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BERLIN BRANDENBURG INTERNATIONAL (BER): PLANNING AND IMPLEMENTATION OF A CONCRETE SUPPLY CHAIN FOR THE AIRPORT CONSTRUCTION SITE

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ABSTRACT. Background: With the decision to extend the airport Berlin-Schönefeld to the new airport Berlin Brandenburg International (BER) in 2006, a construction of superlatives has emerged. One of the biggest challenges was the supply of around 2.5 million cubic meters of high quality concrete that had to be produced for the construction of the airport. Due to the scale of this enterprise as well as its environment, the logistic solution of raw material supply has to be found.
Method: The planning of the concrete supply chain for the airport construction site BER had to be carried out with two major goals: the stability of the supply chain to assure that the demands of the construction site are met and delays are prevented, as well as assurance of the high quality standards of the concrete production and to avoid an alkali silica reaction and the resulting unavoidable disaggregation of the concrete. External effects, such as the carbon dioxide emission and the effect of the supply chain on adjoining residents were key factors that had to be integrated in a holistic supply chain concept. The principle underlying method is an analysis of limiting conditions for two approaches: a centralized supply chain with on-site concrete factory and upstream transport of raw materials versus a decentralized supply chain with off-site factories and downstream transport of ready-mixed concrete.
Results: The analysis of constraints and the effects on key requirements of the concrete supply chain for the BER airport construction site lead to the installation of the most modern concrete plant in Europe. The benefits of a centralized supply chain are significant. On one hand, the high quality standards can be met with the on-site mixture of the concrete and centralized quality assurance, on the other hand, the majority of the supply traffic for the construction site was moved from the road to train-bound logistics, meeting the emission requirements of the planning permission for the airport.
Conclusions: Every logistical supply chain has its own individual requirements and constraints. This approach shows how a centralized supply chain could be installed that meets all the individual constraints of this construction site. The key components of the concept are the on-site concrete plant, the delivery of raw material by train, a centralized quality assurance and a specific contract structure with the operator of the concrete plant.

Key words: Construction of the new airport Berlin Brandenburg International (BER), supply chain, concrete, ecological and social sustainability, planning and implementation.

INTRODUCTION

With the decision to extend the airport Berlin-Schönefeld to the new airport Berlin Brandenburg International (BER) in 2006, a construction of superlatives has started. The planning and implementation of the new Capital Airport is associated with major challenges for the airport operator, the Flughafen Berlin Brandenburg GmbH (FBB). About 2.5 million cubic meters of concrete had to be worked up for the construction of terminals, the run- and taxiways and other infrastructure measures such as the terminal station of the Deutsche Bahn and the highway connection to the Airport. To ensure the supply security of the site, peak loads of 10,000 cubic meters of concrete per day or 900 cubic meters per hour must be achieved. This is comparable to approximately 100 truck mixers per hour. To manage these processes the FBB is working with experienced partners such as the Logistik

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und Management Beratungsgesellschaft mbH (LMBG) for the planning and with the Becker Bau GmbH & Co. KG for the implementation and operation of the concrete plant. The following article describes the key challenges for the concrete supply of the BER airport construction site, evaluates these major constraints in light of two different supply chain approaches and summarizes the analysis with the presentation of the selected supply chain concept.

CONSTRAINTS AND EVALUATION

SECURITY OF SUPPLY The biggest challenge for the logistical supply chain concept for this construction site of superlatives lies in the high peak loads [Caldwell, Roehrich, Davies 2009; Wickramatillake et. al. 2007]. To be able to assure the security of the supply of the site, risks have to be minimized. For this specific site, the adjoining streets and highways connecting the airport to the public street network are under construction themselves, leading to a limited accessibility. However, an analysis of surrounding concrete plants and the matching of availability of concrete with the accessibility of the numerous construction sites showed that a decentralized supply chain is possible. In contrary, in a centralized supply chain, traffic congestions on the road can be avoided, as the centralized supply chain entails delivery of the raw material of the concrete by train.

Fig. 1. Constraints for the Supply Chain
Rys. 1. Ograniczenia łańcucha dostaw

QUALITY ASSURANCE In addition to the high demands on the quantity there are equally important requirements to the quality of the concrete. This is caused by the large spectrum of types of concrete. Manufacturers now are able to consider up to 250 different types of concrete. Especially for the use to build runways, the highest quality standards are required [Lingard, Eowlinson 1994]. This is mainly due to the usage of de-icing agents in the airport operations. After penetrating into the concrete surface it results a risk of alkali silica reaction. If such a reaction starts, known colloquially as "concrete cancer", there is no turning back of a complete destroying of the surface. The quality of the concrete is predominantly determined by the quality of its raw materials. In a centralized logistical supply chain, the effect on the quality of the concrete becomes inevitable. By minimizing the sources of raw materials to a few sources, quality assurance becomes much more effective [van Weele 2010].

