## CURRICULUM-VITAE





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Academics

**Post-doctoral Research**, Numerical simulation for assessment of yielding characteristics of coal pillars at Great Depth (900m), Institute of Geonics of the Czech Academy of Sciences, Ostrava, Czech Republic.

Ph.D., Mining Engineering, Indian Institute of Technology (ISM) Dhanbad, India.

**B.Tech.**, Mining Engineering, Birsa Institute of Technology, Sindri, India.

#### Area of Interests

Rock Mechanics; Numerical Modelling; Ground Control; Underground Coal Mining; Thick/Contiguous Seam Mining; Instrumentation and Strata Monitoring; Stability of Geotechnical Structures in Underground Coal Mine.

## Research Experience

#### April, 1999 - December, 2020

I was associated with CSIR- Central Institute of Mining and Fuel Research (CIMFR), Dhanbad. I applied basics of rock mechanics principles to minimize strata control problems for safe and efficient recovery of coal from underground mines. I carried out different R&D investigations related to different underground coal mining methods in more than <u>80</u> in-house and industry-sponsored projects, including <u>two</u> S&T projects of the Ministry of Coal, Govt. of India and <u>one</u> S&T project with international collaboration. Extensive field-based rock mechanics investigations during continuous miner based mechanized and semi-mechanized workings in underground coal mines and studies on numerical models are the basic tools of the study.

#### **Research Skills**

Field studies, numerical simulation, instrumentation and monitoring

#### Important R&D skills

• Design of different geotechnical structures including rib/snook and breaker line supports for continuous miner based mechanized depillaring.

- Numerical modelling and field investigation-based performance evaluation of different underground geotechnical structures like pillar/fender/ snook/rib.
- Mechanisation and automation of underground instrumentation and monitoring with continuous in time during underground coal mining using different manner of extraction.
- Extraction of thick seam (up to 6m) using 4.6m cutting height of continuous miner.
- Development of numerical models for yielding/fracturing characteristics of coal pillar at great depth (900m).
- Empirical models for mining induced stress development during depillaring.
- Empirical models for estimation of roof sagging limit for prediction of roof fall.
- Development and execution of hard roof management system during mining under bump/rock bursts prone geo-mining conditions (International collaboration).
- Design of strata control and monitoring plan for depillaring with caving and stowing system of goaf management.
- Development and application of a new process: known as "combined instruments approach" (CIA) for the strata mechanics studies proved to be an efficient approach for improvement in safety of underground mining.
- Active contribution in development of following underground coal mining methods:
  - ✓ Cable bolting based depillaring of thick seams
  - ✓ Underpinning based simultaneous extraction of contiguous sections under fragile parting
  - ✓ Wide stall mining
  - ✓ Cross development based underground extraction of a critically thick coal seam standing on pillars and the development made along the roof horizon and
  - ✓ Eco-friendly mining method for partial extraction of coal from locked-up pillars under various surface and sub-surface constraints

## 💿 Software Skill

FLAC<sup>3D</sup> and MATLAB.

## **E** Teaching Experience

December, 2020 - Present, Assistant Professor, National Institute of Technology Rourkela.

Course Teaching: Advanced Coal Mining

## **Research Guidance**

Under Graduate Students: 04

#### **Awards and Honors**

- <u>The MGMI Silver Medal Award</u> for 2005-2006 for the paper on "Encountering induced horizontal stress during simultaneous depillaring of thick and contiguous section below hilly terrain: a case study".
- Received <u>Post-doc Fellowship</u> for the project "International Mobility of Researchers of IGN" supported by European Structural and Investment Funds, Operational Programme Research, Development and Education, Programming 2017-2020.
- <u>Certificate of Outstanding Contribution in Reviewing</u> awarded in August, 2018 from International Journal of Rock Mechanics and Mining Sciences (IJRMMS) in recognition of the contributions made to the quality of the journal.

## Professional Memberships

- International Society of Rock Mechanics.
- Mining Engineers' Association of India.
- Society for Mining, Metallurgy & Exploration.

## **Reviewer of journals**

- International Journal of Rock Mechanics and Mining Sciences.
- Arabian Journal of Geosciences.
- Acta Geodyn. Geomater.

