VSL NEWS

ISSUE TWO 1990

VSL – Adding Value Worldwide

VSL is not only the brand name for the hardware of an excellent post-tensioning system. VSL is much more than that.

The VSL Group is a transnational organization which has simultaneously the ability to meet local customers' needs and to integrate operations to face global challenges. In this way VSL is developing innovative solutions in construction which add value to the whole industry. At the recent FI P Congress in Hamburg, the VSL Group demonstrated its capability and flexibility in a rapidly changing environment.

The topic of our last editorial, "Preparing for a Decade of Opportunity and Change" has been confirmed by reality. 1990 has already created exceptional stimulation and motivation for the VSL Group. The new ultimate shareholder BOUYGUES will bring to our group a spirit of dynamic management methods and leadership, supporting VSL people's belief in challenge as a source of progress. However, BOUYGUES does not at all intend to jeopardize VSL'S relationships, based on mutual trust and partnership, with our long-standing and future clients.

Other obvious signs of change are the new people taking over responsibilities from their experienced and successful predecessors. *Heinz Warkalla*, the head of our affiliated company and licensee, SUSPA of Germany, has retired recently. We are pleased that he will be an adviser of "his" company and the industry in the future. The new executives of SUSPA are *Elmar Conrads* and *Ralf Porzig*. Another well-known personality of our industry, *Rolf Nystrôm*, has also retired and has been followed by *Sten Forstrôm* as head of our Scandinavian licensee ISAB.

A very significant change has taken place within the VSL Group Management. On October 1, 1990, *Peter Marti*, the VSL Group Chief Technical Officer for three years, started as Professor at the Swiss Federal Institute of Technology (ETH) as successor of *Prof. Dr. Bruno Thürlimann*. We are honoured that *Dr. Marti* has been appointed to such an important assignment which will allow him to continue to contribute to the bright future of both, post-tensioning and VSL, with his originality and rich imagination. The new CTO of the VSL Group, *Dr. Hans Rudolf Ganz*, is well prepared for his new assignment and will occupy the position with the same enthusiasm and competence.

This issue of VSL News reflects once more VSL's expanding rote in a changing construction world. A large number of stories concern VSL structural frame redesigns and value-added engineering services, rather than just material supply and installation. The issue also focuses on new developments, like VSL's monostrand concept for external post-tensioning tendons or the new system for improving the earthquake resistance of concrete columns by wrapping them with prestressing wire under tension. Both examples demonstrate challenge turned into progress. Dear reader, if you want to support progress, challenge VSL'S people !

Reto Jenatsch

Chairman of the Board and
Chief Executive Officer

contents

Cover : Construction of the Qurashiyah bridge in Riyadh, Saudi Arabia, represents a confluence of several VSL technologies and services. See story on page 14.
(Cover photo by Kurt Feller, VSL International Ltd., Berne, Switzerland).

From VSL to ETH: Dr. Peter Marti (right) and his successor as VSL's Chief Technical Officer, Dr. Hans Rudolf Ganz.

Dr. Peter Marti : Reflections at a turning-point

There is a bright future for post-tensioning and for VSL.

Admittedly, we are dealing with a mature technology. However, there remains considerable potential for future growth. It depends on us to develop this potential by combining good marketing, state-of-the-art consulting, and impeccable field performance.

A recent world-wide survey reveals pronounced differences in the saturation of individual nations' structural concrete markets by post-tensioning. To a large extent, the wide spread can be explained by differences in local needs, standards, education and habits. However, even in those countries featuring the highest saturation of post-tensioning, a great number of structures, mainly buildings, are conceived, designed and built as non-prestressed, even though post-tensioning would clearly provide a superior solution. Hence, there are ample opportunities to increase the share of post-tensioning.

For too long, non-prestressed and prestressed concrete have been treated as two completely different entities in both standards and education. Fortunately, the unifying view of structural concrete, which considers a continuous range of construction options from non-prestressed to prestressed concrete, is now gaining acceptance and is being introduced into leading standards and textbooks. This trend will assist our attempts to create and maintain a favourable climate for the application of post-tensioning.

While post-tensioning of bridges is commonplace, major expansion opportunities lie in building construction. Apart from floor slabs, several other areas warrant our attention, including : post-tensioning of foundations, transfer beams and plates, and other rarely treated applications such as post-tensioning of precast elements assembled on site and post-tensioning of masonry structures. Furthermore, considering storage and environmental protection needs, there is a considerable demand for tight containers. Finally, there is a rapidly growing market concerning the life extension of concrete structures. In all such projects, involvement and consulting during the conceptual stages should result in more structures being designed and built as post-tensioned.

