PEEM, spol. s r. o.

project, engineering, management

Exclusive structural design and performance

1. Introduction of the company

The company **PEEM Ltd.** originated in 1992 initially as an association of designers. It became a legal entity in March 1993 and has maintained this status till the present time. The original name of the company, PEM (projects, engineering, management) was changed into PEEM in July 2002. The reason for this change was the coincidence of the company name with the name of an Austrian Company which enjoyed the priority of having been registered earlier in the European register of company names.

Ever since the establishment of the company we have been devoted to designing almost exclusively for a number of years. We have focused on designing for production of building materials, for cement and lime plants, but as well as for other industry (foundries, energy plants) and in so doing continuing with our previous work in Keramoprojekt, Brno. In our designing work we have always endeavored to invent new, non-traditional and original solutions which would eventually bring about advancement.

There still has been a larger demand for delivery of services of the more complex nature in the market in the recent years. Now a good design is not good enough, a solution „on paper“, a customer needs a bid to help him with his idea/intention from the beginning till the end, ie. till the problem has been resolved and the build has been handed over or till the facility has been launched into operation. We have therefore entirely altered our mission and made adaptation to the organization and operation of the company to completely correspond to the new motto ***„From design up to realization“.***

Currently we would like to concentrate on two branches of action.

- The first one being, traditional branch, those are services involved in various designs of modernization of production of building materials, energy or as well as other industries especially where bulk materials are handled.
- The second one, a new branch, it is about the application of exclusive structural work, which involves specially efficient reinforcement of existing brick, stone, concrete and steel structures by subsequently prestressing high-grade steel strands introduced into them.

Every new problem poses a challenge for us to find the best possible solution. We always offe a complete range of services right from the assessment of the investment plan, through individual phases of the project documentation, delivery, realization, assembly or installation up to launching into operation.

Brno, March 17, 2009
Dipl. Ing. Jiri Chalabala
Company Executive, Company owner.

2. Exclusive structural work

Pre-stressing of structures has more than a sixty-year old tradition but despite this tradition it is still not quite entirely a normal method especially for some applications. In any case however it brings a whole lot of utility advantages or benefits. Pre-stressing enhances the load-bearing capacity of building constructions and helps to maintain and prolong their life-span (durability) and hence as well as their function and for this matter even for damaged structures. And at last pre-stressing still and more often finds its position and significance in the designing of new structures, where it so remarkably influences not only the architectural design of the structure, but from the point of view of the ratio of mass and price to the load-bearing capacity of the structure, as well as its utility factor.

The modification of the internal stress respectively the force ratios in the already existing structure is – besides the change in the structural diagram – perhaps only the introduction of a new force system. And this is why subsequent pre-stressing is the elegant and efficient way of how to achieve that. Via a suitably channelled post-tensioned steel strand we can transfer the result force from one point of the structure to another – more suitable point. The introduction of a compressional force either reduces or eliminates unfavourable tensile stress which develops on the application of loads onto structures.

Out of aesthetic reasons our natural effort is to inbuild all the steel strands – hide them in the structure itself to avoid disruption of the interior or facade of the structure.

It is infinitely possible to modify the procedures of pre-stressing because the flexible steel strand enables channeling according to necessity and disposition of the structure. Apart from reinforcing structures it is possible to cut parts of concrete structures and replace them by three-dimensional steel strand support, it is possible to increase utility inconsistence of the structure by leaving out columns thereby replacing them with a strand system.

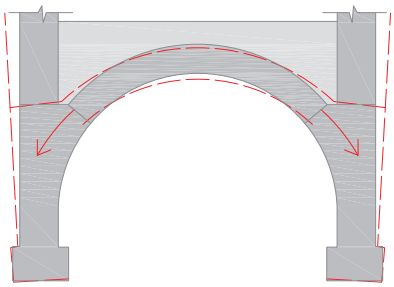
> The Company PEEM Ltd. is a holder of an application for a European patent for „Strengthening of reinforced concrete corbels by subsequent post-tensoning“, and is a holder of reserved right of a technical reference manual „Partially prestressed frame diagonal with parabolic belts“, the author of the technical solution „Reinforcement of a bridge crane by subsequent post-tensioning“.

> The Company PEEM Ltd. has been dedicated methodically to independent scientific research activities in this field. It has been co-operating closely with the institute of concrete and brick structures of the Faculty of Civil Engineering of the Brno University of Technology in terms of research.

In the next part we would like to touch on and introduce to you individual applications in more detail.

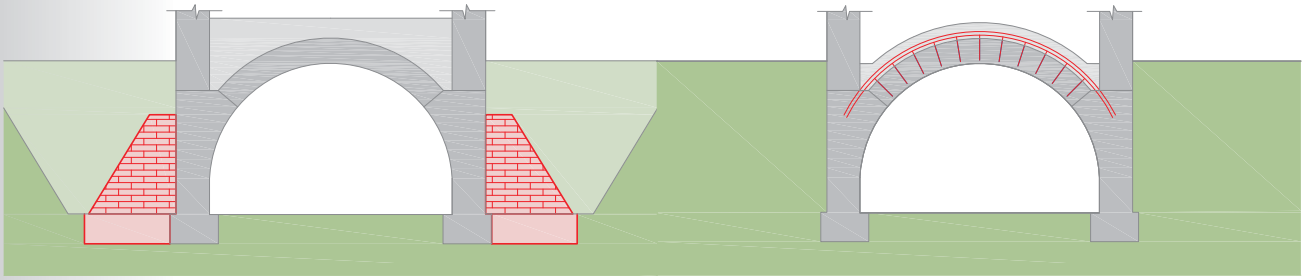
2.1. Masonry structures

The static safety of old monuments or historical buildings guaranteed by fastening together with pre-stressed strands is an effective, fast, sensitive and financially acceptable way of how to protect them or save them from the ravages of time and preserve them for other generations to come. In this way it is possible to resolve problems of cracks in vaults, inclination of walls and columns in the longitudinal direction, failures of foundations and other serious static or structural failures.



