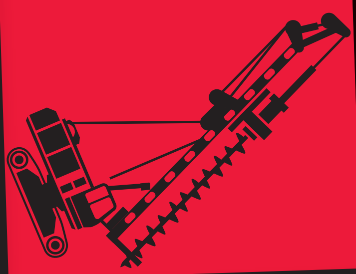
CLIENT / PRINCIPAL

PLANNER / PROJECT CONTROLLER

BUILDING CONTRACTOR

STOPP



MACHINE TIPPING OVER

LEAFLET FOR THE PREVENTION OF MACHINE TIPPING OVER IN SPECIAL FOUNDATION ENGINEERING

STOPP MASCHINEN UMSTÜRZE

CONTENTS

STOPP MASCHINEN UMSTÜRZE

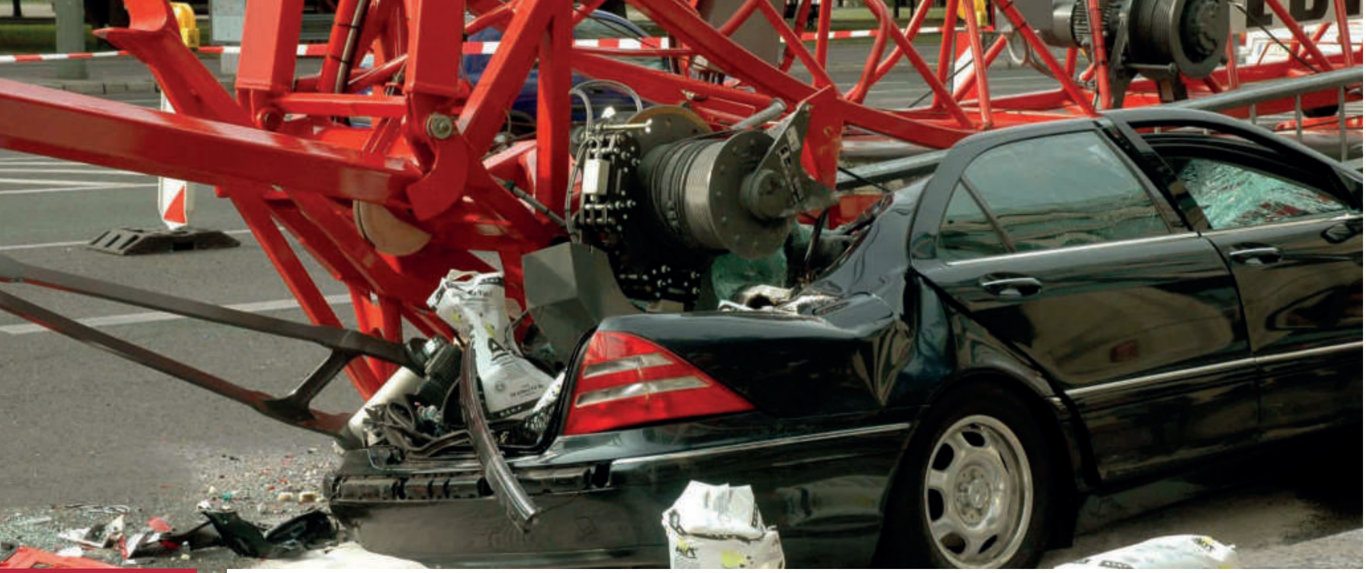
MOTIVATION AND PROBLEM

It is normally the case that equipment that is used in special civil engineering has a high dead weight and a system centre of gravity that is also high. Their travel and working movements also result in cyclical and dynamic loads being transferred into the ground. They are therefore susceptible to a risk of tipping over when in use on the construction site. Outmost importance is to be given to the prevention of large pieces of equipment from tipping over both from an occupational safety and an economical point of view as the tipping over of large pieces of equipment is the cause of the most serious accidents of construction activities. Not only are employees at risk of suffering severe or fatal injuries, a great risk is also posed to uninvolved third parties. Accidents and "near misses" also place the construction site personnel under a heavy burden, possibly resulting in a temporary or permanent incapacity to work. This often goes hand in hand with massive production losses and additional costs as a result of project delays. Last but not least, this can cause a considerable loss of image for those participating in the construction and the construction project as a whole.

Practical experience has also shown that the installation of professional working platforms results in an improved working performance, as the implementation and work processes are accelerated, etc. The consequence is that economical working is possible so that the client is provided with a direct benefit.

An analysis of more than 75 cases of equipment tipping over on special civil engineering construction sites in Germany and abroad has concluded that the majority of the tipping over occurred as a result of an inadequate working platform. Additional fundamental aspects are the qualification of the equipment operator and the construction site personnel in addition to the coordination, controlling and communication on the construction site. A defective equipment technology was only responsible for the tipping over in a few cases.

The editors have intensively researches this subject in recent years in addition to having worked in cooperation with experts, research facilities, training facilities, subject experts and legal experts on specific recommendations of actions for those involved in the construction process.



1. SCOPE OF VALIDITY

The information leaflet provides information on the planning, installing, driving on and maintenance of special civil engineering working platforms including the access roads to the construction site, the preparing of driving surfaces and ramps in the excavation pit.

Special civil engineering work is substantially deemed to be:

- drilling work according to ATV DIN 18301
- trench sheeting work according to ATV DIN 18303
- ramming, vibrating and pressing work according to ATV DIN 18304
- water retention work according to ATV DIN 18305
- injection work according to ATV DIN 18309
- slurry trenching work according to ATV DIN 18313
- jet grouting work according to ATV DIN 18321
- foundation soil improvement work according to DIN EN 14731
- anchoring and nailing work according to ATV DIN 18301 and 18309

and

- drilling work for geothermal energy close to the surface.