Clearly, many of the new challenges involve more sophisticated applications of post-tensioning than in the past and require greater expertise and novel technical solutions. Hence, around our own expertise of applying large forces to obtain favourable stress conditions in structures, we must maintain special know-how in concrete, reinforcement and formwork technology as well as construction and erection procedures so that we will remain desirable partners of our clients and their advisers.

Post-tensioning is not a novelty anymore and any mystique about ii has long gone. However, ii represents an essential specialized service to the public, providing challenging opportunities at the forefront of concrete construction. It is a business with considerable potential, and there is indeed a bright future for both post-tensioning and VSL.

After only three and a half years with VSL, ii is non without sadness that 1 am stepping down from my present position to take up my new office at the Federal Institute of Technology (ETH) in Zurich.

It gives me great pleasure to introduce my successor as Chief Technical Officer of the VSL Group : Dr. Hans Rudolf Ganz. Dr. Ganz graduated as a civil engineer from ETH Zurich in 1978 and he obtained his doctorale from the same institution in 1985. He then joined the VSL Group as a structural engineer where he has been involved in a great variety of design and development projects. Dr. Ganz is well prepared for his new position and he heads a motivated and capable team. I convey my best wishes to him, his team and the whole VSL Group, with my sincere thanks to all those who supported me during my tenure. I trust that all the goodwill and assistance that I enjoyed will be extended to Dr. Ganz.

Dr. Peter Marti
VSL In ternational Ltd.,
Berne, Switzerland

VSL's new external post-tensioning system utilizes individually greased and sheathed monostrands for increased corrosion protection and reduced tendon friction.

The VSL monostrand concept for external post-tensioning tendons

The desire for structures with improved corrosion resistance and easier maintenance has led to a renewed interest in external post-tensioning. To address today's requirement, VSL has developed a highly corrosion resistant external tendon which can be inspected, monitored, restressed, and replaced.

The new tendon utilzes individually greased and sheathed VSL Monostrands Which are grouted inside a thick-walled polyethilene tube. The anchorage zones are encapsulated by steel transition pipes and subsequently filled with a special corrosion protection compound. This design provides four effective levels of corrosion protection.

The new monostrand concept also produces tendons with lower friction than ordinary external tendons, allowing more efficient use of the available prestressing.

The development of the system required extensive research and testing. Tests utilizing tendons up to 70m in length were conduceted to evaluate several factors, including : groutability, the behaviour of the outer polyéthylene pipe and monostrand sheathing, the friction losses over the saddles, and the separation of the cement group from the corrosion protection compound in the anchorage zone.

The first application of the system took place in 1990 on the 617m long Bois de Rosset viaduct in Switzerland. Each of the twin superstructures is a composite box girder consisting of steel trough sections and a 13m wide concrete deck. For the longitudinal post-tensioning, the new VSL tendons were installed inside the steel boxes and routed over a maximum of five upper and ten lower deviation saddles. Tendon lengths range from 196m to 216m.

Site measurements at the viaduct confirmed the low friction values of the monostrand tendons. Two tendons are equipped with permanent VSL Load Cells as part of a long term observation and monitoring program to assess the behaviour of the superstructure.

Testing program was performed on tendons up to 70m in length

Peter Buergi
VSL International Ltd.
Berne, Switzerland

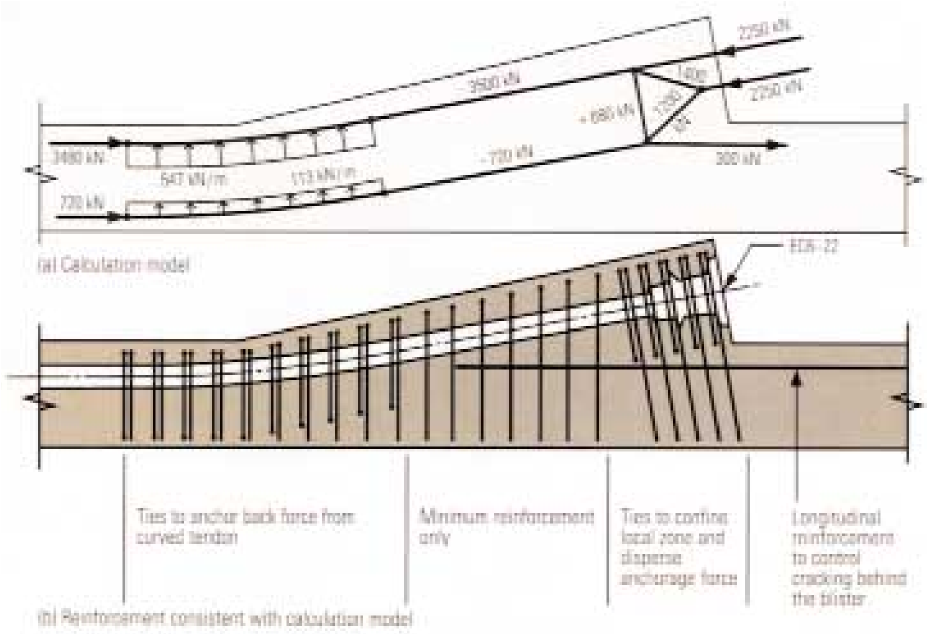
Marcel Grimm
VSL International Ltd.
Lyssach, Switzerland