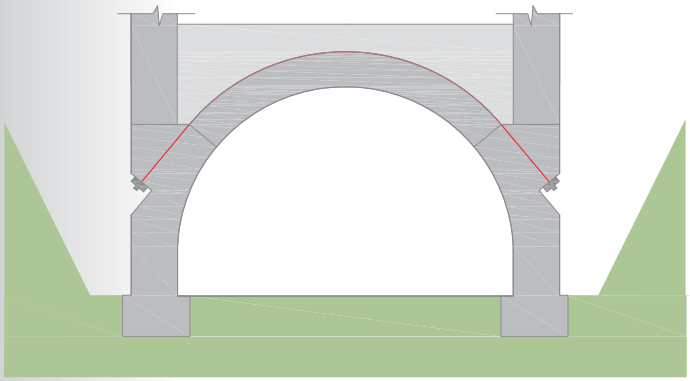
The main cause of failures in vaults is loss in load-bearing capacity of side columns. The vault therefore loses its support and declines.

The traditional method of correction is:



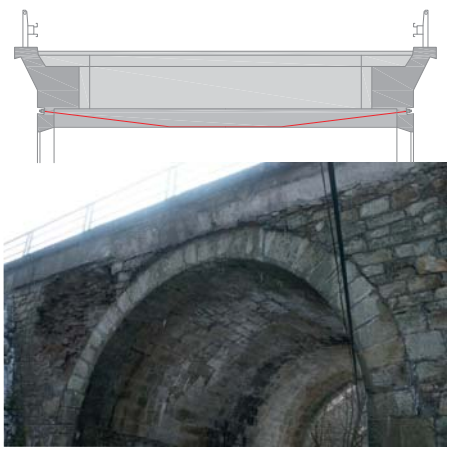
a) increase in rigidity of supports in the form of side-brickwork columns

b) increase of valut rigidity in the form of reverse side construction



The approach of the company PEEM Ltd. lies in fastening the structure together as a whole

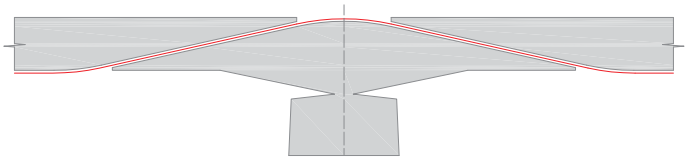
A very effective way is the application of strengthening by post-tensioning for bridge-vault structures. Besides longitudial fastening together of the vault it is also possible to effect a transverse posttensioning of the vault bridge structure and transfer of the main load to the edge reinforced concrete load-bearing walls.



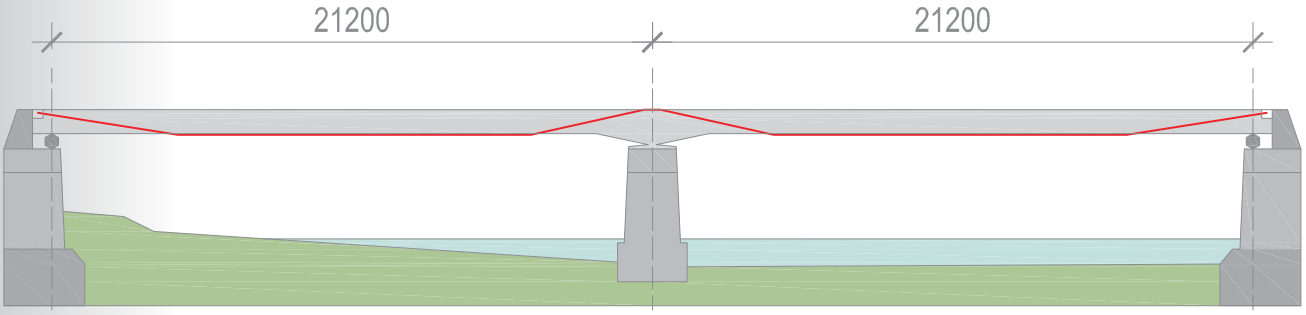
Repair of vaults of baroque colonnade

2.2. Bridge reinforced concrete construction

It is possible to achieve an almost unbelievable effect by reinforcement of slab and beam reinforced concrete bridge constructions by the method of substitutional subsequent drilled ducts through which steel strands are pulled and post-tensioned. The channeling of the strand is made with the aid of steel deviators, which by their dimensions or geometry prevent the strand from getting damaged.



The channeling of the strand above backing



Contrary to adhesive reinforcement steel glued onto the surface of the construction which is activated only after application of load and hence does not participate in transfer of forces from constant load, the post-tensioning, introduced into the structure immediately participates in transfer of forces developed from constant load and significantly or remarkably improves the state whereby the structure is not exposed to incidental load.