## 🚳 Patents: 02

- A method for efficient design of breaker line support in mechanised depillaring. Submitted to the concerned authority in CSIR (2016). <u>Investigators:</u> Sahendra Ram, Rajendra Singh, Dheeraj Kumar, Arun Kumar Singh, Ashok Kumar, Rakesh Kumar and Amit Kumar Singh. (Status- Filed, No. 0244NF2016).
- Indigenous design of rib/snook for mechanised depillaring. Submitted to the concerned authority in CSIR (2015). <u>Investigators:</u> Rajendra Singh, Arun Kumar

Singh, **Sahendra Ram**, Ashok Kumar, Rakesh Kumar and Amit Kumar Singh. (Status- Filed, No. 3765DEL2015).

Country	Year	Institute and Place	Purpose/Work Done
Czech	2012	Institute of Geonics,	Interacted with scientists of Czech under CSIR-CSAV
Republic		Ostrava	exchange programme and visited their underground coal
			and metal mines.
Czech	2014	Institute of Geonics,	Attended and presented a paper in the 5 <sup>th</sup> International
Republic		Ostrava	Colloquium on Geo-mechanics and Geophysics
United States	2016	West Virginia	Participated and presented a technical paper at the 35 <sup>th</sup>
		University,	International Conference on Ground Control in Mining
		Morgantown	(ICGCM)
Poland	2018	CMI - Department of	Participated in the XXV International Scientific and
		Rock bursts and Rock	Technical Conference, GZN 2018 (Organised by GIG
		Mechanics and	and JSW), Jaworze, Poland, 7th - 9th November 2018.
		Mining Commission of	Interacted with different participants about mining
		the Polish Academy of	activity, rock burst and other rock mechanics issues.
		Science, Katowice	
Poland	2018	Katowice	Attended annual mining celebation and technical
			discution with scientists of central Mining Institute
			(GIG), Katowice.
Czech	2018	Institute of Geonics,	Worked as post-doc researcher at Institute of Geonics of
Republic	and	Ostrava	Czech Academy of Sciences.
	2019		Organised International workshop on "Coal mining at
			great depth", which is to be held on 23-24 <sup>th</sup> April, 2019
			at Institute of Geonics, Ostrava.
Australia	2019	University of	Participated and presented a technical paper in 19 <sup>th</sup>
		Wollongong,	Australian Coal Operators' Conference, held on 18 - 20 <sup>th</sup>
		Wollongong, NSW	February 2019 and visited Metropolitan Colliery of
Peabody and South32 Illawarra coal mine.		Peabody and South32 Illawarra coal mine.	

## **M** Deputations/Assignments abroad

#### Publications/communications: 55

- Book Chapter: **01**
- Journals Articles: 28 (SCI/SCOPUS:18 and other reputed journal:10)
- In conference proceedings: 26
- Publications impact factor (Total): 26.318
- Researchgate Score: 13.23

#### **Book Chapter: 01**

 Ashok Kumar, Dheeraj Kumar Arun Kumar Singh, Sahendra Ram, Rakesh Kumar, Mudassar Raja, Amit Kumar Singh (2020). Developments Made for Mechanised Extraction of Locked-Up Coal Pillars in Indian Geomining Conditions. Publisher: IntechOpen, Open Access books "Mining Techniques - Past, Present and Future", DOI:10.5772/intechopen.93636, September 2020.