Solve detailing problems on the drawing board rather than on the site

Where do most difficulties with projects occur? Usually in the details ! This has prompted VSL to prepare " Detailing for Post-tensioning", a new technical report which addresses the all important, but often misunderstood details. The objective is to assist engineers in producing better designs which are easier and more economical to build.

The report discusses all of the forces produced by post-tensioning including those in anchorage zones and regions of tendon curvature. Practical problems not usually found in textbooks are presented along with design examples for various slab anchorages, girder end-blocks, anchorage blisters and tank buttresses.

A portion of the blister design example is shown here to illustrate the contents of the report. For blisters which are used to anchor tendons along the length of a box girder, there are many design approaches available which produce reinforcement requirements differing by more than 100%. In this case, a strut-and-tie model is used to quantify the force flow throughout the entire zone in a consistent manner, thus eliminating the needless superposition of reinforcement to deal with the various actions within the blister.



Simple, consistent calculation model solves blister design problems.

The technical report is generally not code dependent and should be of interest to all VSL system users around the world. The report is in final preparation and will be available in the fall of 1990. Contact your local VSL representative to obtain a copy of "Detailing for Post-tensioning".

David Rogowsky, Ph. D.
VSL International Ltd.
Berne, Switzerland

"Detailing for Post-Tensioning" provides practical solutions to everyday detailing problems.

1. *How do I design the local zone spiral reinforcement for an anchorage?*
2. *When can the spiral be omitted?*
3. *How does an H-anchorage work and how do I include it in the tendon elongation calculation?*
4. *How do I control cracks which might form behind an interior anchorage (anchorage located away from the member end)?*
5. *Do I have to superimpose stirrups and general anchorage zone bursting reinforcement?*
6. *How can I reduce reinforcement congestion?*

European Strobaelt Group verified VSL's blister design model with full-scale testing.

Post-tensioned structural system allowed 2.7 m high cellings and 1200 m^2 of column-free space on each floor.

Post-tensioned beam and slab design provides column-free office space

Opened in June, 1990, the Waterside Office Park in Bundall is a prestigious twin-tower complex development, ideally located on the water frontage of Australia's Gold Coast. The six storey complex contains approximately 14,300m^2 of office space and an additional 8,400m^2 of car park and podium area.

A large part of the development's attraction is provided by the 2.7m high ceilings and column-free floors, with 1200m^2 of open plan space on each level. These features were made possible by an efficient post-tensioned band beam and slab design produced by VSL in conjunction with the Consulting Engineer.

In addition to the structural frame design, VSL furnished ail post-tensioning materials and installation labour for the project. The framing system consisted of 500mm deep beams spanning 12m from the central cores to the perimeter columns. The floor slabs were typically 150mm thick.

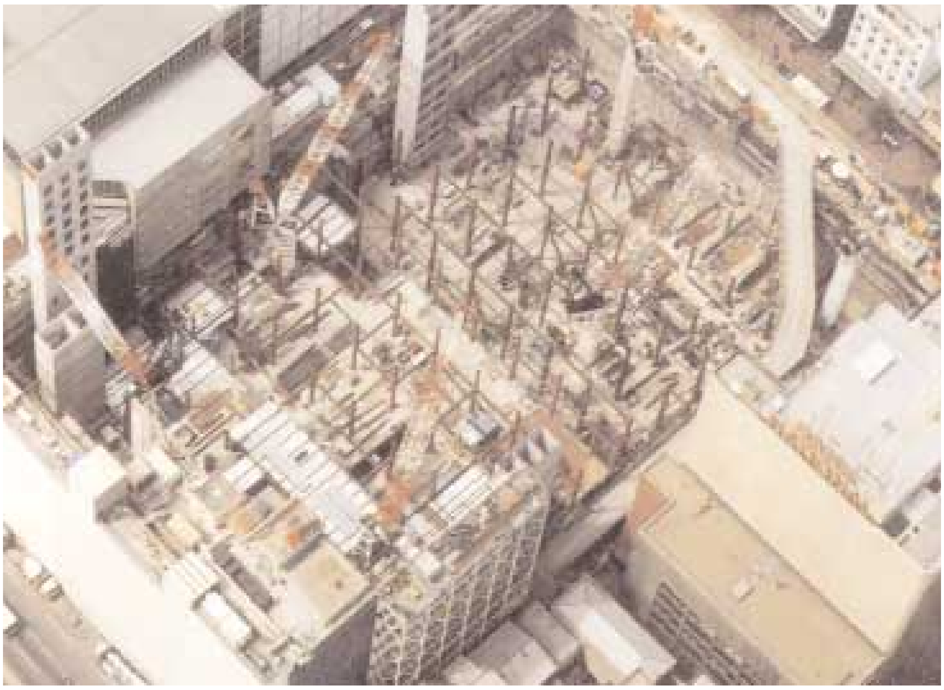
John Davie
VSL Prestressing (Aust.) Pty. Ltd.
Brisbane, Queensland