The information leaflet is not valid for contact surfaces for mobile cranes, mobile excavators, mobile concrete pumps, wheeled hoisting platforms and other vehicles with tyres. The information leaflet is also not valid for work on floating equipment.

TERMS

2

Working platform (also often referred to as a work formation level or a work level)
Level surfaces that exist naturally or are created as a result of planned earth working measures with adequate load-bearing capacity to ensure a secure and suitable placement of all special civil engineering equipment, vehicles and equipment normally equipped with crawler tracks, taking into account all of the controlling operating and load conditions and the respective construction site conditions.

Contact surface
Direct contact surface (area of contact) between the crawler track and the working platform.

Maximum stress or tension σ
The maximum stress or tension σ that is generated as a result of the maximum load that a special civil engineering machine applies to the working platform. This is typically specified as kN/m^2 ($1\ kN/m^2 = 1 kPa$).

Stability
The stability is the requirement of a structure and equipment that it is unable to collapse or tip over. The stability is calculated as a quotient between the absorbable loads and the existing loads.

3 WHY EQUIPMENT TIPS OVER

GENERAL PRESENTATION OF THE PROBLEM

3.1

The basis for working with special civil engineering equipment that is deemed to be safe under all of the decisive operational and load conditions is an adequately dimensioned working platform as especially high drilling and pile driving machines are subjected to specific stability problems. The reasons for this are the high centre of ravity position that permanently changes and the associated focus exentricity. The inclination changes and the pivot angle changes therefore substantially influence the stability of these types of equipment to a greater extent than is the case with normal excavating machines (e.g. crawler excavator). Furthermore the subsoil is very frequently subjected to process-related extreme tensile forces and dynamic loads in the course of the working process.

The stability of special civil engineering equipment is regulated in DIN EN 16228 "Drilling and Foundation Equipment". This stipulates that the manufacturers are to design and manufacture the equipment to be stable under the intended operating conditions (transportation, erection, moving, placing and working) and without risk of tipping over. Anticipated misuse is also to be taken into account. The results of the calculations and the assumptions that are made hereby – e.g. the maximum angle of inclination of the leader – are to be stated as the threshold values in the operating instructions of the equipment. This only provides information on the stability of the rigid body, i.e. the use on a rigid substrate.
The reality in the special civil engineering practice is unfortunately not adequately represented with this view. In fact the foundation soil reaction under the tracks is highly ductile from a soil mechanics point of view creating lasting deformations.
The stability of the equipment can also be placed at risk when in use on the construction site as a result of additional effects such as the consolidation or time-settlement behaviour of cohesive soils, soil displacement, creep settlements and liquefaction effects under the dynamically moved tracks or as a result of the application of vibrational energy when carrying out vibration and pile driving work for example.

ANALYSING THE CAUSES OF THE TIPPING OVER

3.2

The analysis that was performed regarding the 75 cases of equipment that tiped over in the construction industry resulted in the determination that all of those involved in the construction work (the equipment manufacturer, the client/principal, the planner, the controller, the building contractor, the subcontractor, etc.) need to act in accordance with their tasks and obligations to a greater extent than is currently the case, to prevent accidents. Tipping over is often the result of a combination of various causes.

The following list of accident causes is presented in principle, regardless of the respective responsibility that can vario from construction site to construction site.

Cause of the turnover – inadequate working platform

The following causes were determined (no ranking implied):

- inadequate density and quality of the executed working platform (e.g. type and installation, soil engineering materials, geotextiles)
- inadequate width of the working platform
- inadequate labelling of the working platform, i.e. load-bearing areas
- maintenance of the working platform (subsequent improvement, drainage etc.)
- unidentified structures or foundation soil anomalies in the subsoil
- unsatisfactory filling/compacting after completion of previous work or work that is being carried out parallel to this (e.g. trenches, manholes, boreholes)
- excessive inclination of working platforms, ramps and access roads
- not taking special events into account (freeze-thaw changes, heavy rainfall, etc.)

Other causes for tippimg over

- inadequately qualified machine operators (operating error – risks are not detected and/or not taken account of, inadequate knowledge of the "physical limits" of the equipment that is used)
- inadequate qualification/awareness of the other construction site personnel and the other construction work participants (risks – such as permissible boundary loads/load torques - are not detected and/or not taken account of)
- deficient coordination, communication and control on the construction site (intra-company and inter-company)
- errors made when servicing and repairing the used construction equipment
- a lack of rules and contractual agreements with regard to the planning, manufacturing, operating/ controlling of the working platform
- general time and costs pressure
- too many construction site activities parallel to each other
- non-observance of intermediate construction stages

4 RESPONSIBILITIES OF THOSE INVOLVED IN THE CONSTRUCTION WORK IN ORDER TO PREVENT MACHINES FROM TIPPING OVER

GENERAL ASPECTS

4.1

On the basis of their legal position within the construction project and their professional competences, those involved in the construction work have different responsibilities in connection with the prevention of accidents. Clear regulation of responsibilities in connection with the planning, installation, maintaining and controlling of the working platform is essential for this.

In addition to the obligations that the contractor has in the scope of the preparation and execution of the construction work, the client/principal and the supporting specialist planners (load-bearing structures designer, the controller, the soil expert, construction supervision) all have a special responsibility for the safety of the construction work they have carried out.