CONTRACT STRUCTURE Besides these previous key constraints, an important aspect in the decision process for a logistical supply chain concept lies in the legal differences of the approaches. Whereas in a decentralized concept a somewhat classical contract structure with clear liability of the suppliers is applied, the contract structure in a centralized concept is more complex and involves certain risks. The antitrust law requires a legal unbundling of the operator of a centralized concrete plant and the individual contractors of the construction projects. Furthermore, contractors cannot be liable to obtain all concrete from a single plant in a monopolistic structure. As a result, in a centralized concept, the building owner has to provide the concrete for the individual contractors and the liability for the quality of the concrete lies on the operator of the concrete plant and respectively on the building owner himself. Therefore, the legal structure implies a considerable risk when applying a centralized logistical concept.

ECOLOGICAL AND SOCIAL SUSTAINABILITY The ecological and social sustainability of a supply concept is also significant. In a decentralized supply chain, approximately 500 daily trips by truck for the delivery of almost three million tons of gravel and 400,000 tons of cement have to be realized by truck on the public road network. In a centralized supply chain, these truck movements can be avoided and achieved train-bound. This leads to a reduction of traffic congestion and the emission requirements of the planning permission can be met [Ibrahim et. al. 2010].

THE DECENTRALIZED SUPPLY CHAIN

The decentralized supply chain implies the delivery of all necessary concrete from surrounding concrete plants. The analysis of the regions concrete plant structure shows, that all capacity as well as peak-loads can be handled from numerous plants within a radius of 30km around the airports construction site.

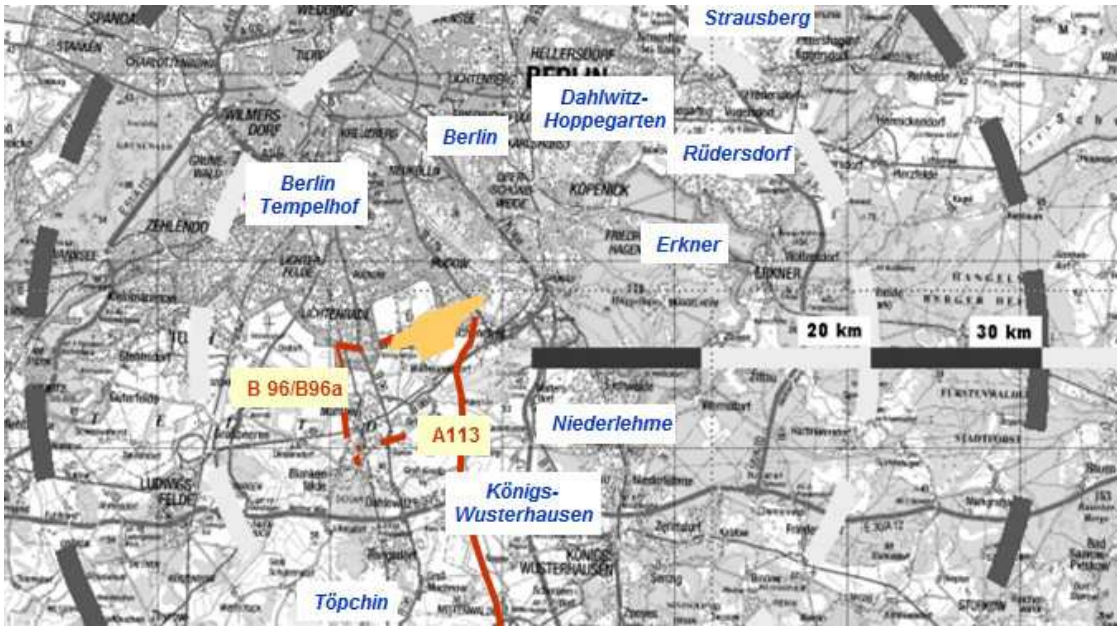

Fig. 2. Concrete Plants in surrounding area
Rys. 2. Wytwórnie betonu w analizowanej okolicy

The benefits of a decentralized supply chain concept lie in the simplicity of the legal structure as well as reduced investment costs. However, in this specific case, the fallbacks of a decentralized solution are significant. The risk of a breakdown of the supply of the construction site as well as the

risk of poor quality of the concrete outweighs the benefits of a decentralized concept. The feasibility of a centralized supply chain has to be tested.

