIRDERS WERE 45 M LONG AND DESIGNED TO BE BUILT BY THE ADVANCING SHORING METHOD OF CONSTRUCTION. SERVICES INCLUDED: PRELIMINARY DESIGN - CONTRACTORS CONSULTANT DETAILED DESIGN - EQUIPMENT DESIGN	2001-2003
HOCHTIEF / BALLAST NEDAM / PAN ASIA; JOINT VENTURE	TAIWAN HIGH SPEED RAIL, CONTRACT C 250, COMPOSITE LAUNCHED BRIDGE, DU 11.01	SERVICES WERE PROVIDED FOR DETAIL DESIGN AND CONSTRUCTION SUPPORT FOR THE 259.8 M LONG AND 8 SPAN COMPOSITE LAUNCHED HIGH SPEED RAIL BRIDGE CROSSING THE FIRST NORTH SOUTH FREEWAY NEAR TAICHUNG. THE COMPOSITE CONCEPT CALLED FOR THE ERECTION METHOD TO LAUNCH THE U SHAPED STEEL TROUGH AND THEN FINALLY CAST A CONCRETE DECK SLAB ON TOP USING A MOVABLE FORM TRAVELLER.	2001-2003
HOCHTIEF / BALLAST NEDAM / PAN ASIA; JOINT VENTURE	TAIWAN HIGH SPEED RAIL, CONTRACT C 250	DESIGN OF TWO OF THE TEMPORARY WORKS STEEL LOADING PLATFORMS TO RECEIVE THE HIGH SPEED RAIL CONCRETE BOX GIRDERS FROM THE TWO PRECAST FACTORIES IN C 250. THE PLATFORMS SERVED AS THE RECEIVING STATIONS FOR THE TRANSPORTATION OF THE CONCRETE BOX GIRDERS FROM THE TWO PRECAST FACTORIES TO THEIR FINAL FULL SPAN POSITIONING AND PLACEMENT AS THE PERMANENT WORKS HIGH SPEED RAIL VIADUCT ALIGNMENT.	2001-2003



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## BRIDGE SERVICES



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CLIENT, COUNTRY	PROJECT	SCOPE OF SERVICES	YEAR (S)
OBAYASHI / FUTSU JOINT VENTURE.	TAIWAN HIGH SPEED RAIL, CONTRACT C 210, WARREN TRUSS STEEL BRIDGE, DESIGN UNIT 08	SERVICES WERE PROVIDED TO THE OF JOINT VENTURE FOR THE PRELIMINARY AND DETAIL DESIGN OF THE 1,800 TON WARREN TRUSS STEEL BRIDGE IN DU 08 TO CROSS A BUSY HIGHWAY IN NORTHERN TAIWAN. THE BRIDGE HAD A SPAN OF 65 M AND CONSISTED OF TWO PARALLEL STEEL TRUSSES JOINED BY CROSS BEAMS; AND UTILIZED A COMPOSITE CONCRETE SLAB FOR THE HIGH SPEED RAIL DECK.	2001-2003
OBAYASHI / FUTSU JOINT VENTURE.	TAIWAN HIGH SPEED RAIL, CONTRACT C 210	SERVICES WERE PROVIDED TO OBAYASHI / FUTSU; FOR THE DESIGN OF TWO SETS OF 88 M LONG MOVABLE SCAFFOLDING EQUIPMENT ON C 210. THE MSS EQUIPMENT WAS USED FOR THE CONSTRUCTION OF 2,580 M OF 40 M FULL SPAN CAST IN PLACE CONCRETE BOX GIRDER UNITS. THE SERVICES ALSO INCLUDED ENGINEERING SUPPORT DURING THE CONSTRUCTION.	2000-2003