The client/principal and the specialists that support them have joint responsibility for safe working in civil engineering. The legal provisions (e.g. in labour law, construction contract law, criminal law) necessitate a consistent and serious addressing of the correct exploration, planning, installation and adequate maintenance of an adequately safe working platform. Special attention needs to be paid to a stable platform as a large number of the above accident causes can be avoided with a foresighted and professional planning and controlling of the construction process.

The following chapters 4.2 - 4.4 present specific responsibilities.

RESPONSIBILITIES OF THE CLIENT/PRINCIPAL

4.2

The principal/client is responsible for the provision of a suitable piece of land and a suitable working platform with an adequate load-bearing capacity (§ 4 (3) of the Construction Tendering and Contract Regulations (VOB/B) in conjunction with DIN 18299 Sections 0.1.9, 0.1.10, 0.1.15 and 0.1.16 in addition to Section 2.1.3, etc.).

The principal is also responsible for ensuring that a corresponding regular investigation of the construction site is carried out prior to commencement of the construction work also concerning the load-bearing capacity of the subsoil in regarding subsequent driving of heavy equipment (conform with DIN EN 1997-2, DIN 4020). A compulsory part of this is the taking of the subject "working platform" into account in the subsoil expertise or geotechnical report, respectively. The knowledge gained as a result are to be taken into account during the planning. The working platforms and all related performances hereto (e.g. maintenance and dismantling) are to be subjected to a detailed invitation to tender.

The assigning of the responsibility to provide a suitable piece of land and a suitable working platform to his planner or another agent, should be recorded in writing for evidential purposes. The release of the working platform at a very early phase is to be documented in writing and handed in time to the parties involved in the construction work as a requirement for the commencement of the construction work. Delays to the commencement of the construction work or work interruptions could otherwise result.

The costs incurred for the provision of the working platform and the related investigations and planning performances are normally borne by the principal/client. It is recommended that a clarification be carried out at an early phase in order to gain knowledge with regard to the load-bearing capacity of the soil (please refer to ATV DIN 18299, Sections 0.1.9 and 0.1.10).

It is also fundamentally the case that costs incurred for a necessary removal of existing or detected obstructions or damaging inhomogeneities in the subsoil or similar circumstances, wich could place the load-bearing capacity of the soil and the required working platform above it at risk, are also to be borne by the client/principal (please refer to ATV DIN 18299 Section 4.2.15, DIN 18300 Sections 3.1.5, 3.1.6, 4.2.1; DIN 18301, Sections 3.1.7, 3.1.8, 4.2.1).

Should it be the case that obstructions or inhomogeneities (e.g. old cables, shafts, cavities, soft spots, etc.) are detected during the construction work or should there be a suspicion that such could pose a risk when driving on the working platform, a written order for the suspension of the construction work is to be issued without delay. Should this necessitate to the adoption of corresponding securing measures, the principal is to bear the incurred costs (please refer to ATV DIN 18299 Section 4.2.15, DIN 18300 Sections 3.1.5, 3.1.6, 4.2.1; DIN 18301, Sections 3.1.7, 3.1.8, 4.2.1).

- Substantial importance is to be attached to agreeing on a realistic period of construction (observance of the weather conditions, the cooperation between different trades, etc.) – taking a professional installation of the working platform into account.
- The principal/client is responsible for the on-site and time-related coordination of the different trades on the construction site (e.g. by the health and safety coordinator). This also includes clear rules regarding the specific responsibilities of those participating in the construction work in connection with the working platform.
- The aforementioned responsibilities are fundamentally valid for both public and private clients since the underlying regulations are based on present recognised state of the art. These are generally binding. In case of private clients, a deviating agreement is possible in individual cases, but this necessitates a specific risk allocation.

RESPONSIBILITIES OF THE PLANNER AND THE PROJECT CONTROLLER

4.3

- The planner is responsible for instructing the principal on the necessity to determine the quality and the bearing capacity of the foundation soil. Additionally, the extent and the quality of the execution of the required working platforms needs to be determined. This also includes performing standard foundation soil investigations so that a qualified analysis out of the foundation soil situation can be performed (DIN EN 1997-2 or DIN 4020).
- Typically the (specialist) planners assume responsibility for the obligations and duties of the principal/client listed in Chapter 4.2. The assuming of the responsibility for the obligations should be recorded in writing for evidential purposes.
- This includes the compulsory inclusion of the subject "working platform" in the foundation soil expertise or the geotechnical report respectively. The resulting knowledge is to be taken into account at the planning phase. The working platforms and all of the related performances (e.g. maintenance and removal) are to be the subject of a detailed invitation to tender. The responsibilities of each of those involved in the construction work are hereby to be clearly regulated.
- The approval of the working platform in good time is to be documented in writing and handed to the each of those involved in the construction work in good time as a prerequisite for the commencement of the construction work. Delays to the commencement of the construction work or work interruptions could impend otherwise.
- It is to be taken into consideration that the aforementioned standards are deemed to be recognised states of the art and that the adherence to such are the responsibility of the principal in addition to them being technical construction regulations as defined in DIN EN 1997-1.

EXTRACT:
DIN EN 1997-2:2010-10

2 PLANNING OF FOUNDATION SOIL INVESTIGATIONS

2.1.1 GENERAL ASPECTS
• (1)P Geotechnical investigations are to be planned so that the fundamental geotechnical information and parameters are certain to be available during the various project phases. The geotechnical information have to be sufficient so that known or anticipated risks for the construction project can be dealt with. As far as the states of construction and the final state are concerned, information and data are to be made available in order to cover the risk of accidents, construction delays and damage.