VSL slab design wins big in Adelaide

At Myer Centre, the largest single property development in Adelaide's history, a VSL floor slab redesign has resulted in major savings in construction time and cost.

VSL'S design and construction contract for the centre's 24,000m^2 underground carpark was based on a post-tensioned, two-way flat plate solution. The large horizontal loads resulting from the deep excavation in local days are transferred from the diaphragm watts into the post-tensioned slabs. The typical slab is based on a 8.8m x 8.8m grid.

12 David J. Pash
VSL Prestressing (Aust.) Pty. Ltd.
Adelaide, South Australia



VSL alternative slab design successfully combined structural steel shear heads with the area's seismic reinforcement requirements.

VSL Climbform will create 34,000m^2 of vertical surface for the 27 storey tower. Post-tensioned slab area exceeds 40,000m^2.

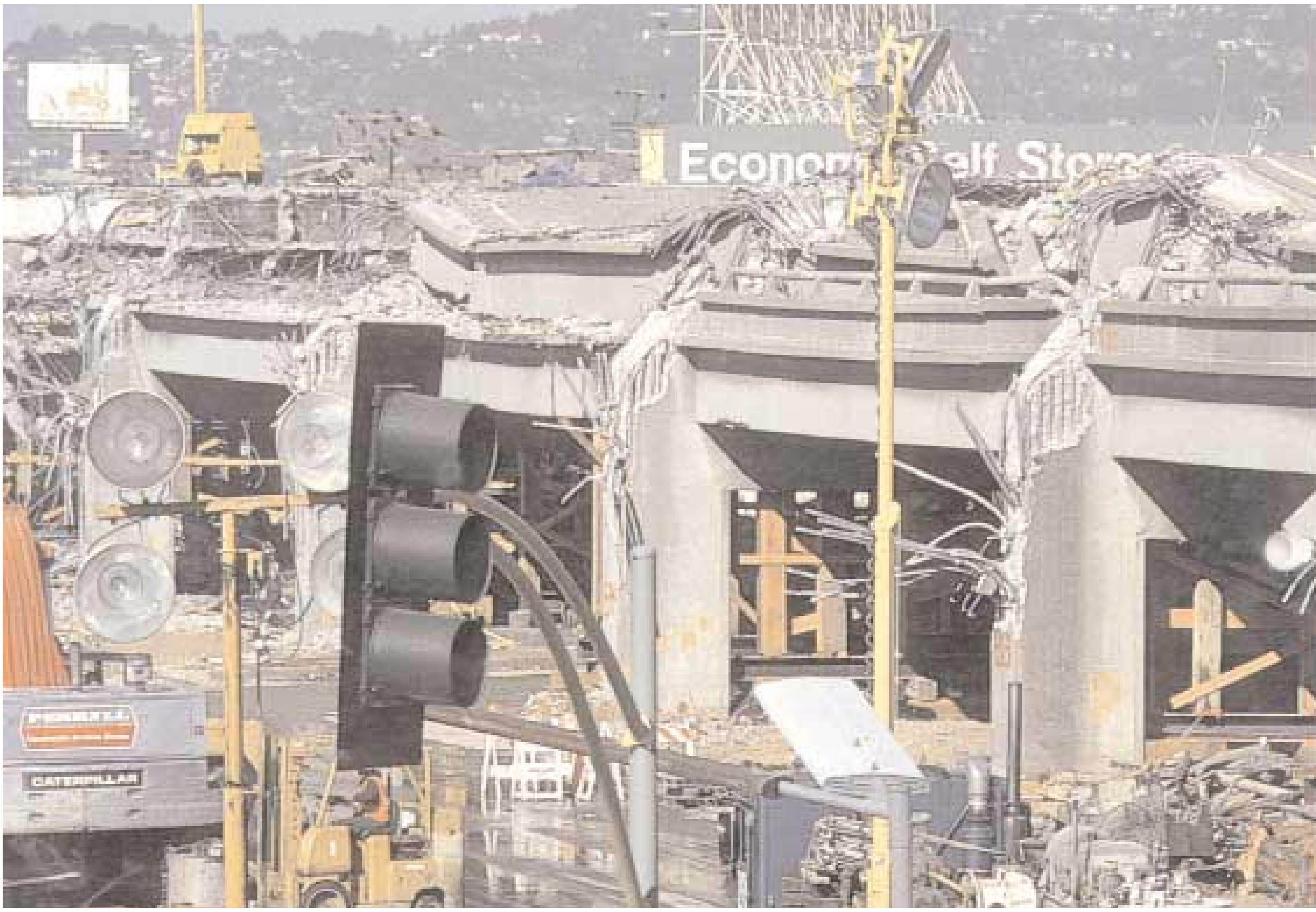
VSL Climbform and Post-Tensioning combine on Sydney development

