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STRUCTURAL SYSTEM OVERVIEW

THE GRC FACADE IS SUPPORTED FROM A STEEL STRUCTURAL FRAME THAT WRAPS AROUND THE STATION BUILDINGS. THE FACADE STRUCTURE HAS 'PROWS' TO THE NORTH WEST AND SOUTH EAST OF BUILDINGS A AND C. THESE PROWS HAVE LONG-SPAN CANTILEVERS.

THE STEEL STRUCTURE IS SPLIT BY MOVEMENT JOINTS INTO TWO MAIN STRUCTURAL SYSTEMS. THESE SYSTEMS ARE *BOTTOM-SUPPORTED* (I.E. WITH FOUNDATIONS, GENERALLY AT PROW LOCATIONS) AND *TOP HUNG* (I.E. SUPPORTED VERTICALLY FROM THE CONCRETE SUPERSTRUCTURE). REFER TO DRAWING M-BAR-1F4TS0-CB00-EDR-204001 FOR LOCATIONS OF BOTTOM-SUPPORTED AND TOP HUNG STRUCTURES.

BOTTOM-SUPPORTED STRUCTURE

VERTICAL LOAD PATH

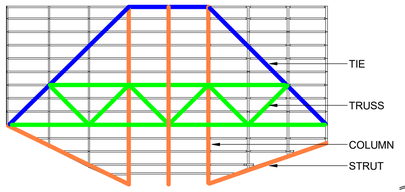
THE BOTTOM-SUPPORTED STRUCTURAL FRAME HAS A CENTRAL TRUSS, SUPPORTED BY COLUMNS IN THE MIDDLE AND BY TIES/ STRUTS AT THE ENDS, TO TRANSFER VERTICAL LOADING FROM THE GRC FACADE TO THE FOUNDATIONS. THE BOTTOM-SUPPORTED STRUCTURE IS INTENDED TO BE A NEAR-BALANCED CANTILEVER SYSTEM. SEE FIGURE, BELOW. ANY OUT-OF-BALANCE LOADS (IN ADDITION TO WIND LOADING) IS TRANSFERRED BACK TO THE CONCRETE SUPERSTRUCTURE VIA PERMANENT PROP TYPES PT-2.

LATERAL STABILITY

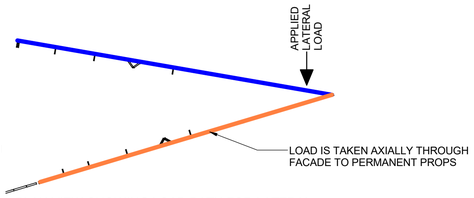
THE STRUCTURE IS SUPPORTED LATERALLY BY A SERIES OF PERMANENT PROPS WHICH CONNECT THE FACADE STRUCTURE BACK INTO THE CONCRETE SUPERSTRUCTURE. THERE ARE 4 MAIN PROP TYPES EACH SERVING A DIFFERENT PURPOSE. THESE PROPS ARE INDICATED ON DRAWING M-BAR-1F4TS0-CB00-EDR-204121. THESE PROPS HAVE SLIDING BEARINGS TO ALLOW THE FACADE SUPPORT STRUCTURE TO MOVE INDEPENDENTLY OF THE CONCRETE SUPERSTRUCTURE AND ALSO TO ALLOW THE FACADE SUPERSTRUCTURE TO MOVE FREELY UNDER THE EXTREME TEMPERATURE CONDITIONS WHICH ARE OUTLINED IN THIS DRAWING.

THE BOTTOM-SUPPORTED STRUCTURE ALSO RELIES ON OUT-OF-PLANE TRIANGULATION AT THE PROWS WHERE TWO BOTTOM SUPPORTED ELEVATIONS MEET. REFER TO THE FIGURE, BELOW.

ALL MEMBERS ARE MOMENT CONNECTED U.N.O. THIS IS TO REDUCE THE EFFECTS OF BUCKLING IN THE MEMBERS.



ELEVATION SHOWING VERTICAL LOAD PATH FOR BOTTOM -SUPPORTED FACADE



PLAN VIEW SHOWING LOAD PATH FOR LATERAL LOADS IN BOTTOM-SUPPORTED STRUCTURE

TOP HUNG STRUCTURE

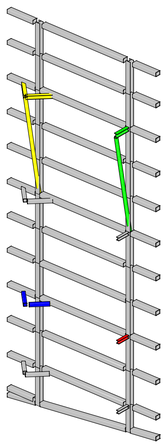
THE TOP-HUNG STRUCTURE IS SUPPORTED VERTICALLY BY PERMANENT PROPS THAT ARE CONNECTED TO PLATES THAT ARE CAST INTO THE CONCRETE SUPERSTRUCTURE. PROP TYPES PT-1 AND PT-2, ALONG WITH MOMENT CONNECTIONS IN THE STEEL FRAME, TRANSFER LATERAL LOADS BACK INTO THE SUPERSTRUCTURE.