2.1.2 FOUNDATION SOIL

• (1)P The foundation soil investigations are to provide a description of the foundation soil situations that are decisive for the intended construction project in addition to them providing a basis for the determination of the geotechnical parameters that have validity for all of the states of the construction.
• (2) If possible, the information that is gained, should enable the evaluation of the following aspects.: [...]
• the deformation of the foundation soil by the building structure or by construction work, its spatial extent and its timly progression;
• the safety with regard to the boundary conditions (e.g. soil subsidence, soil uplift, buoyancy, soil slides and rockslides, a buckling of piles, etc.):
• [...]
• Effects of the construction work on the environment.
• In the scope of his performance, the planner / project controller also has a liability to enabling the construction work to be carried out without risks. He therefore also actively controlls the process up to the installation of a work formation level that is capable of load bearing and is suitable. It is especially the case that the bearing capacity of the existing soil is to be ensured as a result of a clarification of the soil situation in good time, so that the planning can be adhered to both in economical and construction duration terms and all of those involved in the construction work can work without risks.

EXTRACT:
DIN EN 1997-1:2014-03

DIN EN 1997-1 is a technical construction regulation.

11.3 INFLUENCES AND DESIGN SITUATIONS

• [...]
• (2)P The effects of the following circumstances are to be included in the considerations if appropriate:
• the construction method;
• [...].

11.4 CALCULATION AND EXECUTION ASPECTS
• [...]
• (6)P The planning is to be carried out so that all of the on-site construction activities are planned and executed so that an occurrence of boundary conditions in connection with the load-bearing capacity and the suitability for use are sufficiently unlikely. [...]

Sufficient information such as the relevant parameters for the special civil engineering equipment and the work processes (also refer to the table in Annex 1) exists for the stated planning tasks. Should isolated information nevertheless be missing, these need to be requested from the executing building contractor by the client and his planner.
It is hereby to be ensured that the latest state of the execution planning takes the actual equipment and the construction method into account.

- There is also an obligation to provide information and instructions with regard to the potential risks that are posed to the own employees on the construction site by the use of heavy equipment (Sections 4 and 12 of the German Health and Safety at Work Act - ArbSchG). This instruction is to be documented.

- The following is especially to be taken into account should the person concerned also be the site manager: an obligation to provide information and instructions with regard to the risk posed by an instability in the subsoil also exists towards the other companies and persons that work on the construction site should numerous companies or different trades (including structural engineering or finishing trades) work parallel or subsequent to each other on the construction site. The information concerned is also to be made available to the health and safety coordinator.

- Should instabilities resulting from subsoil conditions be encountered in the course of the construction work, or should there be a presumption that such instabilities could exist, suitable measures are to be taken without delay. This even includs a stopping of the construction work if necessary.
A suitable form of appropriate securing measures are to be adopted.
The costs incurred for such measures are to be borne by the principal/client, unless otherwise stated in the contract.

Scheduled tipping test as part of equipment driver training („Point of No Return")

RESPONSIBILITIES OF THE BUILDING CONTRACTOR

4.4

It is fundamentally the case that prior to commencement of the construction work, the contractor is to ensure that he is in possession of adequate information pursuant to ATV DIN 18299, Sections 0.1.9 and 0.1.10 VOB/C. This information is normally to be provided by a suitable specialist planner/foundation soil expert, commissioned by the principal/client.

In the event of adequate foundation soil and groundwater information not being provided (including such regarding obstructions or inhomogeneities in isolated cases), a concerns report pursuant to Section 4 (3) VOB/B in conjunction with an impediment report pursuant to Section 6 (1) VOB/B are to be sent to the client and his construction supervisor/planner. Both the written form requirement and the proof of receipt are hereby to be taken into account.

Should the contractor assume that there are obstacles/instabilities in the foundation soil in isolated cases, suitable measures are to be adopted without delay, even including a stopping of the construction work if necessary and the construction site is to be secured correspondingly. It is also the case here that a corresponding written concerns report pursuant to Section 4 (3) VOB/B and a written impediment report pursuant to Section 6 (1) VOB/B are to be sent to the client and his construction supervisor/planner without delay.

Should it be determined during the construction work that there are signs that the equipment and the employees on the working platform could be subjected to instability, the work is to be stopped without delay, the construction site is to be secured accordingly and the further procedures are to be discussed with the client and his specialist planner.

It is fundamentally the case that there is an information and instruction obligation towards all of the employees that work on the construction site with regard to possible instabilities (Sections 4 and 12 ArbSchG). The entire construction site personnel is hereby to be sensitized on the risk of equipment tipping over. These instructions are to be documented accordingly.

Companies and their employees have to inform each other of working platforms that do not have a load-bearing capacity and equipment that tips over. Agreement is to be reached on possible measures to prevent risk situations.

Sensitization and adequate qualification of the construction site personnel with regard to the risk of equipment tipping over.

Upon request: supporting the planner by forwarding the specific equipment and work data for the planning and invitation to tender for the working platform on the construction site.

5 PLANNING

GENERAL ASPECTS

5.1

The installation of a secure working platform that is suitable for use is a geotechnical construction measure that necessitates a corresponding specialist planning incl. investigation.

This is also to include water retentions and/or drainage measures if necessary. The results of the specialist planning form the basis for a detailed invitation to tender.