## Journals Articles: 28

#### 🌕 Publications/Communications in SCI/SCOPUS Journals 🥯

- 1. **Sahendra Ram**, Rajendra Singh, Ashok Kumar, Arun Kumar Singh, Rakesh Kumar, A. Ramesh Rao and Srinivasa Rao (2020). Strata mechanics study during extraction of a thick coal seam by continuous miner. Communicated to Rock Mechanics Rock Engineering (under review).
- 2. Sahendra Ram, Petr Waclawik, Jan Nemcik, Radovan Kukutsch, Ashok Kumar, Arun Kumar Singh and Libin Gong (2020). Assessment of yielding characteristics of inclined coal pillars at great depth. Communicated to Rock Mechanics Rock Engineering (under review).
- 3. **Sahendra Ram**, Arun Kumar Singh, Rakesh Kumar, Ashok Kumar, Niraj Kumar, Petr Waclawik, Abhishek Gautam and Mudassar Raja. Design of rock bolt-based goaf limit line support for conventional depillaring with stowing. Communicated to Arabian Journal of Geosciences (under review).
- 4. **Sahendra Ram,** Ashok Kumar, Rajendra Singh, Utpal Kumar Dey, Arun Kumar Singh, Rakesh Kumar (2020). Influence of dyke on uniaxial compressive strength of coal: a field study using nondestructive technique. Communicated to *Journal of Mines Metals and Fuels* (under review).
- Rakesh Kumar, Arvind kumar Mishra, Ashok Kumar, Arun kumar Singh, Sahendra Ram, Amit kumar Singh, Rajendra Singh (2020). Importance of fracturing hard and massive overlying strata for complete extraction of thick coal seam. Communicated to Geotechnical and Geological Engineering (under review).
- Pushpendra Sharma, Ashok Kumar Noorullah Shams, Amit Kumar Verma, Dheeraj Kumar, Arun Kumar Singh, Sahendra Ram (2021). Parametric study to design competent irregular shaped remnants in mechanised depillaring. Arabian Journal of Geoscience, ISSN 1866-7511.
- Arun Kumar Singh, Ashok Kumar, Dheeraj Kumar Rajendra Singh Sahendra Ram, Rakesh Kumar, Amit Kumar Singh (2020). Field and simulation studies for mechanised depillaring below incompetent geological formations of an Indian coalmine. Journal of the Geological Society of India.
- Arun Kumar Singh, Ashok Kumar, Dheeraj Kumar Rajendra Singh Rakesh Kumar Sahendra Ram, Amit Kumar Singh (2020). Coal Pillar Extraction Under Weak Roof. Mining, Metallurgy & Exploration. DOI: 10.1007/s42461-020-00277-8.
- 9. Ashok Kumar, Dheeraj Kumar, Arun Kumar Singh **Sahendra Ram,** Rakesh Kumar, Abhishek Gautam, Rajendra Singh (2019). Roof sagging limit in an early warning

system for safe coal pillar extraction. International Journal of Rock mechanics and Mining Sciences. Vol. 123 (2019) 104131;DOI: 10.1016/j.ijrmms.2019.104131

- Ashok Kumar, Petr Waclawik, Rajendra Singh, Sahendra Ram and Jiri Korbel (2019). Performance of a coal pillar at deeper cover: Field and simulation studies. International Journal of Rock Mechanics and Mining Sciences, ISSN 1365-1609, vol.113, pp. 322-332; DOI: 10.1016/j.ijrmms.2018.10.006
- 11. Ashok Kumar, Dheeraj Kumar, Amit Kumar Verma, Arun Kumar Singh, Sahendra Ram and Rakesh Kumar (2018). Influence of overlying roof strata on rib design in mechanised depillaring. Journal of Geological Society of India, ISSN 0016-7622, vol.91, pp.341-347; DOI:10.1007/s12594-018-0860-7.
- Ashok Kumar, Rakesh Kumar, Arun Kumar Singh, Sahendra Ram, Pradeep Kumar Singh and Rajendra Singh (2017). Numerical modelling-based pillar strength estimation for an increased height of extraction. Arabian Journal of Geoscience, ISSN 1866-7511, vol. 10(18) pp. 411;DOI: 10.1007/s12517-017-3179-6.
- Sahendra Ram, Dheeraj Kumar, Arun Kumar Singh, Ashok Kumar and Rajendra Singh (2017). Field and numerical modelling studies for an efficient placement of roof bolts as breaker line support. International Journal of Rock Mechanics and Mining Sciences, ISSN 1365-1609, vol. 93, pp. 152-162; DOI:10.1016/j.ijrmms.2017.01.013
- Rajendra Singh, Ashok Kumar, Arun Kumar Singh, John Coggan and Sahendra Ram (2016). Rib/snook design in mechanised depillaring of rectangular/square pillars. International Journal of Rock Mechanics and Mining Sciences, ISSN 1365-1609, vol. 84, pp. 119-129; DOI: 10.1016/j.ijrmms.2016.02.008.
- 15. Rakesh Kumar, A. K. Mishra, Arun Kr. Singh, Amit Kr. Singh, Sahendra Ram and Rajendra Singh (2016). Depillaring of total thickness of a thick coal seam in single lift using cable bolts: a case study International Journal of Mining Science and Technology, vol. 26, pp. 223-233; DOI: 10.1016/j.ijmst.2015.12.007.
- 16. Arun Kumar Singh, Sahendra Ram, Rajendra Singh and Ashok Kumar (2016). Rib/snook competency in mechanised depillaring of the conventionally developed coal seams Journal of Mines Metals and Fuels. vol.64, pp.414-423.
- Arun Kumar Singh, Rajendra Singh, Prabhat Kumar Mandal, Rakesh Kumar, Amit Kumar Singh and Sahendra Ram (2009). "Rock mechanics challenges of depillaring at deep cover". Journal of Mines, Metals and Fuels. vol.57(9), pp.298-306, Mar 2009.
- 18. Rajendra Singh, Sahendra Ram, Amit Kumar Singh and John Buragohain (2004). Underground extraction of contiguous coal seams/sections consisting thin parting: a case study. Journal of South African Institute of Mining and Metallurgy (SAIMM), ISSN 2225-6253 vol. 104(1), pp.17-27.