The cracks that develop in the tensile parts of reinforced concrete structures remarkably speed up the process of corrosion of the reinforced concrete. Introduction of compressional forces by post-tensioning leads to closing of these cracks and hence the resistance of the concrete structure is significantly prolonged.

All the work associated with this technology can be done without interrupting traffic on the bridge or with only little restriction. It is possible to apply this method well to structures, which seem to be statically beyond repair or else it is impossible to achieve the required carrying capacity.

By this method it is possible to increase the carrying capacity by 200 up to 300 % contrary to other methods which range from 20 to 30 %.

2.3. A complete system of reinforced concrete strengthening constructions of existing halls with in-built craneways.

For production halls which are made of reinforced concrete construction with an in-built craneway, we ften encounter these requirements :

- supplement or change the production assortment – handle larger and more complex units so that a finished product can be shipped to the customer as a whole.
- install a bigger and stronger bridge crane in an existing hall.
- higher demands for handling the product.

An old hall, the part of which or its craneway however do not conform to the higher requirements for load. **An intelligent and elegant solution** to this difficult problem lies in the application of high-tech technology – strengthening of the existing reinforced concrete structures with the aid of post-tensioning anchor strands known as Monostrands.
Our Company is hereby providing a complex approach :

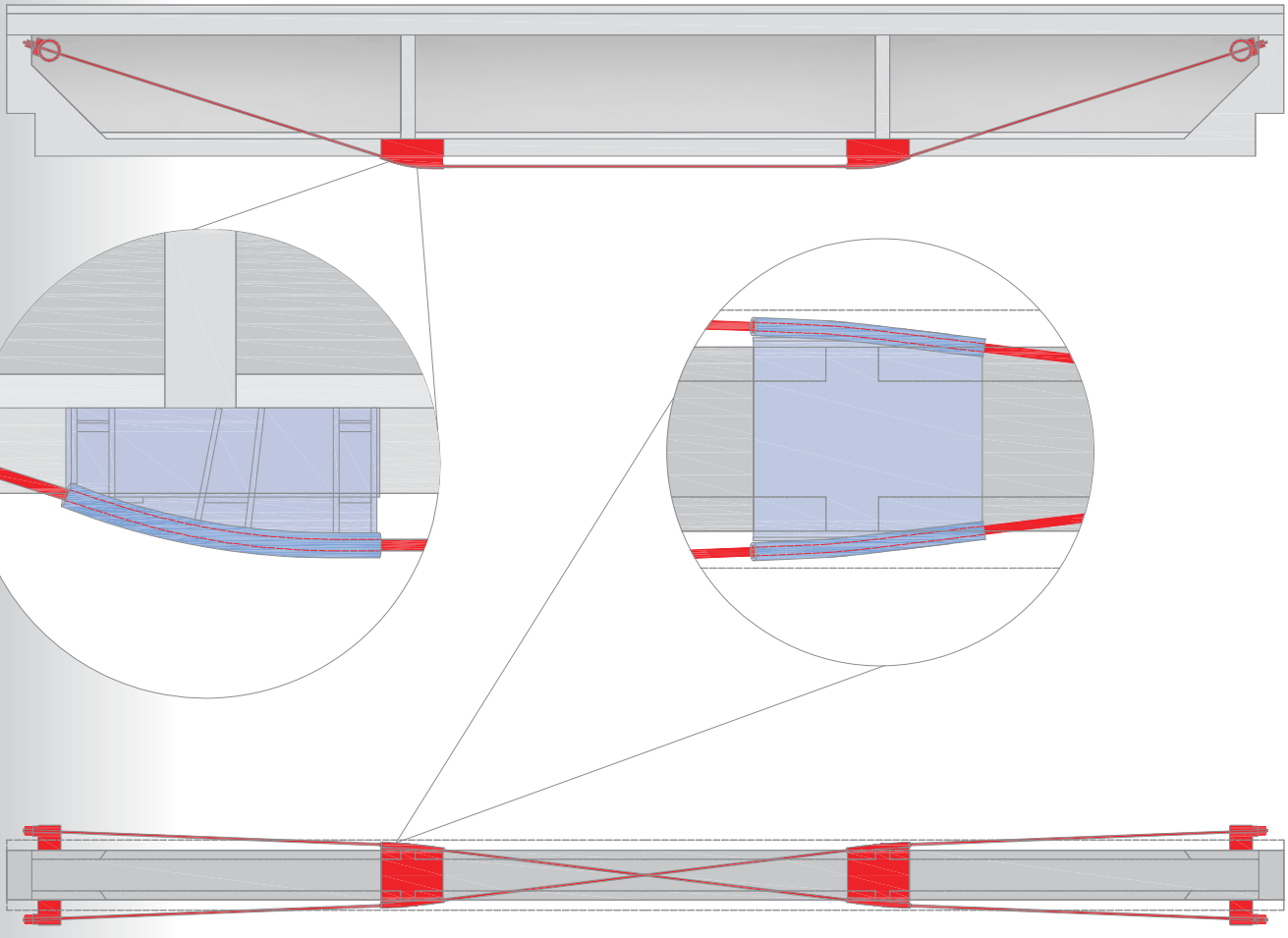
- reinforcement of girder / primary beam of the craneway
- reinforcement of girder / primary beam of the roof tie-beam of the hall.
- reinforcement of the columns corbel
- reinforcement of the columns foundation base plinth, of its shaft
- reduction of sag of the bridge crane, increase in its load-bearing capacity.

