Title: A TEMPORARY CONCRETE BATCHING PLANT

Abstract: The present invention relates to a temporary concrete batching plant that encompasses all required elements to produce concrete as close as possible to a job site providing concrete in a safe and profitable way, with a high quality and minimizing the time of transportation. A transportable mobile equipment is also disclosed to assist in these purposes. It is also proposed an optimization of parameters regarding the production of concrete in the production plant.
A TEMPORARY CONCRETE BATCHING PLANT

FIELD OF THE INVENTION
The present invention is related to a method of concrete production in a transportable batching unit. The present invention encompasses all required elements to produce concrete as close as possible to a job site or inside the job site.

BACKGROUND OF THE INVENTION
Concrete is generally produced and delivered from a central large batching plant to dedicated job sites and users located in an area in a radius of less than 20 Km. Concrete is mainly transported by concrete trucks with a wide range of nominal capacity from 5 to 7 or even 12 M³ for bigger jobs.

Concrete delivery from a centralized large batching plant presents some drawbacks for large urban job sites. Typically, large job sites located in urban areas are facing a problem of traffic and room availability for trucks that has several consequences: on one side, the flexibility of dispatching and the "just on time" delivery of the concrete always represents a critical logistical problem. Usually a big number of trucks are required many times during the day, creating bottle necks where any delay gives room to losses of productivity and cascading effects on the overall progresses, enhanced by the problem of traffic, traffic jams and priority of delivery since a centralized batching plant has many simultaneous costumers. On the other side, the quality of the concrete, its placing properties are very much affected by the time the truck takes to transport the concrete from the centralized batching plant to the job site. Furthermore, the immediate need for concrete volumes and concrete types on a job site is versatile and varies from typically for 1 to more than hundred cubic meters, so that the delivery by trucks is sometimes highly inefficient, (when delivering only one cubic meter with a truck having a capacity 5 times larger) or triggers production jams (many trucks over a very short period of time) when dozen of cubic meters are required. In additional concrete returns for none conformity related to excess transportation time, to excess capacity of pure logistics issues between job site readiness of concrete delivery yields wastes and retardation in the building.

As fresh concrete cannot be store in large volume for obvious reasons, one solution to overcome some of these difficulties is to have a conventional concrete batching
plant dedicated to a large job site that is erected close to or inside the job site. This solution however requires a huge surface (over 1,500 m²), is very work and time intensive since the erecting/dismantling required times are important and eventually the solution is very expensive while transportation by trucks is still mandatory and you need place for the trucks to move inside the facility and to the job site.

DESCRIPTION OF THE INVENTION

The present invention is a temporary concrete batching unit that encompasses all required elements to produce concrete as close as possible to a job site, avoiding all problems mentioned above and providing concrete in a safe and profitable, technical and economical way, with a high quality and quality reliability that is a good, if not superior, to the one ensured by a large conventional batching plant.

Typically, 1 m³ of fresh concrete is made of 280 - 350 kg of cement (or up to 550 for self leveling concrete), 150 - 250 liters of water, 600 kg of fine aggregates (0.1 - 2 mm) and 800 kg of coarse aggregates (2-25 mm), some 1-2 kg of admixtures and in some cases some weight % of mineral additives, fibers, etc. Each concrete receipt or mix design is different, and each one requires an accurate dosage of each component to ensure quality, both for mechanical, and for placing properties and repeatability to ensure overall reliability.

The mixing of the ingredients to produce a homogenous concrete that is ready to use requires intensive mixing, over short periods of time. Finally the overall production throughput of the batching plant will be characterized by its maximal production capacity (maximum quantity of batch mixing by unit of time).