PLANNING BASICS

5.2

Geotechnical report or geotechnical expertise

A geotechnical report or a geotechnical expertise that meets the requirements of DIN EN 1997-2:2010-10 (EC) and DIN 4020: 2010-12 is an indispensable basis for the planning of the installation of a load-bearing working platform. Geotechnical investigations conform with this standard are the requirement for proof of stability in soil and foundation engineering as defined in DIN EN 1997-1:2009-09 (EC 7-1) and DIN 1054: 2010-12.
Therefore the geotechnical report or geotechnical expertise respectively is not only to concern itself with the foundation situation concerning the future building structure. On the contrary, an investigation of all of the areas of the required platform is to be carried out in terms of the load-bearing capacity in addition to any existing cavities, filled cellars, former watercourses, bodies of peat, soft spots, lines and conduits or trenching. The investigation work for the water drainage, water discharge/drainage measures that are normally necessary are also to be carried out in connection with this.
It could make sense in the interest of economical working, to break the working platforms down into different design scenarios.
The following differentiations could be made for example:

- pure driving surfaces
- access roads and ramps
- working platform "Type A" with max. bearing pressures, e.g. for the installation of standard vertical piles
- working platform "Type B" with temporary max. bearing pressures (e.g. special piles in corner arears with very high max. bearing pressures).

It is to be ensured in all cases that the construction site personnel has been informed and that the areas with varying load-bearing capacities are clearly discernible and permanently designated.

Specific equipment data for evaluation of the stability

DIN EN 16228-1: 2014 "Drilling and Foundation Equipment - Safety" forms the basis for the stability evaluation of equipment used in civil engineering – especially large equipment in special civil engineering. In addition the manufacturer is being placed under an obligation of Chapter 5.2.3. to provide proof of the stability based on calculations made. All conceivable operating statuses and transfer operations are hereby to be recorded. The calculations are made under the assumption that the equipment is on solid ground. Chapter 5.2.3.7 "Bearing pressure" in DIN EN 16228 refer to Annex F with regard to the calculation of the bearing pressure.

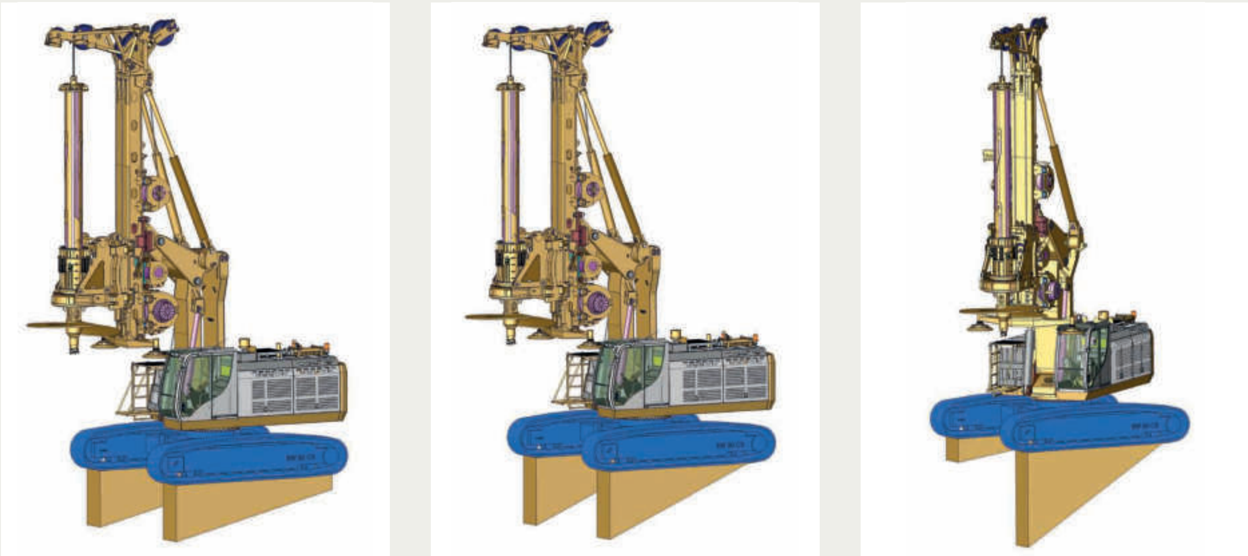
The maximum bearing pressure is to be calculated conform with Annex F of the aforementioned DIN EN 16228. The manufacturer is to state the calculated max. bearing pressure in kN/m² for all of the operating conditions, load positions and transfers made and is to document these in the operating instructions. The datasheet for the special civil engineering equipment is to present the max. bearing pressures for the decisive operating statuses in a pictorial and clear manner.

Typical large equipment that is used in special civil engineering generates average max. bearing pressures of approx. 600 kN/m². Extreme working positions can however generate maximum values that exceed this, that need to be especially taken into account. These bearing pressures can exceed 1.500 kN/m².

NOTE:
The information provided in Annex 1 (table) is initially deemed to be rough orientation values for an initial estimation of a stability evaluation (preplanning) and do not replace the specific proof of the necessary bearing pressures for the specific machine that is in use on the construction site. This data needs to be put in more specific terms in the course of the execution planning with regard to the equipment that is used and the construction method.

As far as older equipment is concerned, for which a calculation of the max. bearing pressure does not exist, the planner is to at least request the following equipment data for the calculation of the decisive operating statuses:

- the force P applied to a chassis in Newtons
- the eccentricity e of the force in metres
- the length d of the contact surface (e.g. crawler track unit) in metres
- the width b of the contact surface in metres.



Principle representation of the surface pressure under the chains of a rotary drilling rig with Kelly equipment for different load positions

The specific geometry of the used equipment is also to be taken into account when planning the working platform. This has an influence on the permissible inclination of ramps for example (the standard inclination is between 1:6 and 1:10) depending on the machine, the width of the working platforms and the driving surfaces and the location of the equipment in relation to the member that is to be constructed (inclined piles, piles in cornet areas, etc.). Adequately sized manoeuvring and erection surfaces that have a load-bearing capacity, minimum clearances from members, secure standing surfaces for the operating personnel and surfaces for the use of any auxiliary equipment that might be required (mini-excavators, telescopic forklifts, mobile cranes etc.).