We will introduce some of the approaches / solutions in detail.

a)Reinforced concrete girder/primary beam

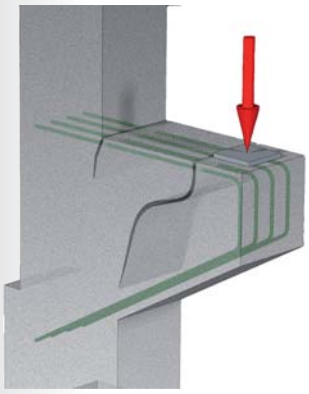
For reconstruction of industrial monolithic halls, increase in load – bearing capacity of the craneway is often a requirement. This is limited by the load-bearing capacity of the reinforced concrete primary beam and the reinforced concrete column.

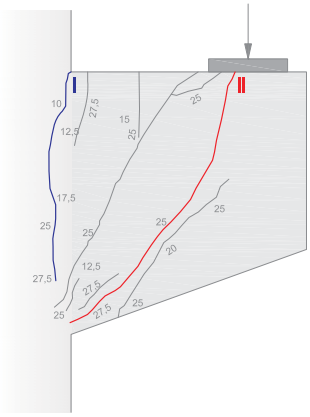
The load-bearing capacity of the reinforced concrete beam of the craneway is increased by superficial channelling of post-tensioned strand. The beam is supported at one-third of its length by a steel deviator, above which the post-tensioned strand is subsequently laid. By this method the beam becomes stronger and its load-carrying capacity increases by about 200 % and its life-span also gets prolonged.



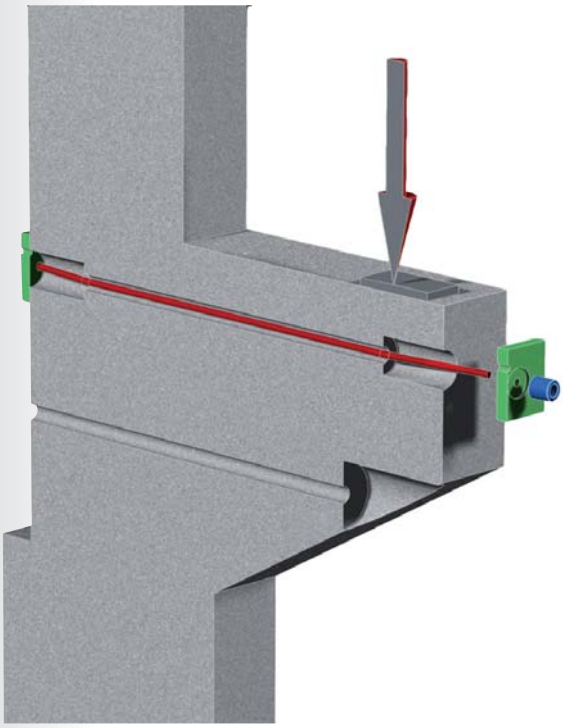
b) The corbel of the reinforced concrete column.

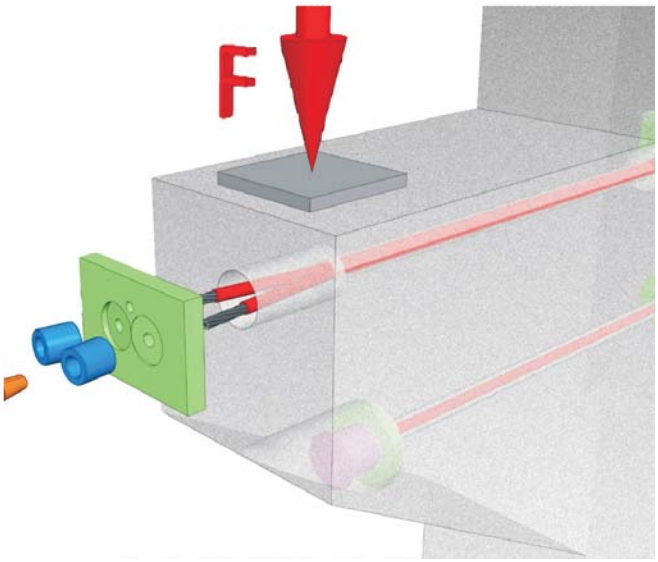
The load-carrying capacity of the whole hall and its craneway is very often limited by the load-carrying capacity of the corbel of the reinforced concrete column.ts reinforcement often leads to a significant increase in its load-carrying capacity and hence as well as the utility function of the whole structure.





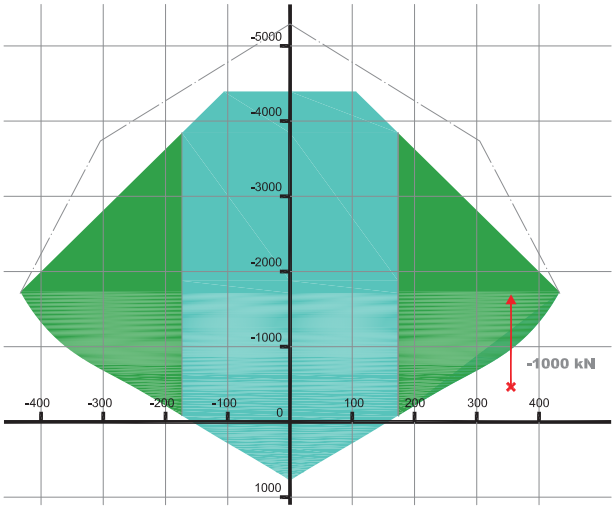
The figure above shows the way how the corbel cracks in case of overloading. The concrete of the short corbel is under a longterm repeated tensile stress. In the first place the blue crack appears and the decisive destruction takes place along the line of the red crack. The transverse fastening together of the corbel completely eliminates the development of tensile forces and increases the load-carrying capacity of the corbel by about 500 % and prolongs its life span. The method of keeping taut a short strand is the technical know-how of PEEM Company. The performed work quality is verified by tensometric measurement through compressing the corbel of the column.