The invention is related to an. optimized overall system that encompasses the size and land footprint of the zone dedicated to the temporary batching plant as well as the storing, the feeding and the weighting of the various ingredients (aggregates of various types, sands, cementitious material or binder, additives, admixtures and water). The mixing of the ingredient to form fresh concrete, the interface between the mixing and the dispatch of the fresh concrete to the job site (buckets transported by cranes, concrete pumps, etc.), as well as the logistical aspects to supply the materials stored that are consumed to produce concrete.
The optimization is based on 6 main set of criteria:

- Minimizing the size of the production zone (PZ) while optimizing its shape with respect to the maximum nominal capacity of the non-permanent concrete batching plant, the refilling logistics for cement, aggregates, water and other consumables, including the access to the storage zones inside the production zone (PZ) for trucks.
- Delivering the concrete from the closest place directly to the job site.
- Optimizing the storage size of the consumed ingredients in the production zone with respect to the refilling logistics aspects and the nominal maximum production.
- Optimizing the quality of the various concrete that will be producing by reproducing at smaller scale of the technological key elements of a large plant.
- Minimizing the time to transport, erect and dismantle the non-permanent concrete batching plant by using the appropriate technology and avoid foundation work on the production zone (PZ).

A typical production zone according to the invention, including the transportable batching unit and additional elements coupled to the unit, comprises (as can be seen in figure 1a) and 1b):

- Aggregates storage zones (ASZ) that may have 2-4 types of different aggregates.
- Cement trailer (truck) discharging zone (CDZ).
- A cement silo (CS).
- An aggregates dosing zone (ADZ) comprising the hoppers and batch storage for aggregates (2-4 different types), the dosing system for aggregates (combination of scales and valves).
- Transportation system to transport the aggregates into the mixer, containers pumps and dosing systems for admixtures and water for the binder (cement).
- A mixer zone (MZ).
- A mixer discharge zone (MDZ) where the mixer discharging the fresh concrete ready to be used; the mixer discharge zone may be occupied by buckets that are distributed to the placing area in the job site by cranes, or by concrete pumps.
- A loader (LO) to execute all tasks related to the storage of aggregates, the transportation of aggregates from the storage zone (ASZ) to the various aggregates hoppers of the dosing system zone (DSZ).
- A zone ATZ (aggregates transportation zone) shared:
a) by the loader (LO) to transport the aggregates from the aggregates storing zone (ASZ) to the aggregates dosing system ADZ.
b) and the trucks (not shown) delivering and refilling aggregates to the aggregate storage zone (ASZ).

Alternatively to the example of the figure 1b), the aggregates dosing zone (ADZ) and the cement silo (CS) may be in parallel rather than in series, the cement container zone being longer that the aggregates dosing zone.

The whole surface footprint of the mobile equipment zone (MEZ) comprises at least the cement silo (CS), the aggregates dosing zone (ADZ), all the dosing systems conveying systems for cement and aggregates to the mixer (M) as well as the mixer zone (MZ). In addition, the MEZ may also encompass the water storage zone the zones for admixture storage (not shown).

With respect to figures 2a, 2b and 3a the surface SMEZ mobile equipment zone MEZ, can thus be characterized by a rectangular surface including the footprint projections at least the cement silo (CS), the aggregates hoppers (AH), the concrete mixer (M) and the aggregates transportation weighting system (ATWS) and cement transportation weighting system (CTWS).

The invention thus concerns a temporary concrete mixing plant with a nominal concrete production capacity of 25-30 m³/h, using a mixer with an individual batch capacity located between 0.7 m³ and 1.3 m³, and ideally having an overall surface footprint of the production zone (PZ) of around 400 m² although smaller than 650 m² to minimize the used space.

The overall arrangement of all zones and equipment is optimized to produce one batch of concrete every 2 to 2.5 minutes if required by the concrete consumption on the job site.