The Metroplaza project is a retail and office development located in the North Sydney Business District and sited adjacent to a major bus and rail interchange linking the Northern Suburbs with Sydney C.B.D. This project consists of a 6-level podium with 200 shops and a 29 storey office tower.

VSL has been awarded the contract by Metroplaza Construction Pty. Ltd. for the Climbform and post-tensioning of the tower floors on the project. The Climbform will form 34,000m^2 of vertical watt surfaces through 40 concrete peurs to construct the services core of the tower. Post-tensioning of the 27 tower levels will produce a slab area in excess of 40,000m^2. Approximately 270 tonnes of 15.2mm diameter strand will be used.

VSL has worked dosely with the builder and engineer to implement many innovations and to optimize the benefits of Climbform and post-tensioning. The structure is scheduled for completion in mid 1991.

Nerf Audsley, Trevor Webster
VSL Prestressing (Aust.) Pty. Ltd.
Thornleigh, New South Wales



The Cypress Street Viaduct in Oakland after the October 17, 1989 earthquake.

Column test installation for California Departement of Transportation.

New Seismic retrofit system improve

VSL Western has developed a new wire wrap retrofit system which gives concrete columns the necessary strength and ductility to withstand a major earthquake. After extensive equipment development, testing and evaluation, the system has received the approval of the California Department of Transportation (CalTrans) for the rehabilitation of state highway bridge piers.

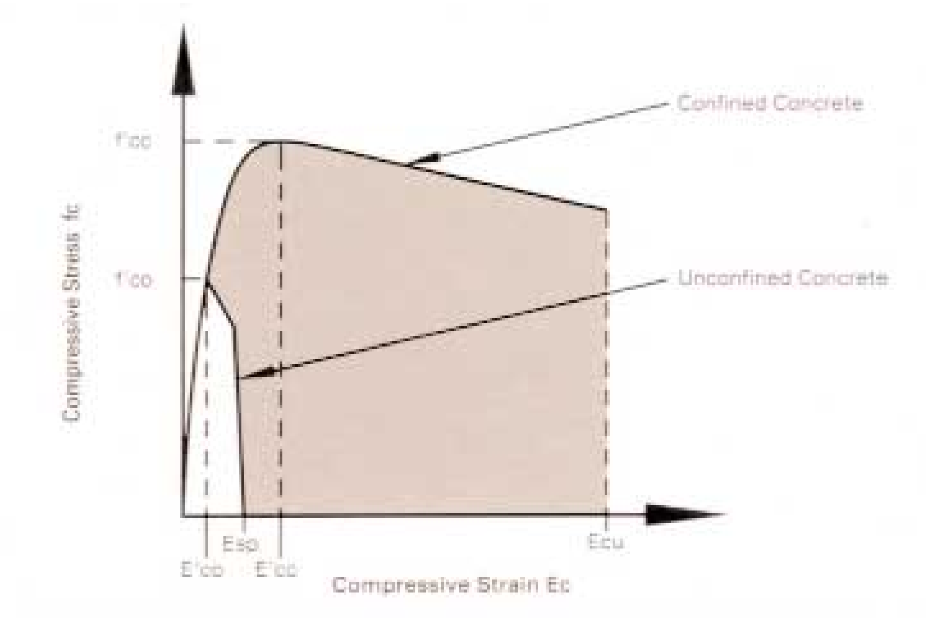
Northern California's recent 7.1 magnitude earthquake caused substantial damage to many structures, especially to bridges designed before 1970. The collapse of the Cypress Street Viaduct in Oakland (shown above), and the damage suffered by other bridges and buildings, clearly demonstrated that many concrete structures have columns with insufficient strength and ductility.