The working platforms are to be designed so that all of the starting points for the foundation elements that are to be installed can be reached without difficulty when taking the inclinations and the position of the equipment into account, also having an adequate safety clearance from the edge of the working platform (this is normally a minimum of 1.00 m from the outer edge of the crawler). The required safety clearances in the area of slope edges, etc. are also to be taken into account.

While planning, the professional drainage of the working platform is also to be planned by installing drainage/material that is able to drain water and/or the installation of drainage trenches. This is valid both for precipitation water and for water from the work process.

RESULTS OF THE PLANNING

5.3

Proof of the conducting of plate load tests normally suffices for paved traffic surfaces or alternative/ estimated development of a working platform with a load-bearing capacity on a foundation soil that is proven to have an adequate load-bearing capacity (e.g. undisturbed and compacted soil that is non-cohesive). It is to be ensured necessary that the foundation soil also has an adequate load-bearing capacity beneath the tested soil stratum (the normal testing depth is approx. 30 cm) down to the influencing depth of the load effect. Additional tests might be necessary depending on the actual loads – e.g. as a result of large equipment.

The following values are to be adhered to as a minimum on the basis of ZTV E-StB 17:	
Formation level on the foundation soil	Ev2 ↗ 45 MN/m^2
Developed bearing course	Ev2 ↗ 80 – 100 MN/m^2 depending on the size of the equipment
The permissible ratio value of Ev1 and Ev2 is hereby to be taken into account.	

A terrain/slope failure calculation or shear failure proof is to be provided in the event of complicated foundation soil, e.g. due to the soil being cohesive or when working in trenches and on slopes.

The proof is provided pursuant to EC7-1 (DIN EN 1997-1) and the corresponding national regulations in DIN 1054, DIN 4017 and DIN 4084.

The results of the planning are to provide the contractor with specific information that is required for the erection of the working platform and the adherence to the suitability for use. The following measures are to be determined and described in details should it be determined that the load-bearing capacity of the foundation soil is inadequate:

• measures that are required in order to improve the foundation soil, e.g. compacting, soil replacement, lime stabilisation or the insertion of geosynthetics.
• Soil engineering methods that are designed to develop a load bearing stratum, stating the layer´s density, the degree of compaction and the compacting in layers, the material requirements for the bulk materials and the minimum scope of the proofs of the test certificates (Evdyn, Ev2).
• Measures designed to drain off or carry off surface water. If necessary, drainage measures or a lowering of the groundwater down to a minimum of 0.50 m beneath the work level.
• If necessary, additional measures that are designed to secure/remove underground installations, channels or lines by means of load distribution elements (e.g. steel sheets, excavator support mats).

The working platform is to be planned with sufficient space for manoeuvring and for the changing of positions. For inclined piles or inclined boreholes or inclined driven elements, the set up of the equipment has to take place behind the drilling location in the direction of the inclination. It is highly recommended that a detailed coordination of the space requirement is carried out with the contractor (building contractor).

6 TENDERING FOR THE INSTALLATION AND MAINTAINING OF WORKING PLATFORMS MEASURES

- Ensuring a non-existence of contamination and unexploded ordnance (please also refer to the "Merkblatt Kampfmittelfrei Bauen" (Information leaflet "Construction Free from Unexploded Ordnance") at www.kampfmittelportal.de).
- Clearing the construction field, removal of unsuitable top soil – if necessary.
- Final calculation of the working platforms, access roads, ramps, etc. for the use of special civil engineering equipment by a geotechnical expert on the basis of the foundation soil expertise or the geotechnical report. (Note: the characteristics of the decisive equipment that is actually used on the construction site serve as a basis for the final calculation pursuant to DIN 16228-1 Annex F. When requested to do so, the contractor is to provide the client/principal with the corresponding characteristics for the final planning of the working platform in the scope of the awarding of the contract.)
- Creation of the installation concept for the intended materials incl. a drawing showing a plan view and a cross-sectional view. The positions of slope faces, ramps and underground installations are especially to be included. The working platforms are to be clearly identified and permanently marked on the site.
- Installation of the working platform conform with specialist planner specifications: incl. material requirements, information regarding any geosynthetics that might be required and the use of (hydraulic) binding agents, layer densities, surcharges and alternative positions for any necessary amendments/adaptations to the actual situation on the construction site, determination of the installation and compacting requirements and the specific testing requirements.
- Maintaining of the working platform during construction work with assurance of the suitability for use (incl. materials/equipment for reworking, incl. performances for ensuring the functionality of the water discharge and drainage system, incl. the removal of drilling mud, hourly wage performances, allocation of responsibilities) – as long as this work is not deemed to be supplementary work in part or as a whole as defined in VOB/C.
- Dismantling and disposal of the working platform considering the contamination due to the construction work and any installed geosynthetics.

It is hereby reiterated that the performances for the "manufacturing, paving, reinforcing and removal of the work level, of floor and storage spaces, access roads ..." etc. are deemed to be "special performances" as defined in ATV DIN 18304 pile driving, vibrating and pressing work.

7

INSTALLATION AND PROOF OF THE REQUIRED PROPERTIES OF THE RESPECTIVE WORKING PLATFORM

The professional installation of the working platform on the basis of the planning and detailed tendering as per Chapters 5 and 6 is of essential importance. Not only does this include the quality assurance for the materials that are to be inserted, but also the meeting of the installation and compacting requirements. Proof is to be provided of the adherence to the requirements by using suitable test procedures (e.g. dynamic or static plate load tests, standard penetration tests).