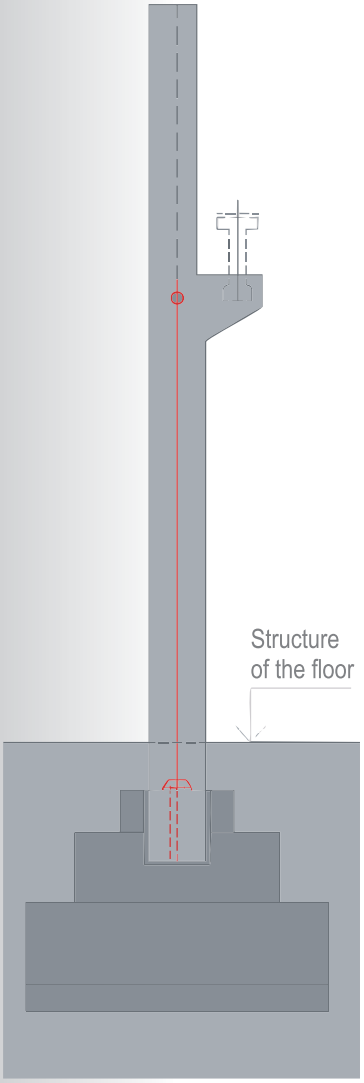




c) Reinforced column

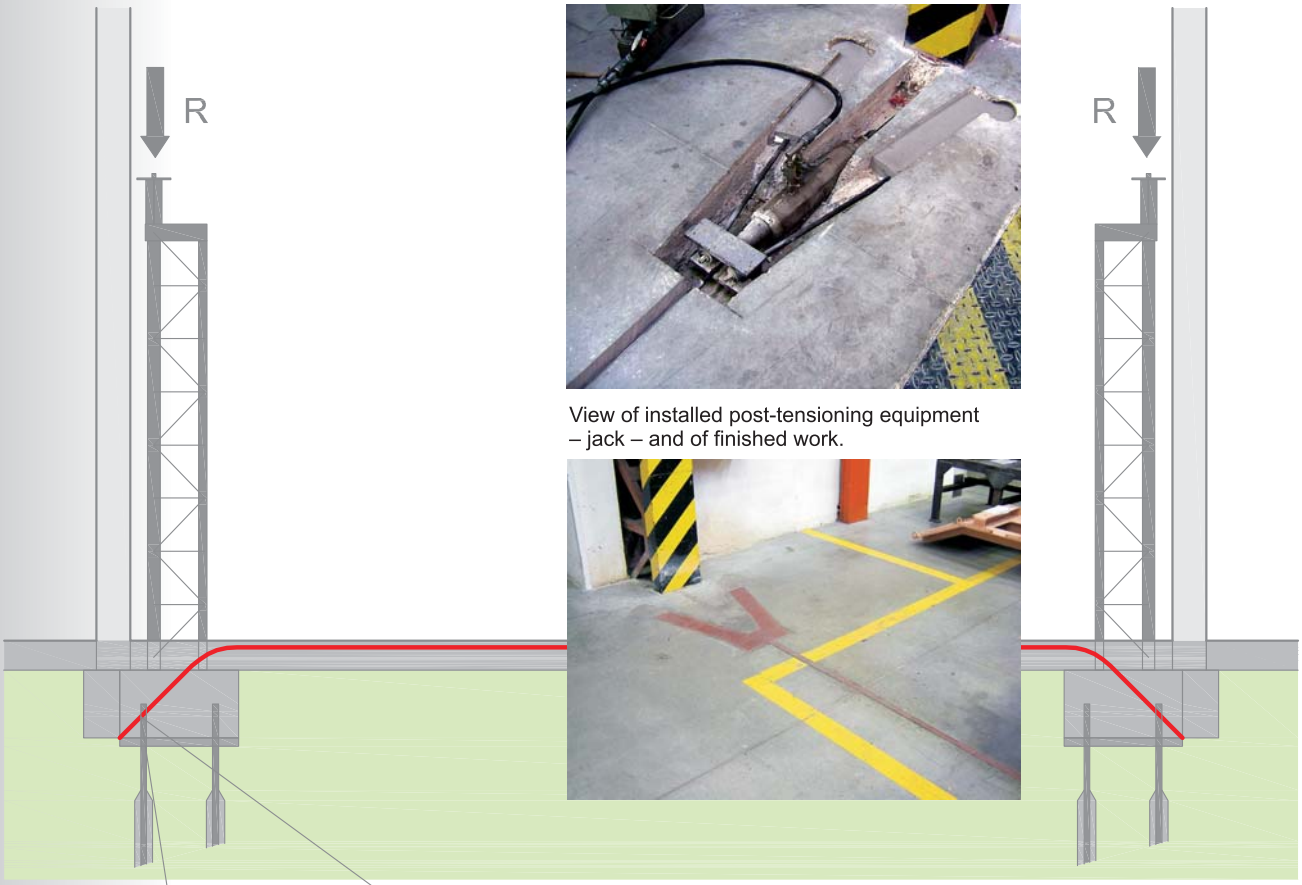
Especially for hall structures, reinforced concrete column is under the action of a large horizontal force from inconsistency and braking of the crane and from wind effects. This force action causes a bending mo-ment in the base of the column. The cross-section of the column is on one side under compressional force and on the other side under tensile stress which a concrete column is unable to transfer. The introducti-on of perpendicular compre-ssional force into the column leads to elimination of unfavourable tensile stress and hence leads to increase in load-carrying capacity.
By introducing compressional force into the existing less loaded but bent column, it will lead to a remarka-ble increase in its load-carrying capacity by about 200%. However it will not lead to overloading of the foundations.