In response, VSL developed a method of wrapping columns with prestressing wire under tension, thus creating an active confinement of the concrete core without affecting the stiffness of the column. The tests demonstrated that the VSL solution offers the following benefits :

– Substantial increase in shear strength and ductility – the CalTrans requirements for a displacement ductility factor of 4 is easily exceeded.
– Wire wrapping of the potential plastic hinge region has no significant influence on column stiffness or load distribution on the substructure.
– No bond failure of substandard lap splice at column base.

Edgar Davis, David Swanson
VSL Western Campbell, California

es strength and ductility of concrete columns



Confined compression stress-strain model.

Wire wrapped column base after testing.

Post-tensioned alternative design reduces parking structure cost by $1 million

The parking facility of the Principal Financial Group's new office complex in Des Moines, Iowa is an eight story structure designed to accommodate an additional eight stories of office space in the future. The structure contains 250,000 sq.ft. (23,000m^2) of elevated slabs.

The original structural design called for steel beams acting compositely with a cast in place concrete deck. Through an alternative design utilizing a post-tensioned beam and slab system, VSL was able to reduce the project cost by over $1 million, as well as provide significant savings in long-term maintenance costs.

VSL acted as Engineer-of-Record for the structural frame design, which consisted of post-tensioned beams, 18 in. wide x 33.5 in. deep (457mm x 851mm) spanning 58 ft. (17.7m), and 6.5 in. (165mm) slabs spanning 24 ft. (7.3m). The design eliminated the need for shear watts by utilizing the action of the concrete frame.

To provide maximum corrosion protection of the post-tensioning steel, the fully encapsulated VSL CP+ System was utilized.

Marty Mikula
VSL Eastern
Minneapolis, Minnesota

VSL CP+ post-tensioning system provides maximum corrosion protection for unbonded tendons.

Monostrand post-tensioning provides crack-free super-flat slab

The new DuPont distribution center in Atlanta, Georgia, is a 165,000 sq.ft. (15,000m^2) facility containing offices, a fully-automated warehouse, and a 20,000 sq.ft. (1860m^2) cold room for storing special diagnostic products.

To ensure proper operation of the automated storage and retrieval equipment, a super-flan slab (F 100 minimum) was required. VSL supplied and installed ail post-tensioning materials for the 111,000 sq.ft. (10,000 m^2) warehouse slab, including the cold room area.

The longitudinal post-tensioning provided a final compressive force of 250 psi (1.72 MPa). To prevent shrinkage cracks, partial stressing was performed one day after concreting. The fuit force was applied after the concrete developed 3,000 psi (20.7 MPa) compressive strength. Two layers of polyethylene sheeting reduced subgrade friction and allowed for slab shortening.

An area of 30,000 sq.ft. (2800m^2) was post-tensioned bath longitudinally and transversely in order to lie all joints together and allow storage racks to run in either direction.

Miroslav Vejvoda
VSL Eastern
Atlanta, Georgia

Colorado highway bridges utilize VSL service package

VSL has recently completed the fabrication, installation and stressing of ail post-tensioning materials for two long-span bridges near Denver. The project resulted in an "Award of Excellence" presented by the Rocky Mountain Chapter of the American Concrete Institute.

The Mainline Bridges are part of the new C-470 highway loop connecting south Denver with 1-270 on the west. The 760 foot long twin structures have four spans each II 50', 220', 220', 170'). VSL'S contract consisted of supplying and placing 240 tons of 0.5 in. diameter strand, 38,000 ft. of galvanized steel duct, 900 tons of reinforcing steel, and the injection of 150 tons of cementious grout. To anchor the 570 post-tensioning strands in each structure, the VSL EC 5-27 anchorage system was used.

Robert H. Allen
VSL Eastern
Lakewood, Colorado

Cast-in-place, post-tensioned box girder structures have proven to be the mostcost-effective solution for long-span Colorado bridges.

VSL develops new architectural Retained Earth™ panels

Retained Earth "Ashlar Stone" panels support access ramps for I-270 near Washington, D.C.

When the Maryland Departement of Transporation awarded a series of contacts to widen Interstate 270 to twelve lanes, environmental impact considerations dictated special architectural treatment for ail retaining watts and sound barriers. In response, VSL designed a cul stone facing panel to simulate the region's turn-of-the-century hand placed block retaining walls.

In contrast to VSL's standard hexagonal Retained Earth panels, the new panels are square. Five foot forms with elastomeric form-liners are utilized for production. An exposed aggregate finish enhances the aesthetics by creating a deeper colour tone.

The Maryland project utilized over 23,000 sq.ft. of the newly-designed watts for two interchanges.