OBAYASHI / FUTSU JOINT VENTURE.	TAIWAN HIGH SPEED RAIL, CONTRACT C 215	SERVICES WERE PROVIDED TO OBAYASHI / FUTSU ON C 215 FOR THE DESIGN OF THREE SETS OF 88 M LONG MOVABLE SCAFFOLDING EQUIPMENT. THE MSS EQUIPMENT WAS USED FOR THE CONSTRUCTION OF 40 M FULL SPAN CAST IN PLACE CONCRETE BOX GIRDER UNITS FOR A TOTAL LENGTH OF 7,240 M.	2000-2003
BILFINGER BERGER AND CONTINENTAL ENGINEERING, JOINT VENTURE	TAIWAN HIGH SPEED RAIL, CONTRACT C 260	SERVICES WERE PROVIDED TO PLAN AND DESIGN THE CASTING YARDS FOR SEVERAL INCREMENTALLY LAUNCHED PRESTRESSED CONCRETE BRIDGES ON THE PROJECT. PRESTRESSED CONCRETE BOX GIRDERS WERE DESIGNED TO BE CONSTRUCTED BY THE INCREMENTAL LAUNCHING METHOD. SERVICES WERE PROVIDED TO BACK STONE AS THE SPECIALIST CONSULTANT TO SUPPORT THEIR INCREMENTAL LAUNCHING ACTIVITIES.	2001-2003
TAIWAN HIGH SPEED RAIL	CONTRACT C 250, OVERPASS BRIDGES, DU 04.06 & .07	SERVICES WERE PROVIDED FOR THE DETAILED DESIGN AND CONSTRUCTION SUPPORT FOR TWO OVERPASS ROAD BRIDGES DU 04.06 AND DU 04.07 ACROSS THE TAIWAN HIGH SPEED RAIL ALIGNMENT NEAR TAICHUNG. SERVICES INCLUDED: PRELIMINARY DESIGN - CONTRACTORS CONSULTANT DETAILED DESIGN - EQUIPMENT DESIGN	2001-2003



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EVERGREEN CONSTRUCTION / ITALIAN THAI / PEWC; JOINT VENTURE	TAIWAN HIGH SPEED RAIL, CONTRACT C 295	SERVICES WERE PROVIDED FOR THE DESIGN OF FIFTEEN SETS OF ADVANCING SHORING EQUIPMENT USED FOR THE CONSTRUCTION OF MOST OF THE HIGH SPEED RAIL BRIDGES IN THE DESIGN AND CONSTRUCT CONTRACT C 295. IN ORDER TO MEET THE VERY EXACTING CONSTRUCTION SCHEDULE FOR THE HIGH SPEED RAIL ELEVATED LINE, THE DESIGN OF THE EQUIPMENT WAS BASED ON THE CAPABILITY TO CAST TWO 30 M SPANS AT ONE TIME. THIS ALLOWED THE CONTRACTOR TO ACHIEVE A PRODUCTION RATE OF 2 X 30 M SPANS IN 10 DAYS FOR EACH SET OF EQUIPMENT.	2001-2003
BANGKOK METROPOLITAN ADMINISTRATION, THAILAND	BTS SKY TRAIN MASS TRANSIT SYSTEM	INDEPENDENT CHECKING ENGINEER FOR THE BOT MASS TRANSIT BTS SKYTRAIN IN BANGKOK, THAILAND. THE SYSTEM COMPRISED OF TWO LINES 6.5 KM AND 17 KM IN LENGTH WITH 23 STATIONS. THE LINES WERE ELEVATED ON TWIN PRECAST CONCRETE SEGMENTAL VIADUCT STRUCTURES EACH 23.5 KM LONG. SERVICES WERE PROVIDED FOR DESIGN REVIEW AND CONSTRUCTION REVIEW SERVICES.	1993-2000