The invention therefore is related to the arrangements of the different zones (ASZ, CDZ, CS, ADZ, MS, MDZ at ATZ) with respect to the nominal production capacity in order to maximize the nominal production capacity, minimize the footprint of the production zone PZ and avoid problems with traffic and logistics matters by minimizing the critical refilling requirements for consumables.
The advantages related to the inventions are obvious with respect to the conventional concrete production and delivery:

- Flexible volumes of production as well as type of concrete to supply, adapted to the just in time concrete needs in quantity and type for the job site.
- Exclusivity of the plant production for the job site.
- Flexibility of the concrete receipts.
- No need for plant erection permits.
- Avoidance of traffic perturbation.
- Minimum surface requirement compared to the size of the job site itself (400 - 700 m²) compared to many thousands m² for an average building job site. Erecting time and dismantling time in less than a day.
- Flexible timing for concrete dispatching and delivery.
- Reduction of traffic in the job site since there are no concrete trucks moving inside the job.

The productivity of the none permanent concrete mixing plant is given by the size of the mixer defining the size of the concrete batch and by the number of batches per hour that can be produced including the following operations:

a) Feeding the aggregates hoppers (AH) (2-3) from the aggregates storing zone (AS2) using the loader (LO)

b) Dosing the aggregates using for instance balances and rotation dosing valves or motorized apertures (not shown).

c) Dosing the cement from the cement silo (CS) to the cement balance (not shown).

d) Transporting liquids (water, admixtures) to the dosing system (balances).

e) Inserting all ingredients in the concrete mixer (M).

f) Mixing all components in the concrete mixer (M).

g) Pouring out the concrete to a concrete pump or a container for concrete placing using a crane.

In a concrete plant according to the invention, all dosing and transportation operations for cement, aggregates, water, additives and admixtures are automatized using rotation valves, balances or scales, band conveyors for aggregates from the hoppers to the mixers, screw or pneumatic conveyors for and balances for the fine powders like cement or additives pumps, mass-flow meters or balances for the liquids
like water or additives, and all process are controlled with a PLC or a PC. Therefore, some operations can be done in parallel if need be. For instance, operations a), b) c) and d) can be done in parallel.

Typically, all automatic operations from a) to g) will take around 2 minutes when optimized.

On figures 2 and 3 the aggregates hoppers (AH) have typically a nominal capacity that is superior to the maximum requirement (depending on the concrete mix design) in aggregates volume of each type per cubic meter of concrete produced. For a mixer with a batch capacity of 1m³, aggregates hoppers will typically have a capacity of around 1 m³. This means that for each batch, the loader (LO) will have to feed each hopper (2-3 hoppers) at least one time, meaning that the loader (LO) will have to load aggregates in the aggregates storage zone (ASZ) and transport them to the hoppers 2 or 3 times per concrete batch depending on the mix design that may requires 2 or respectively 3 types of aggregates.

The loader LO is typically a wheel loader with a bucket capacity of around 1 m³.

The cement silo (CS) on the other hand is designed to minimize the number of refill since such refill cannot be performed by a manual or semi manual operation. The transportation and moving of cement is highly hazardous due to the nature of the cement powder. Therefore, refilling operations of the cement silo (CS) according to the invention is done using a conventional cement trailer that is placed in the CDZ zone according to figure 1, typically located along the mobile equipment. The transfer of the cement from the trailer to the cement silo (CS) is normally performed used the pneumatic equipment of the cement trailer. The operation of moving the cement to the cement silo takes from 30 minutes to 1 hour. Cement trailer or semi-trailer are of large dimensions (over 15 meters in length) and their insertion into the traffic is complicated. A cement trailer or semi trailer has nominal capacities of 35 - 45 tons and in order to minimize the number of refilling operations and to use the full capacity of the cement trailers, the cement silo (CS) according to the invention will have a nominal storage capacity in the same range as the cement trailer.
The conventional average cement consumption per cubic meter of concrete is 320 kg, so the cement silo (CS) according to the invention is capable to store cement for a production of over 100 cubic meters of concrete, corresponding at full plant production capacity of 3 hours of capacity.