#### • Publication in other reputed/referred journals

- 1. Rajendra Singh, **Sahendra Ram**, Arun Kumar Singh, Ashok Kumar, Rakesh Kumar and A. K. Singh (2017). Rock mechanics considerations for roof-bolt based breaker-line design. Procedia Engineering 191:551-559, doi:10.1016/j.proeng.2017.05.217.
- Arun Kumar Singh, Sahendra Ram, Rajendra Singh and Ashok Kumar (2016). Rib/snook competency in mechanised depillaring of the conventionally developed coal seams. *Journal of Mines Metals and Fuels, Special Issue on CSIR-CIMFR: IN PURSUIT OF EXCELLENCE*, vol. 64, pp. 414-423.
- Sahendra Ram, Dheeraj Kumar, P. Konicek, Arun Kr. Singh, Rakesh Kumar, Amit Kr. Singh and Rajendra Singh (2015). Rock mechanics studies during continuous miner based coal pillar extraction in Indian coalfields. *Transactions of MGMI*, ISSN 0254-8003, vol. 111: April 2014 - March 2015, pp. 89-104.
- 4. Arun Kumar Singh, Rajendra Singh, Prabhat Kumar Mandal, Rakesh Kumar, Amit Kumar Singh and **Sahendra Ram (2009).** Rock mechanics challenges of depillaring at deep cover. *Journal of Mines, Metals and Fuels,* vol. 57(9), pp. 298-306.
- Satyabadi Kumar Jena, R. S. Singh, T. K. Mandal, Rajendra Singh, Prabhat Kumar Mandal, Arun Kumar Singh, Rakesh Kumar, Sahendra Ram and Amit Kr. Singh (2007). Interaction of ground movement with underground mining of thick and contiguous sections below hill terrain: a case study. *Minetech*, vol. 28(2), pp. 33-44
- Rajendra Singh, Prabhat Kumar Mandal, Arun Kumar Singh, R. Kumar, Sahendra Ram and Satyabadi Kumar Jena.(2005). Encountering induced horizontal stress during simultaneous depillaring of thick and contiguous sections below hilly terrain: A case study. *MGMI Transaction*, vol. 102, No. 1 & 2, April 2005 - March 2006, pp. 37-61.
- Rajendra Singh, Manoj Kumar Singh, Sahendra Ram, Amit Kumar Singh (2005). Automation and Automatic Measurement for Mining: CCD-Based Approach. Minetech. Vol. 26 (6), pp. 37-45.
- 8. Prabhat Kumar Mandal, A. K. Singh, **Sahendra Ram**, Amit Kr. Singh, Nirmal Kumar and Rajendra Singh (2004). Strata behaviour investigation of India's first depillaring face with continuous miner and shuttle car (2004). *Minetech*, vol. 25(6), pp. 3-12
- Prabhat Kumar Mandal, A. K. Singh, Sahendra Ram, Amit Kr. Singh and Rajendra Singh (2004). Depillaring of a thick coal seam using cable bolts under shallow depth cover- A case study. *The Indian Mining and Engineering Journal*, vol.43 (7), pp.11-18.

10. John Buragohain, Rajendra Singh, Arun Kr. Singh and **Sahendra Ram (2001).** In-situ investigations to study interaction between two close seams/sections extracted with critical interburden thickness. *Minetech*, vol. 22(4), pp.13-23.