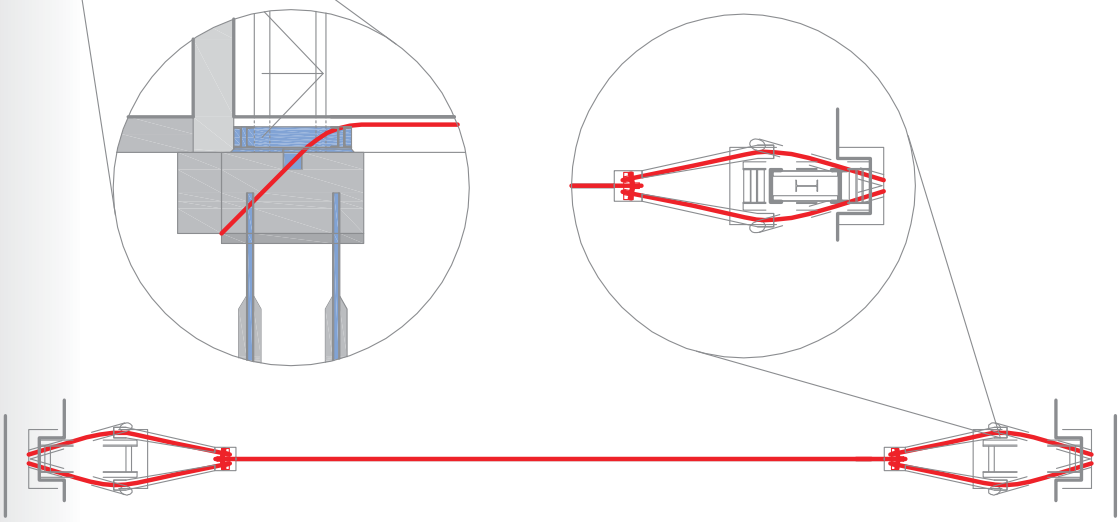


d) Reinforced foundation of the craneway

We have already shown how to strengthen the primary beam, column and corbel of the craneway. We are yet to show how to strengthen its foundation.
Non-uniformly loaded foundation base – it is possible to stabilize it with the aid of suitably shaped and subsequently post-tensioned strand. This results in uniform or even distribution of the load from the base to the underlayer of the base which leads to increase in load carrying capacity.



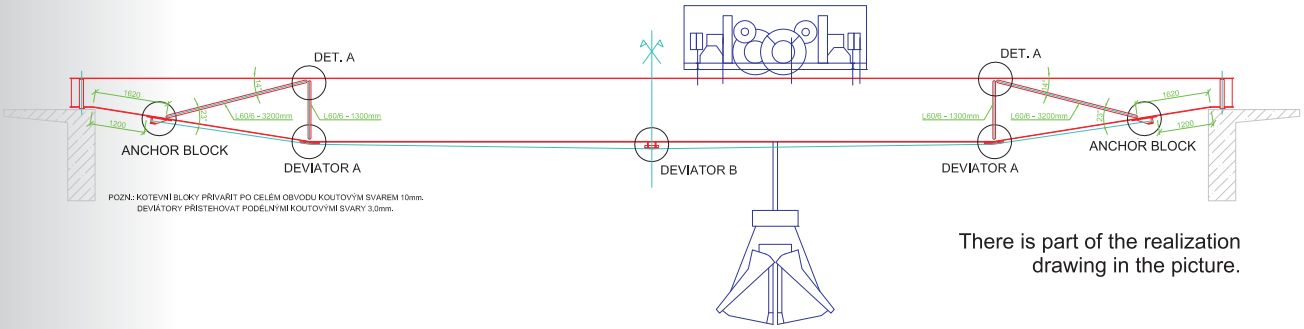
View of installed post-tensioning equipment – jack – and of finished work.



e) Reduction of bridge crane sag, increase in its load-carrying capacity

With the aid of post-tensioned strands it is possible to resolve not only problems of reinforced concrete or brickwork structures but also for example for steel beam of a bridge crane.

Through the influence or impact of longterm operation the crane is usually permanently bent by tens of mm. We are able to correct this deformation or reduce it to the minimum and at the same time increase the load-carrying capacity of the crane.