The aggregates (sand medium and/or coarse aggregates) are not hazardous and conventional dump trucks can be used to refill the aggregates storage zone (ASZ). According to the invention, the aggregates storing zone (ASZ) per type of aggregates has a footprint of 10-15 m², and the each half pile (wall end) has a capacity of 15 - 22 m³ corresponding to 25 to 35 tons.

Each cubic meter of concrete consumes around 800 Kg of coarse aggregates so the storage capacity according to the invention enables to produce 30-35 cubic meter of concrete before refilling is required. Therefore, at maximum capacity, the aggregates storing zone (ASZ) is designed to ensure at least one hour autonomy of concrete production.

Dump trucks for 25 - 35 tons have an average length of less than 10 meters that makes them easier to manoeuvre in the traffic and inside the production zone (PZ).

Water storage as well as admixtures storage (both not shown) are smaller in volumes than the cement and aggregates storage. Water storage is for instance of 3-10 cubic meters and is easy to refill whereas the admixture storages have individual volume of 1 cubic meter.

Preferably, all the elements of the mobile equipment are placed on a common transportable frame that can be trailed. Alternatively, the water storage and the admixture storage are also placed on the common frame, minimizing the work required for connections while erecting the plant. The transportable frame encompassing all the elements of the mobile equipment can be placed in the production zone (PZ) without requiring any foundation.

The transportable frame encompassing the elements of the mobile equipment may also comprise a concrete mixer (M), an electrical generator, a hydraulic pump and a pressed air compressor.
With respect to figures 1 and 2, the size of the production zone (PZ) according to the invention is typically around 400 - 600 m² for a nominal maximal productivity of 25-30 m³/h. The dimensions of the PZ are optimized to ensure the minimum footprint. Typical dimensions according to the invention are the following: length of the production Zone LPZ= 22 m to 35 m and width of the production zone WPZ: 16 - 22 m. The mobile equipment comprises at the cement silo (CC), arranged horizontally, the aggregates hoppers (AH), the aggregates transporting and weighting systems (ATWS), the cement transporting and dosing system (CTWS); the mobile equipment is normally placed parallel to the length of the LPZ.

According to the invention, the various zones with dedicated functionality have the following respective sizes, in the case of a maximum nominal productivity of 30 m³/h.

The cement discharge zone (CDZ) is the largest zone, and occupies a surface of 220 to 260 m².

The mobile equipment zone (MEZ), including the mixer (M) is typically using a surface of 35m² to 50 m², with a length that varies from 10 to 18 meters.

The aggregates storage zone (ASZ) is using around 15 m² to 30 m² per aggregates type (up to 4 types).

According to the previous description, the nominal productivity of 30 m³/h cannot be maintained for hours, mainly since aggregates silos needs to be refilled and since the loader (LO) will have to be used to arrange the aggregates half piles once refilled material has been delivered.

In reality, the concrete request for the job site is not steadily at maximum production capacity; over time, and in average over some days, the real production will be located around 60-65% of the nominal maximum capacity or 18-20 m³/h. This of course depends mainly on the job site's organization.

Nevertheless, the most important aspect of the invention is that the nominal capacity of 30 m³/h can be achieved and maintained for at least 30 to 60 minutes.
**BRIEF DESCRIPTION OF THE FIGURES**

Figure 1 (a and b) provides a schematic top view of the production zone PZ with the different zones.

Figure 2a) and 2b) show a top view of a detailed production zone PZ for a specific lay-outs

Figure 3a) is an elevation schematic view of an example of the assembly for the transportable plant including the cement silo, the hoppers and scales for aggregates, the water silo, the transportation band and the dosing system for the cement and admixture.

Figure 3b) is an elevation schematic view of an example of the assembly for the transportable plant including the cement silo, the hoppers and scales for aggregates, the water silo, the transportation band and the dosing system for the cement and admixture, together with a planetary concrete mixer drum.