STAR TRANSIT KUALA LUMPUR, MALAYSIA	KUALA LUMPUR LIGHT RAIL TRANSIT, MALAYSIA	PROJECT COORDINATION AND DESIGN REVIEW OF THE 24 KM LONG LRT RAILWAY LINE WITH 6.4 KM ON BRIDGES. THE STAR LINE HAD A CAPACITY OF 32,900 PASSENGERS PER HOUR AND DIRECTION.	1992-1996
KUMGANG CONSTRUCTION, KOREA	KOREA HIGH SPEED RAIL VIADUCTS	DESIGN OF THREE SETS OF ADVANCING SHORING EQUIPMENT FOR THIS ELEVATED SECTIONS OF THE KOREA HIGH SPEED RAIL PROJECT. SERVICES ALSO INCLUDED FACTORY INSPECTION, CONSULTING AND CONSTRUCTION SUPERVISION.	1996
POSHR, TAIWAN	HIGH SPEED RAIL VIADUCTS, TAIWAN	OPTIMIZATION STUDY OF STRUCTURES FOR 310 KM TAIWAN HIGH SPEED RAIL PROJECT. TECHNICAL FEASIBILITY STUDY CONSIDERING THE INFRASTRUCTURE, ALTERNATIVES ANALYSIS AND COST EFFICIENCY.	1992-1994
J&S CONTRACTORS, TAIPEI TAIWAN	MIAOLI RAILWAY BRIDGE	BASIC AND DETAILED DESIGN FOR THE TAIWAN RAILWAY ADMINISTRATION BRIDGE 1.5 KM LONG WITH A DECK WIDTH OF 11 M AND WITH A 32 M MAXIMUM SPAN.	1993-1994

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DORTS, TAIWAN	CONTRACT C 206 A, TAMSHUI LINE TRTS, TAIPEI	THE FULL SPAN LAUNCHING METHOD WAS USED ON THE TAIPEI RAPID TRANSIT SYSTEM CONTRACT C 206 A ELEVATED SECTION. EACH FULL SIZE SEGMENT WEIGHED 320 TONS WITH AN OVERALL DECK LENGTH OF 9 KM AND AVERAGE SPAN OF 30 M. SERVICES INCLUDED: - CONSTRUCTION ENGINEERING SUPERVISION - CONSULTANT TO THE CONTRACTOR - PRECASTING YARD LAYOUT DESIGN - ERECTION EQUIPMENT DESIGN	1993-1994
HONG KONG MASS TRANSIT RAILWAY CORP. HONG KONG	LANTAU FIXED CROSSING, HONG KONG	RISK ASSESSMENT AND SAFETY EVALUATION OF RAILWAY TRAFFIC ON THE LANTAU FIXED CROSSING COMPRISING THE TSING MA SUSPENSION BRIDGE (2,160 M), KAP SHUI MUN CABLE STAYED BRIDGE (820 M) AND MA WAN VIADUCT (500 M), COMBINED DOUBLE-DECK HIGHWAY AND RAILWAY BRIDGE. ASSESSMENT OF RAIL MOVEMENT JOINTS WITH MOVEMENTS OF $\pm 835$ MM.	1994
POSHR, TAIWAN	HSR CROSSING OF PROVINCIAL HIGHWAY No.1 AND No.1D, TAIWAN	CONCEPT DESIGN AND FEASIBILITY STUDY FOR THE HIGH SPEED RAIL CROSSING CONSIDERING INFRASTRUCTURE, ALTERNATIVE ANALYSIS, COST EFFICIENCY AND SPECIFICATIONS AND PROCESS MANAGEMENT. WITH A DECK LENGTH OF 460 M, AND A WIDTH 12 M WITH 160 M MAXIMUM SPAN.	1992
EBASCO CTCI CORPORATION, TAIPEI TAIWAN	TAIPEI METROPOLITAN AREA RAPID TRANSIT SYSTEM	TECHNICAL ADVICE TO THE LOCAL ENGINEERING FIRM, AND DESIGN REVIEW OF 3 APPROACH BRIDGES TO THE JOINT DEVELOPMENT HIGH RISE BUILDINGS ABOVE THE TRTS NANKANG LINE DEPOT.	1990-1991