PERMANENT PROPS

THE PERMANENT PROPS GENERALLY DO NOT ACT ALONE - THE PT-2 TYPE PROPS RELY ON THE PT-1 CONNECTIONS AT EITHER SIDE TO PROVIDE LATERAL STABILITY TO THE SYSTEM. THIS IS ALSO THE CASE FOR THE PT-3 PROPS WORKING WITH THE PT-1 PROPS ABOVE AND BELOW. THIS WORKS IN CONJUNCTION WITH THE MOMENT CONNECTIONS IN THE MAIN FRAME.

PROP TYPES

LATERAL RESTRAINT ONLY	PT-1
LATERAL & LONGITUDINAL RESTRAINT	PT-2
VERTICAL & LATERAL RESTRAINT	PT-3
VERTICAL LONGITUDINAL & LATERAL RESTRAINT	PT-4



PROP TYPES

TEMPERATURE

THE DESIGN HAS BEEN UNDERTAKEN USING TWO SEPARATE TEMPERATURE RANGES, EACH SERVING A DIFFERENT PURPOSE. THESE ARE OUTLINED BELOW.

SERVICEABILITY CONDITION

THE DRAWINGS SHOW THE STEEL AT A TEMPERATURE OF 27 DEGREES CENTIGRADE. THE SITE TEMPERATURE WILL FLUCTUATE AND THE CONTRACTOR WILL NEED TO ENSURE THAT THE STEEL ERECTION PROCEDURE TAKES ANY CHANGE IN TEMPERATURE - AND HENCE ANY CHANGE IN STEEL LENGTH - INTO ACCOUNT.

LOCKED-IN FORCES CONDITION

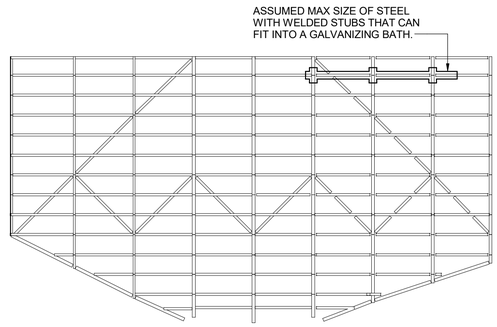
A TEMPERATURE RANGE HAS BEEN DEVELOPED UNDER WHICH THE CONTRACTOR CAN TIGHTEN BOLTS. ANY TEMPERATURE GAINS OR LOSSES ON THE STRUCTURE WHICH OCCUR AFTER THE BOLTS (SPLICES ETC.) HAVE BEEN TIGHTENED WILL RESULT IN LARGE FORCES BEING LOCKED INTO THE STRUCTURE. BECAUSE OF THIS, A RANGE IS GIVEN TO THE CONTRACTOR IN WHICH THE BOLTS MUST BE TIGHTENED - IF THEY ARE TIGHTENED ABOVE OR BELOW THIS RANGE THEN THERE IS A RISK THAT LARGE FORCES WILL BE LOCKED INTO THE STRUCTURE FOR WHICH THE STRUCTURE HAS NOT BEEN DESIGNED.

THE STEEL **TEMPERATURE RANGE AT WHICH BOLTS CAN BE TIGHTENED IS: 20 TO 42 DEGREES CENTIGRADE**.

THE MAXIMUM AND MINIMUM STEEL TEMPERATURES THAT HAVE BEEN DESIGNED FOR, INCLUDING FOR THE CONSTRUCTION STAGE, ARE -2 AND 67 DEGREES CENTIGRADE.

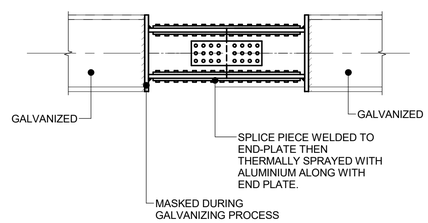
SPLICES

THE DESIGN HAS ASSUMED THAT THE STEELWORK IS DOUBLE-DIP GALVANIZED AND THAT A 20m LONG X 2.6m WELDED SECTION CAN BE GALVANISED IN THIS WAY IN ONE PIECE. THE PROWS ARE SENSITIVE TO BUCKLING AND AS SUCH THE WELDED CONNECTIONS THAT ARE INDICATED ON ARUP DRAWINGS HAVE BEEN DONE TO ENSURE A CONTINUITY OF STIFFNESS IN THE MEMBERS.