**EXAMPLES OF THE INVENTION**

Example 1. Concrete production tests

Different test were performed for different values of Vcs, Pmax, SPZ, FcemR and Mez parameters of the concrete plant facility. The optimization additional plant parameter Optim can be calculated according to equation (1):

\[
\text{Optim} = \frac{1}{100 \times \left( \frac{\text{Vcs}}{\text{SPZ}} \times \left( \frac{\text{Pmax}}{\text{FcemR} \times (\text{SMez})^2} \right) \right)}
\]

where:

- Vcs: is the volume of the cement silo (using an average bulk density of 1.7 ton/m3).
- Pmax is the maximum nominal production capacity of the non permanent concrete batching plant
- SPZ is the surface of the production zone
- FcemR: is the required refill rate per hour at nominal max capacity for cement
- SMez: surface of the mobile equipment including mixer
The following table shows the value of Optim for different values of Vcs, Pmax SPZ, FcemR and SMez:

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The optimal conditions in terms of flexibility, versatility, productivity, foot print of the whole production zone and traffic perturbations is found for Optim values located between 1 and 7.

Higher values leads to inefficient layout and production with respect to the criteria, whereas values below 1 requires a inadequate relation between production and refilling matters, leading to additional issues and jams or leading a to a cement silo size that would be too large for easy transportation.

**MAIN ACRONIMIS**

ADZ: Aggregate dosing zone;
AH: Aggregates hoppers
ASZ: Aggregates storage zones;
ATWS: Aggregates transporting and weighting systems;
ATZ: Aggregates transportation zone;
CS: Cement silo;
CDZ: Cement discharging zone;
CTWS: Cement transporting and dosing system;
DSZ: Dosing system zone;
MDZ: Mixer discharge zone;
MEZ: Mobile equipment;
MZ: Mixer zone;
M: Mixer;
LO: Loader;
PZ: production zone;
WS: Water storage;
CLAIMS

1. A temporary concrete batching plant including at least:
   a) at least one transportable mobile equipment including, at least:
      • a cement silo,
      • at least 2 aggregates hoppers,
      • a concrete mixer,
      • transportation, weighting and dosing means between the silo, hoppers and the mixer,
   b) an aggregate storing zone for at least 2 different types of aggregates,
   c) one water storage,
   d) a control system to fully operate the concrete mixing plant,
   e) a loader;

characterized in that:

a) the temporary plant parameters being expressed by the dimensionless parameter Optim as follows:

   Optim = 1 / (100 * [Vcs / SPZ] * [Pmax / (FcemR * (SMez)^2)])

   where:
   Yes: is the volume of the cement silo;
   Pmax is the maximum nominal concrete production capacity;
   SPZ is the surface of the production zone;
   FcemR: is the required refill cement rate per hour at nominal maximal capacity;
   SMez: is surface of the mobile equipment including mixer;

b) the parameter Optim being located between 1 and 7.

2. A temporary concrete batching plant according to claim 1, wherein the loader has a capacity of at least 1 ton.
3. A temporary concrete batching plant according claims 1 or 2, wherein the overall footprint surface of the production plant (SPZ) is larger than 350 m² and smaller than 700 m².

5. A temporary concrete batching plant according to claim 3, wherein the nominal maximum concrete production capacity is located between 20 and 40 cubic meters per hour.

10. A temporary concrete batching plant according to claim 4, characterized in that the cement silo is placed horizontally on the transportable equipment layout and has a volume of at least 20 cubic meters.

15. A temporary concrete batching plant according to claim 5, characterized in the mixer has a volume capacity of concrete batches from 0.7 to 1.4 m³.
A. CLASSIFICATION OF SUBJECT MATTER

According to International Patent Classification (IPC) or to both national classification and IPC:

B28C9/04

ADD.

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B28C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched:

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of Box C. See patent family annex.

Date of the actual completion of the international search: 25 April 2013

Date of mailing of the international search report: 10/05/2013

Orij, Jack

[Box C]

*Special categories of cited documents:

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