In order to secure the process quality, it is recommended that the handover/acceptance of the working platform between the client/principal or the executing earthworks contractor respectively and the special civil engineering company be documented with a report. A validation is to be carried out and a confirmation be provided that the working platform has been created conform with the stipulations in the latest execution planning/ invitation to tender, i.e. that the equipment and load situations that actually exist were considered. The working platforms are to be clearly identified and permanently marked during the handover/ acceptance at the latest. Peculiarities (areas with special load-bearing capacity characteristics, etc.) are to be noted in the report. The handover/acceptance of the working platform should take place with an adequate lead-time.

8 MAINTENANCE WORK DURING THE CONSTRUCTION ACTIVITIES

The working platform is to be conform with the planning specifications and present an adequate load-bearing capacity in all weather conditions throughout the execution of the construction work. A regular visual inspection is recommended. The suitability for use of the working platform is especially to be inspected after exceptional weather conditions (e.g. heavy rainfall, freeze-thaw changes) or special load conditions. Special measures might need to be adopted in the event of deviations from the planning specifications if determined. Accumulations of water on the working platform are to be avoided. The intended drainage options are to be cleaned and kept in operation during their provision if necessary. The working platform is to be protected from silting. Unavoidable spoil that results from the work process is to be removed at regular intervals.

Should the working platform be used by numerous contractors, clear rules are to be defined in advance with regard to the responsibility for the working platform maintenance.

CITED GUIDELINES AND STANDARDS

9

- ATV DIN 18299 Allgemeine Regelungen für Bauarbeiten jeder Art
- ATV DIN 18300 Erdarbeiten
- ATV DIN 18301 Bohrarbeiten
- ATV DIN 18303 Verbauarbeiten
- ATV DIN 18304 Ramm-, Rüttel- und Pressarbeiten
- ATV DIN 18305 Wasserhaltungsarbeiten
- ATV DIN 18309 Einpressarbeiten
- ATV DIN 18313 Schlitzwandarbeiten
- ATV DIN 18321 Düsenstrahlarbeiten
- DIN EN 14731 Baugrundverbesserungsarbeiten
- DIN 18459 Abbruch- und Rückbauarbeiten
- DIN EN 16228 Geräte für Bohr- und Gründungsarbeiten
- DIN EN 1997-2: 2010-10 Eurocode 7: Entwurf, Berechnung und Bemessung in der Geotechnik - Teil 2: Erkundung und Untersuchung des Baugrunds
- DIN EN 1997-1: 2014-03 Eurocode 7 - Entwurf, Berechnung und Bemessung in der Geotechnik - Teil 1: Allgemeine Regeln
- DIN 1054: 2010-12 Baugrund - Sicherheitshinweise im Erd- und Grundbau
- DIN 4017: 2006-3 Baugrund - Berechnung des Grundbruchwiderstands von Flachgründungen
- DIN 4020: 2010-12 Geotechnische Untersuchungen für bautechnische Zwecke
- DIN 4084: 2009-01 Baugrund - Geländebruchberechnungen

SOURCES

10

- DIN EN 1997-2: 2010-10 und DIN EN 1997-1: 2014-03; Beuth Verlag, Berlin (www.beuth.de)

- Standsicherheit und Gebrauchstauglichkeit von mobilen Baumaschinen – Feldversuche zur Interaktion zwischen Kettenfahrzeugen und Baugrund
Univ.-Prof. Dr.-Ing. habil. Christian Moormann, Rainer Worbes M.Eng.,
Universität Stuttgart, Institut für Geotechnik
Dipl.-Ing. IWE Thomas Lerner, Dipl.-Ing. (FH) Joachim Henkel,
Liebherr Werk Ehlingen GmbH, Ehlingen (Donau)

- „Homogenbereiche – Aus Bodenklassen werden Homogenbereiche – technische und rechtliche Auswirkungen auf die VOB Teil C", *Bundesanzeiger Verlag/Frauenhofer IRB Verlag, 2. Auflage 2017, hrsg. von Prof. Dr. Fuchs/Dipl.-Ing. Hans-Gerd Haugwitz*

- Zur Standsicherheit von Spezialtiefbaumaschinen auf nachgiebigem Untergrund
Prof. Dr.-Ing. Jürgen GRABE, Dr.-Ing. Marius MILATZ, Dominik ZOBEL, M. Sc.,
Marie LIEBETRAU, M. Sc.; Institut für Geotechnik und Baubetrieb, Technische Universität Hamburg (TUHH)

- Verhinderung von Maschinenumstürzen im Spezialtiefbau
Dipl.-Ing. U. Hinzmann, Dipl.-Ing. D. Siewert – BFA Spezialtiefbau im Hauptverband der Deutschen Bauindustrie, Berlin

Appendix 1 Load data for standard devices (orientation values)

! The data below are initially rough orientation values for the first assessment of a stability assessment (preliminary planning) and do not replace, if necessary, concrete proof of the soil pressure for the equipment used in the respective construction site situation. In the course of the detailed design, these details must be specified in accordance with the equipment and construction methods used.