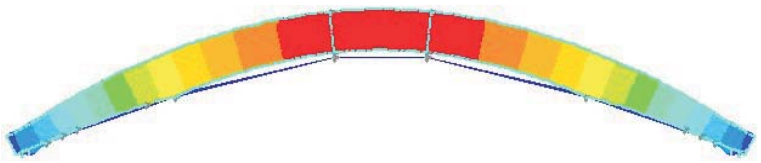


There is part of the realization drawing in the picture.

Before the realization itself a computer simulation of the correction is performed

Illustration of state :

Sag subject to the weight of the load((_z = 9,3mm)



rise of an arch caused by pre-stressing((_z = 42,3mm)

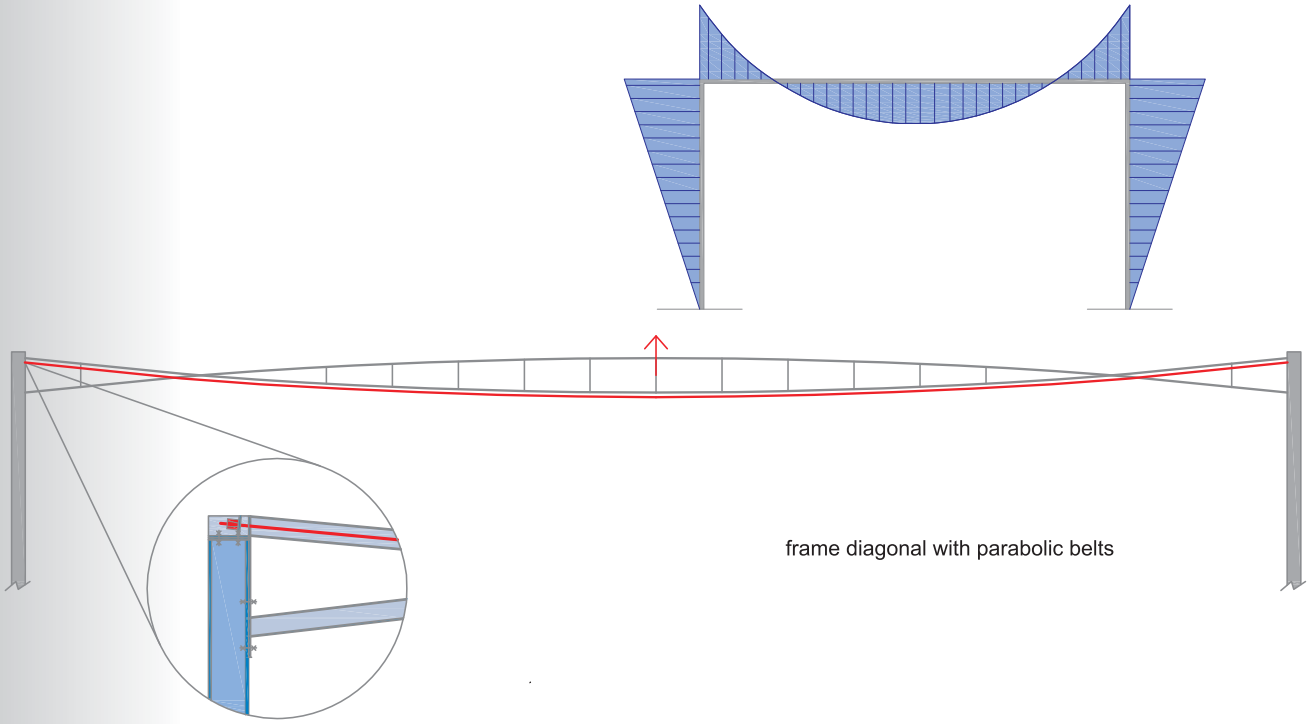
Pre-stressing by strands.

Bridge crane

2.4. Subsequently pre-stressed *new* steel structures

It is possible to apply activated behaviour of structures through pre-stressing as well as when designing steel structures. As an example we are presenting a classic solution to a simple hall construction, where pre-stressing of the lower frame hall parabolically - shaped structure allowed for creating architecturally an interesting and financially economical solution.

The new technical solution is a partially prestressed frame diagonal with mutually intersecting parabolic belts. They form an interesting alternative of classic compartment tie – beams.



From the structural mechanics point of view it is about Vierendeel´s beam, the parabolic belts of which are designed so as to follow the course of bending moment on frame diagonal loaded by a uniform continuous load. The advantage of this approach is that the normal force in the belt is along the whole length of the diagonal, constant and its a related picture of the mentioned bending moment.

Because of the fact that it is possible to design the cross-section of the belts as constant without the material in the edges remaining unused. The mass of the diagonal can be reduced by as much as one third in this way in comparison with classic compartment beam (either already by straight belt or by a saddle one).

The described approach is suitable especially for halls of medium and large spans. The decisive criterion for a design of this type of construction is mostly never the limiting state of load-carrying capacity, but the limiting state of usage – that is sag of the diagonal. In view of the fact that constant load makes up approx. 30-50% of the total load, it appears to be very suitable to eliminate their sag and hence reduce the total deformation of the structure.

The suitable way how to eliminate sag caused by constant loads can be pre-stressed by pre-stressed strands or screws. It is not only that sag caused by constant loads is eliminated but also the stress on frame diagonal gets significantly reduced. It is then possible to design the structure slimmer and lighter.

From the aesthetic point of view it is about an original transparent structure, which especially in shops like car showrooms, hobby markets and the like form elegant, technically clean and interesting view from below.

From the economical point of view this structure/construction is about a third cheaper than classic halls with compartment tie-beams.