Roger Bloomfield
VSL Eastern
Springfield, Virginia

VSL innovation at work in France

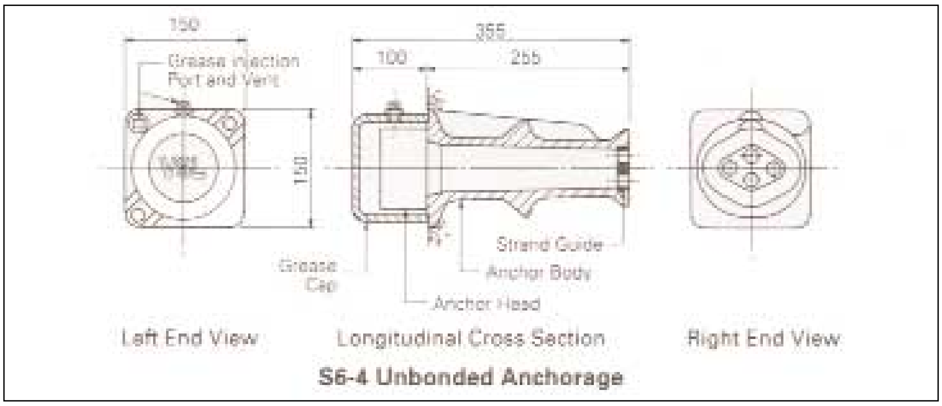
The Somme Viaduct in Abbeville, France uses a unique p-t composite deck. The 760m viaduct crosses the Somme canal and has varying spans of up to 56m. Two steel 1 girders support the cast-in-place concrete deck which utilizes unbonded transverse post-tensioning.

The deck is post-tensioned with monostrand p-t tendons which are individually greased and sheathed in polyethylene. Fiat tendon bundles consisting of four monostrands were anchored with a special anchorage developed by VSL France for this project. More than 2200 56-4 anchorages were used to simultaneously stress and anchor each four strand tendon. After stressing, a permanent grease cap allowed the anchorages to be injected with the same corrosion inhibiting grease as used for the fabrication of the monostrands. The strands are thus fully encapsulated and have two barriers against corrosion. The advantages of such unbonded tendons include extremely low friction values and maximum possible tendon eccentricity. These advantages translate into more load carrying capacity per kilogram of strand than can be achieved with bonded systems.

A moveable scaffold system was used to construct the deck in alternate sections of approximately 20m. The girder span sections were followed by the closure sections over the supports. The weekly cycle of one span section and one closure section required the use of prefabricated reinforcement cages extending over the 18.5m width of the deck. Complete reinforcement cages including strand and anchorages were fabricated on site.

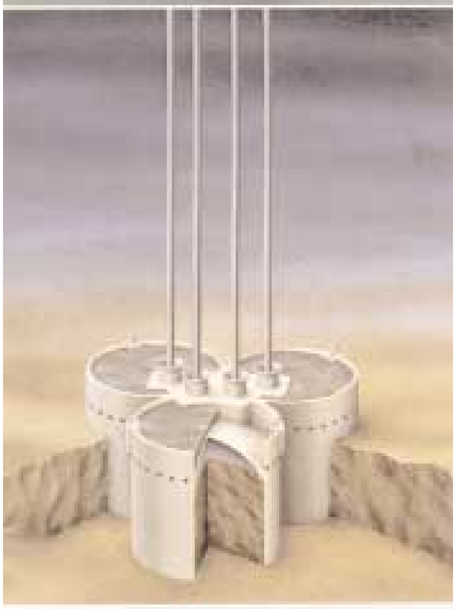
Pierre Bron
VSL France S.a.r.l.
Boulogne-Billancourt, France

Site prefabricated reinforcement, including strand and anchorages, speeded composite deck construction.



Flat tendonbundles, four strands each, were made possible by a specially designed VSL anchorage

Encore for offshore – Concrete reaches new depths



VSL Norge A/S has been selected as the post-tensioning subcontractor for three more Norwegian Contractors offshore structures. These structures follow the successful completion of Gullfaks C. Norwegian Contractors received the "FI P Award for Outstanding Structure" for Gullfaks C, the world's largest platform.

Construction of the Draugen platform, again a Condeep type, has started. The 285m high monotower, with seven cells each with a diameter of 35m and 45m high, will be the tallest concrete platform built to date. In total, about 1400t of prestressing steel and 83,000 cubic metres of heavily reinforced concrete will be required.

Work is also underway on the Sleipner A platform. It is a Condeep type with 24 cells 48m high and four shafts. The platform will support a 54,000t deck structure in 82m of water.

The Snorre tension leg platform will use a new type of concrete offshore structure for the foundation templates. The four templates serve as anchors for the tension legs (tethers) of the semi-submersible platform, which will operate in 310m of water. Each of the four structures consists of three cells 17.3m in diameter and 20m high with an upper dome. They will be pressed/sucked approximately 13m into the sea bed.