Systems	**device weight (magnitude)**	**bottom pressure Standard device in kN/m**		**Remarks**
	Depending on the manufacturing process, geology and drilling depth			
		Standard device under normal operating conditions conditions *	Standard device under special operating conditions conditions **	
SHORING				
girder shoring	40 - 80 to	200 - 300	400	Kelly-Drilling
Sheet piling < 20 m	50 - 90 to	230 - 300	400	Leader Device
Sheet piling > 20 m	90 - 120 to	300 - 400	500	Leader Device
LARGE BORED PILES				
D = 600 to 1500 mm	60 - 110 to	220 - 400	540	Kelly-Drilling
greater D = 1500 mm	130 - 200 to	520 - 600	900	Kelly- or gripper drilling with VRM
DISPLACEMENT PILES				
precast driven piles	60 - 90 to	130 - 150	200	Leader Device
cast-in-place driven piles	110 to	240	320	Leader Device
Full or partial displacement piles	60 - 120 to	280 - 400	600	CFA-Drilling
DIAPHRAGM WALLS				
diaphragm wall D = 40 to 80 cm	70 - 80 to	200 - 230	310	Diaphragm wall grab tool
diaphragm wall D >/= 100 cm	140 to	240	320	Diaphragm wall grab tool
DEEP COMPACTION				
Vibro compaction or Vibro replacement dry	60 to	220	290	Cable excavator Leader device
DRILLING, ANCHORING AND INJECTION WORK				
Soilcrete / Jetting	20 - 25 to	80	120	Underpinnings
Soilcrete / Jetting from 20 m drilling depth	40 - 50 to	150	200	Deep Jetting for sealing
grouted anchor	10 - 15 to	215	365	
micro piles	20 - 25 to	175	270	
WATER MANAGEMENT AND GEOTHERMAL ENERGY				
Dewatering by means of drilled wells	40 - 60 to	200 - 300	400	Kelly drilling otherwise like truck ***
dewatering by means of vacuum lances	25 - 30 to	170	170	TRUCK
Thermal use of groundwater	25 - 30 to	170	170	TRUCK

* Guideline value from the information provided by the equipment manufacturer on the ground pressure (2/3 of the usable track surface under its own weight and max. tractive force) in operating condition.

** Possible ground pressure in special situations taking into account unfavourable mast inclination and torsion of the upper carriage relative to the running gear. In extreme situations, (e.g. cramped conditions, unusual mast inclination with inclined piles, maximum outreach starting point), significantly higher ground pressures can occur locally, which must be considered separately. Values →= 1,000 kN/m are possible.

*** For all trucks, truck mixers, mobile cranes, wheel loaders, etc. registered in traffic, the proof of Ev2 = 45 MN/m is generally considered sufficient in accordance with ZTV E-StB 17 - see also comments under item 5.3.

Appendix 2: Sample data sheet showing the load cases

Typenblatt

Drehbohrgerät BG 24 H | #2789 | 580.ZT41.328
auf Trägergerät BT 75 B

BMTI
BAUMASCHINENTECHNIK INTERNATIONAL

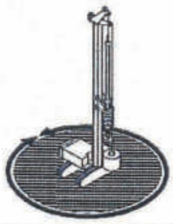
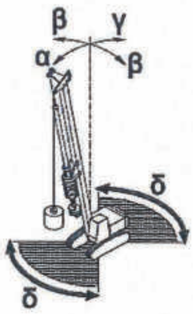
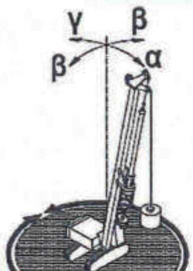
Stand: 31.10.2012
Seite 6/6

Standsicherheit

Gültig nur für		
	Mastverlängerung 2,0 m	1,2 t
	Gegengewicht	8,0 t + 4,0 t
	Kelly BK 28/419/3/30	7,25 t
	Drehteller ∅ 1300 mm	1,48 t
	Bohrwerkzeug ∅ 1180 mm	1,82 t

Achtung: Bei größeren Kellystangen muss eine gesonderte Standsicherheitsberechnung von BAUER angefordert werden!

Bedingungen für Betrieb Hubbegrenzer für Vorschubschlitten montiert (max. Hub: 9150 mm)

B0000689.wmf B00005003.wmf B00005002.wmf		**Maximal zulässige Lasten / max. Bodenpressung**			
		Min. Bohrachse*: 3,5 m		**Max. Bohrachse*: 4,7 m**	
	Hilfsseil		**8 t** 345 kPa		**7 t** 560 kPa
	Hauptseil		**20 t** 325 kPa		**20 t** 555 kPa
	Vorschub		**33 t** 425 kPa		**18,5 t** 555 kPa
	Hilfsseil	α = 5° β = 3° γ = 0° δ = 360°	**8 t** 440 kPa	α = 5° β = 3° γ = 0° δ = 90°	**8 t** 910 kPa
	Hauptseil	α = 5° β = 3° γ = 15° δ = 360°	**20 t** 350 kPa	α = 5° β = 3° γ = 15° δ = 90°	**20 t** 625 kPa
	Vorschub	α = 5° β = 3° γ = 15° δ = 360°	**33 t** 435 kPa	α = 5° β = 3° γ = 15° δ = 90°	**33 t** 1135 kPa
	Hilfsseil	α = 5° β = 3° γ = 0°	**8 t** 440 kPa	α = 5° β = 3° γ = 0°	**1,5 t** 910 Pa
	Hauptseil	α = 5° β = 3° γ = 15°	**20 t** 350 kPa	α = 5° β = 3° γ = 15°	**16 t** 625 kPa
	Vorschub	α = 5° β = 3° γ = 15°	**33 t** 435 kPa	α = 5° β = 3° γ = 15°	**14,5 t** 1135 kPa
Max. Planumsneigung beim Umsetzen / max. Bodenpressung			5° / 280 kPa		4° / 430 kPa

*) Bohrachse = Abstand von Drehkranzmitte zu Mitte Bohrwerkzeug

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