The last but not the least is about a technically interesting construcion with a certain internal beauty, which in full capacity makes use of all positive properties of steel and opens new possibilities in the design of steel structures.

3. The method of realization and its advantages

Pre-stressing system known as Monostrand

A single-strand system without coherence, established under the name Monostrand, is comprised of pre-stressed strands predominantly of diameter 15,7mm (O,6 “S), embedded in HDPE protector with lubricant. This ensures excellent two-degree anti-corrosion protection and leads to minimum loss in pre-stressing force through friction. The exterior diameter of the single – strand cables monostrand is 20 mm. The installation of this light system is extraordinarily fast. Thanks to its dimensions it is possible to use it in very thin structures and it is very flexible in coordination with soft reinforcement steel. the strands can be laid hidden in channels inside structures (monuments, residential buildings). Where aesthetics is not important, the strands run across the surface of the structure (industrial). For anchoring we often use the system DYWIDAG. The strands are made taut with the aid of pre-stressing jacks (machines).

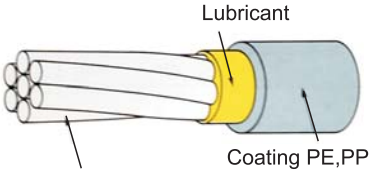
Strengthening with the aid of anchor strands will bring you the following **advantages:**

- Clean solution,installation without debris,dust.
- Without interruption of production and operations
- Very fast realization-not months,but days
- No diminishing of hall and reducing of own values of utilized space/premise
- Increase in load-carrying capacity in orders of not decades but hundreds %
- Elegant, aesthetic and durable solution
- Remarkably favourable price in comparison with classic method
- Increase in work safety
- Complete liquidation of failures in reinforced structures.
- Structurally clear and guaranteed action with the option to verify.
- Environmentally friendly – minimization of production and transfer of materials.

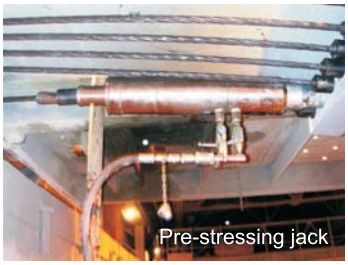
To achieve your objectives, **you don´t need:**

- demolition
- replacement of beams
- new in-built system for new craneway.
- new carrier system of columns and foundation bases besides the existing modular system
- bandagings of reinforced concrete columns in the form of new external carrier steel system
- reinforcement of consoles/cantilevers with the aid of steel attachments

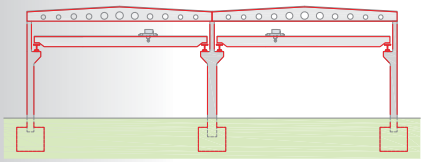
and associated sizeable expenditures which you can save and invest somewhere else and more necessary.




Pre-stressed strand Monostrand


Pre-stressing jack

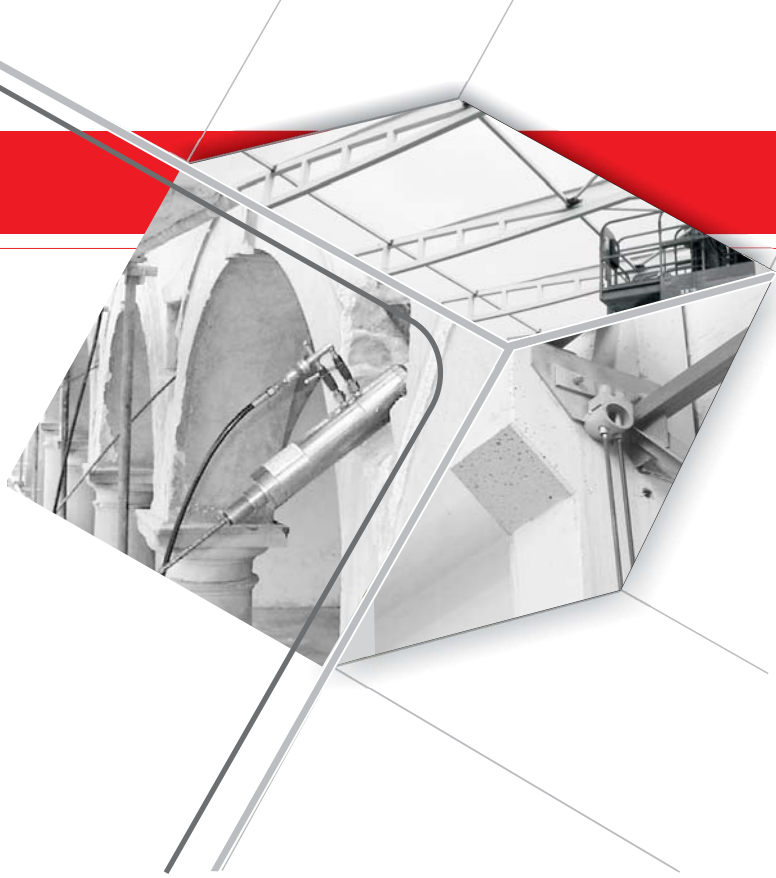

Anchorage DYWIDAG



Tensioning measurement during the realization

The described procedures are liable to infinite modification and to development because flexible strand allows for channeling according to needs and structure disposition. We look forward to new challenges and tasks.

Upon your request we will readily perform structural assessment of your structure and a designed solution free of charge.



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