With these three projects VSL continues to support Norwegian Contractors and the common goal of ON SITE-ON TIME.

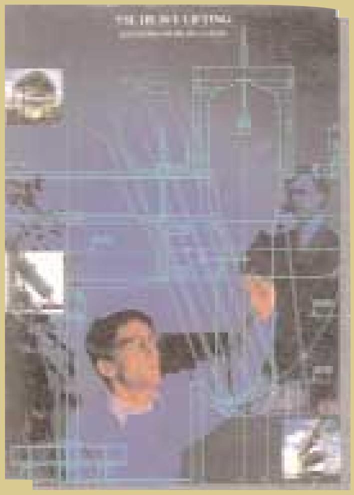
Left: VSL has begun the post-tensioning contracts for the Draugen (top), Snorre (foundation detail centre), and Sleipner A (bottom) offshore oil platforms.

Below: Sleipner A cells are now under construction.

Karl-Erik Nilsson
VSL Norge A/S
Stavanger, Norway

Ferdinand Graber
VSL International Ltd.
25 Lyssach, Switzerland

New Heavy lifting brochure now available from VSL



VSL International has published a new 16 page brochure on the company's capabilities for handling heavy loads. The publication describes VSL's complete range of services and specialized equipement for applications including building construction, bridge erection, and the installation of heavy machinery.

Copies of this full-colour publication are available from the VSL offices in Lyssach, Switezerland; Campbell, California; and Singapore. Pleae refer to the back page of this issue for the address nearest you.

Saudi bridge uses VSL group effort

The Qurashiyah bridge in Riyadh illustrates that VSL is more than just a supplier of excellent post-tensioning systems. Several services and products from the VSL group were used for the construction of the fully precast superstructure of this seven span bridge which has an overall width of 26.51m and a length of 483.6m.

Elegant shell-shaped twin-piers support the bridge deck which consists of a double-cell box spine girder, precast side frames and precast parapets and barriers. The spine girders are made of 3.1m long segments precast by the longline match-casting method. VSL heavy lifting techniques were used to erect the 110t pier head spine segments. Other segments and side frames were erected by balanced free cantilevering using specially designed VSL lifting equipment.

The superstructure uses longitudinal and transverse VSL post-tensioning. Temporary prestressing with high-strength bars was used for segment glueing.

VSL had extensive involvement in the planning and execution of the superstructure construction. Services included :

– Construction engineering for the assessment of temporary work and erection stresses.
– Evaluation of the design engineer's precamber values and follow-up of the defection control during erection.
– Supply of major part of steel formwork for spine segments and side frames.
– Engineering of all lifting activities and provision of VSL Heavy Lifting equipment and supply of free cantilevering lifting equipment.
– Supply of temporary and permanent prestressing.
– Provision of site engineer and specialist personnel for erection and post-tensioning of bridge superstructure.

Erection of the bridge superstructure started in August 1989 and was completed in August 1990.

Ferdinand Graber
VSL In ternational Ltd
Lyssach, Switzerland

VSL work included lifting and placement of pier heads, spine segments and side frames, as well as longitudinal and transverse post-tensioning of the superstructure.

Lifting operation for precast side frames.

VSL alternative design saves time and money on Hong Kong tower project

VSL Hong Kong has recently completed all prestressing work on the new headquarters for the Hong Kong-based Hang Seng Bank. Scheduled to open in fate 1990, the 27-storey building contains 22,100m^2 of completely column-free floor space and offers exceptional harbour views.

The structural frame consists of two main core walls located on either side of the building, with a free spanning post-tensioned beam and slab structure between the walls. Each typical floor contains 10 post-tensioned beams measuring 900mm deep x 600mm wide which support a 150mm thick concrete slab. The beams span approximately 28.5m and utilize the stiffness of the core walls at one end.

The VSL alternative design provided significant economies in construction lime and material quantifies. The major feature of the design was the elimination of large cantilever corbels off the infernal core walls, between which the conforming beams span. These were replaced by a full span propped cantilever structure which sits on a small nib corbel off one core wall. The post-tensioning tendons were stressed from inside the core at the fixed end. One month after stressing, the floor structure was locked into the core wall at the corbel.

The VSL design increased construction efficiency by allowing the cores to be jump-formed easily without any major protrusions, and also eliminated the majority of "wet trades" on the floor after casting. After an initial period, a comfortable cycle of six days per typical floor was achieved.

Duncan Lapsley
VSL Engineers (HK) Ltd.
Hong Kong

The Hang Seng Bank building contains 27 storeys of column-free office space.

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