THE CENTRALIZED SUPPLY CHAIN

In the decision process for a centralized solution, the security of the site and the quality assurance were of the utmost significance. By mixing the concrete on site, the usage of quality-reducing retarders could be prevented. The number of major suppliers is reduced to a few and simplifies the quality control drastically. Bottlenecks by road, just where the road connecting to the airport itself is constructed, could be circumvented. The logistical concept has its own consequences. The solution is associated with the construction of the most modern concrete mixing plant in Europe.

Fig. 3. Centralized Concrete Mixing Plant
Rys. 3. Scentralizowana wytwórnia betonu

With the help of six computer controlled mixing units, the factory can produce up to 960 cubic meters of concrete of different exposure classes. To assure the quality of the concrete, internal and external quality control with scientific support has been established to meet the high standards and prevent a concrete cancer.

Fig. 4. Concrete Plants in surrounding area
Rys. 4. Wytwórnie betonu w analizowanej okolicy

However, the central concept also has bottlenecks. The concrete components are carried over a single-track railway which is parallel used for the fuel delivery for the ongoing operations of the airport Berlin-Schönefeld. At peak times of up to eight trains per day, an excellence in the management of the trains is required. With a lack of redundancy, delays are fatal. With a specially designed tilting edge for the gravel processing and an air evacuation for cement trains the high discharging frequencies could be achieved. A safety stock, which covers the demand of four days, was part of the contract to assure the security of supply.

CONCLUSIONS

The requirements for the logistical supply chain for the construction site of the BBI airport are challenging. However, a centralized logistical supply chain could be implemented that meets all the individual constraints of the construction site. The key components of the concept are the on-site concrete plant, the delivery of raw materials by train, a centralized quality assurance and the specific contract structure with the operator of the concrete plant. Up-to-date, 2.5 million cubic meters of high quality concrete were delivered on time - the supply chain worked.

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BERLIN BRANDENBURG INTERNATIONAL (BER): PLANOWANIE I WDROŻENIE ŁAŃCUCH DOSTAW BETONU NA TEREN BUDOWY LOTNISKA

STRESZCZENIE. **Wstęp:** W wyniku podjętej decyzji o rozszerzeniu istniejącego lotniska Berlin-Schönefeld w nowe lotnisko Berlin Brandenburg International (BER) w 2006 r., wystąpiła konieczność budowy odpowiedniej bazy. Jednym z największych wyzwań było zapewnienie dostaw ok. 2,5 miliona metrów sześciennych betony najwyższej jakości potrzebnego do budowy nowego lotniska.
Ze względu na skalę przedsięwzięcia oraz uwarunkowania terenowe i środowiskowe, należało opracować nowe rozwiązanie logistyczne związane z zaopatrzeniem budowy w surowce.
Metody: Proces planowania zaopatrzenia budowy lotniska BER w dostawy betonu miał dwa podstawowe cele: stabilność dostaw pokrywających zapotrzebowanie budowy, tj. uniknięcie wszelkich opóźnień tych dostaw oraz zapewnienie najwyższych standardów dostarczanego betonu w celu uniknięcia reakcji alkalicznej w betonie i niepożądanej dezagragacji betonu. Efekty dodatkowe, jak na przykład emisja dwutlenku węgla lub wpływ realizacji dostaw na życie okolicznych mieszkańców tego regionu, stanowiły również kluczowe czynniki, które należało brać pod uwagę przy tworzeniu koncepcji łańcucha dostaw betonu. Analizie z punktu widzenia czynników ograniczających poddano dwie propozycje rozwiązania: dostawy zcentralizowane z wytwórni betonu położonej w bezpośredniej bliskości placu budowy wraz z organizacją dostaw surowców potrzebnych do produkcji tego betonu oraz zdecentralizowane dostawy z dalej położonych wytwórni - dostawy na teren budowy gotowego już betonu.
Wyniki: Przeprowadzona analiza ograniczeń i wpływu na kluczowe zapotrzebowania dostaw betonu potrzebnego do budowy lotniska BER doprowadziła do budowy najbardziej nowoczesnej wytwórni betonu w Europie. Korzyści z wyboru zcentralizowanego sposobu organizacji dostaw były bardzo istotne. Z jednej strony zapewniono dostawy najwyższej jakości betonu, z drugiej strony większość dostaw surowców, potrzebnych do wyrobu betonu, zostało realizowanych za pomocą połączeń kolejowych a nie drogowych, co przyczyniło się do przestrzegania zakładanych poziomów emisji.
Wnioski: Każdy logistyczny łańcuch dostaw ma swoje specyficzne wymagania i ograniczenia. Przedstawione podejście pokazuje, w jaki sposób zcentralizowane dostawy mogą spełniać wszystkie stawiane mu ograniczenia. Kluczowe komponenty koncepcji to: wytwórnia betonu zlokalizowana na terenie budowy lotniska, dostawy surowców transportem kolejowym, zcentralizowane zapewnienie jakości oraz indywidualna umowa z operatorem wytwórni betonu.