SPLICE LOCATIONS ASSUMED IN DESIGN

1 : 400



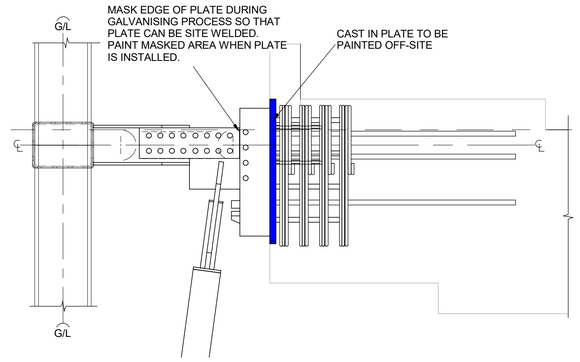
TYPICAL INDICATIVE SPLICE DETAIL A

1 : 20

CORROSION PROTECTION

THE STEELWORK SUPPORTING THE GRC FACADE IS GENERALLY GALVANISED. THE EXCEPTIONS TO THIS ARE: THE CAST-IN-PLATES, WHICH WILL NEED TO BE PAINTED, AND NON-SLIP SPLICE CONNECTIONS, WHICH WILL BE THERMALLY SPRAYED WITH ALUMINIUM. THERMAL ALUMINIUM SPRAY HAS THE SAME SLIP FACTOR AS UNPAINTED STEELWORK, WHICH MEANS THAT THE SPLICES CAN BE KEPT TO A REASONABLE SIZE (GALVANISED STEEL HAS A MUCH LOWER SLIP FACTOR).

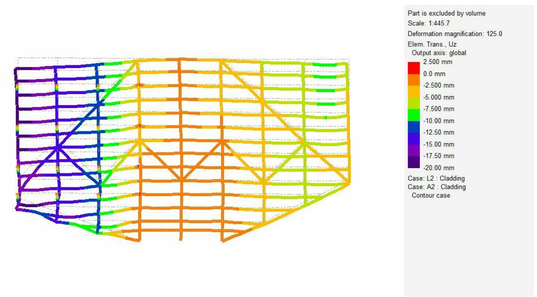
IN THE DESIGN IT HAS BEEN ASSUMED THAT SOME CAST-IN-PLATES MAY NEED TO BE SITE WELDED IN ORDER TO INCREASE TOLERANCE DURING CONSTRUCTION. TO FACILITATE SITE WELDING, IT IS ENVISAGED THAT THE EDGE OF THE BRACKET TAKING THE PERMANENT PROPS WILL BE MASKED DURING THE GALVANISING PROCESS SO THAT IT CAN BE WELDED AND PAINTED ON SITE TO PROVIDE THE NECESSARY CORROSION PROTECTION. REFER TO INDICATIVE FIGURE, BELOW.



STEEL DEFLECTION

THE STEELWORK CONTRACTOR AND CLADDING CONTRACTOR SHALL CONSIDER THE DEFLECTION OF STEEL FRAME DURING THE INSTALLATION OF THE STEELWORK AND GRC CLADDING RESPECTIVELY.

EXAMPLE OF STEEL SELF WEIGHT DEFLECTION (VERTICAL) - NORTH WEST PROW



EXAMPLE OF CLADDING DEFLECTION (VERTICAL) - NORTH WEST PROW

REVISIONS

No	Date	Description	Drawn	Checked	Approved
000	23.03.2018	ISSUED FOR CONSTRUCTION	JDW	EA	JB

PROJECT

قطار الرياض
riyadh metro

CLIENT

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Consortium for Riyadh Metro Project

This drawing has been Approved and Certified as acceptable on behalf of the BACS Consortium.

LEAD DESIGN ENTITY (LDE)	APPROVED BY LDE	DRAWN BY	CHECKED BY	APPROVED BY
	NAME	NAME J. WILLSHIRE	NAME E. ALLSOP	NAME J. BATCHELOR
	DATE	DATE 23.03.2018	DATE 23.03.2018	DATE 23.03.2018

SCALE As indicated

PAPER SIZE A1

DRAWING STATUS ISSUED FOR CONSTRUCTION

CONSULTANT / SUB-CONTRACTOR ARUP

DRAWING TITLE

DEEP UNDERGROUND STATION
LINE 1 - TRANSFER STATION 1F4
STRUCTURE- FACADE SUPPORT
STEELWORK ADDITIONAL DESIGN
AND CONSTRUCTION INFORMATION

DRAWING NUMBER M-BAR-1F4TS0-CB00-EDR-204351

REVISION 000

000v01

(WF-084040) - DCC Iconic Station - 09/04/2018