Słowa kluczowe: budowa nowego lotniska Berlin Brandenburg International, (BER), ekologiczny i społeczny zrównoważony rozwój, łańcuch dostaw, beton, planowanie i realizacja.

BERLIN BRANDENBURG INTERNATIONAL (BER): PLANUNG UND UMSETZUNG EINER BETONVERSORGUNGSKETTE FÜR DIE FLUGHAFENBAUSTELLE

ZUSAMMENFASSUNG. Hintergrund: Mit dem Entschluss zum Ausbau des Flughafens Berlin-Schönefeld zum neuen Flughafen Berlin Brandenburg International (BER) im Jahre 2006 entstand eine Baustelle der Superlative. Eine der größten Herausforderungen war dabei die Versorgung mit rund 2,5 Millionen m³ hochwertigem Beton, welche für den Bau des Flughafens benötigt wurden. Aufgrund des Ausmaßes dieses Vorhabens, sowie der Lage der Baustelle, , musste eine logistische Lösung für die Rohstoffanlieferung gefunden werden.
Methode: Die Planung der Betonversorgungskette für die Flughafenbaustelle BER musste im Hinblick auf zwei Hauptziele durchgeführt werden: Die Stabilität der Versorgungskette, um sicherzustellen, dass die Baustellenanforderungen erfüllt und Verzögerungen verhindert werden, wie auch die Sicherstellung der hohen Betonqualität und die Vorbeugung einer Alkali-Kieselsäure-Reaktion und des daraus resultierenden unvermeidlichen Zerfalls des Betons. Externe Auswirkungen wie der Kohlenstoffdioxidausstoß und die Auswirkung der Versorgungskette auf Anwohner waren Schlüsselfaktoren, welche in ein ganzheitliches Versorgungskonzept integriert werden mussten. Bei der Analyse wurden Randbedingungen für zwei verschiedene Ansätze betrachtet und gegeneinander abgewägt: Für eine zentrale Versorgungskette mit einer Betonfabrik vor Ort und vorgelagertem Transport von Rohstoffen versus einer dezentralen Versorgungskette mit Fabriken außerhalb und nachgelagertem Transport von fertig-gemischtem Beton.
Ergebnisse: Die Analyse von Randbedingungen und ihre Auswirkungen auf Schlüsselanforderungen der Betonversorgungskette für die Flughafenbaustelle BER führten zur Errichtung des modernsten Betonmischwerkes von Europa. Die Vorteile einer zentralen Versorgungskette sind bedeutend. Einerseits können die Qualitätsansprüche mit der Betonanmischung vor Ort und der zentralen Qualitätssicherung erfüllt werden, andererseits wurde der überwiegende Anteil

des Versorgungsverkehrs für die Baustelle von der Straße auf die Schiene verlagert und das Konzept erfüllte somit die Emissionsanforderungen der Planfeststellung für den Flughafen.
Fazit: Jede Logistikversorgungskette hat ihre eigenen individuellen Anforderungen und Einschränkungen. Dieser Ansatz zeigt, wie eine zentrale Versorgungskette eingeführt werden konnte, die alle diese individuellen Beschränkungen dieser Baustelle erfüllt. Die Schlüsselkomponenten des Konzepts sind das Betonmischwerk vor Ort, die Rohstoffanlieferung per Zug, eine zentrale Qualitätssicherung und eine spezifische Vertragsstruktur mit dem Betreiber des Betonmischwerkes.

Codewörter: Bau des neuen Flughafens Berlin-Brandenburg International (BER), Versorgungskette, Beton, ökologische und soziale Nachhaltigkeit, Planung und Umsetzung.

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