## © Conferences: 26

- Libin Gong, Petr Waclawik, Kamil Soucek, Martin Vavro, Jan Nemcik, Sahendra Ram, Radovan Kukutsch (2021). Numerical modelling on the stability of an underground research facility excavation in Czech Republic. Accepted for ROCI 2021, 10-12 February 2021, University of Southern Queensland, Springfield Campus, Springfield Lakes, Australia.
- Sahendra Ram, Arun Kumar Singh, Ashok Kumar, Rakesh Kumar and Mudassar Raja (2020). Support design of a panel during depillaring with sand stowing using numerical modelling and empirical approaches. *Recent Practices and Advancement in Mineral Industry* (RPAMI); 21 – 22 February 2020, pp. 111-119
- Ashok Kumar, Dheeraj Kumar, Sahendra Ram, Arun Kumar Singh, Rakesh Kumar, Amit Kumar Singh, Mudassar Raja and Rajendra Singh (2019). Rock Mechanics Challenges and Advances in Continuous Miner Based Mechanised Depillaring of Coal Pillars. National Conference on Advances in Mining (AIM-2020), 14-15 February, 2020, pp. 32-46.
- 4. Sahendra Ram, Arun Kumar Singh, Ashok Kumar, Rakesh Kumar (2019). Strata control and monitoring plan for pillar extraction with stowing. *8th Asian Mining Congress* to be held in Kolkata, 6-9 November, 2019, pp.465-474.
- Ashok Kumar, Dheeraj Kumar, Arun K Singh, Sahendra Ram, Rakesh Kumar, Anurag Sarthi, Sidheshwar Majhi (2019). Strength estimation of irregular shape heightened rib/snook for mechanised depillaring. 8th Asian Mining Congress to be held in Kolkata, 6-9 November, 2019, pp. 529-538.
- Sahendra Ram, Petr Waclawik, Jan Nemcik, Ashok Kumar, Radovan Kukutsch, Vlastimil Kajzar. Assessment of coal pillar behaviour at great depth using field monitoring and numerical models (2019). ISRM 14th International congress on Rock Mechanics and Rock Engineering, September 13 to 18, 2019, Foz do Iguassu, Brazil, pp. 2812-2820.
- Sahendra Ram, Ashok Kumar, A Ramesh Rao, Srinivasa Rao (2019). Mechanized depillaring of a thick and deep seated coal seam: a case study. International Conference and exhibition on Energy & Environment: Challenges & Opportunities, February, 20-22, 2019, Vigyan Bhawan, New Delhi, India.. Feb. 2019, pp. 678-688.
- Petr Waclawik, Sahendra Ram, Ashok Kumar, Radovan Kukutsch, Adam Mirek and Jan Nemcik (2019). Field and simulation study for rock bolt loading characteristics under high stress condition. 19th Australian Coal Operators Conference, 18-20th February, 2019, Wollongong, NSW. PP.171-179.

- 9. Petr Waclawik, Sahendra Ram and Richard Snuparek (2019). Bolts loading in the strongly stressed rock mass. 24th International Seminar on Reinforcement, sealing and Anchoring of Rock massif and Building Structures, Faculty of Civil Engineering, VŠB –Technical University of Ostrava Department of Geotechnics and Underground Engineering, Czech Republic. 14/15 Feb 2019, pp. 144 -150.
- 10. Ashok Kumar, Arun Kumar Singh, Sahendra Ram, Amit Kumar Singh, Rakesh Kumar and Rajendra Singh (2019). Estimation of roof lowering limit for an efficient and economical strata movement study in mechanised depillaring. 7<sup>th</sup> Asian Mining Congress, Kolkata, India, The Mining Geological & Metallurgical Institute of India, pp. 193-202: 8-10: November, 2017.
- 11. Arun Kumar Singh, Ashok Kumar, Sahendra Ram and Rajendra Singh (2017). Indigenous developments for the design of geo-technical elements of the continuous miner based mechanised depillaring. *International Conference on NexGen Technologies for Mining and Fuel Industries (NxGnMiFu-2017)*, Vigyan Bhawan, New Delhi, India, pp. 117-128: 15-17 February 2017.
- 12. Sahendra Ram, Dheeraj Kumar, Rakesh Kumar, Ashok Kumar and Rajendra Singh (2016). Numerical modelling based rock load height estimation at the goaf edge in a mechanised depillaring panel. *International Conference on Recent Advances in Rock Engineering (A Specialized Conference of the International Society for Rock Mechanics)*,NIRM, Bengaluru, India, pp. 186-190: 16 -18 November 2016.
- 13. Ashok Kumar, Arun Kumar Singh, Sahendra Ram, Amit Kumar Singh, and Rajendra Singh (2016). Practical experiences of instrumentation and monitoring for depillaring. International Conference on Recent Advances in Rock Engineering (A Specialized Conference of the International Society for Rock Mechanics), NIRM Bengaluru, India pp. 164-169: 16-18 November 2016
- 14. Sahendra Ram, Arun Kumar Singh, Dheeraj Kumar and Rajendra Singh (2016). Design of Roof Bolt based Breaker Line Support in a Mechanised Depillaring Panel. 35<sup>th</sup> International Conference on Ground Control in Mining. Morgantown WV USA;, pp. 155-61: 26-28 July, 2016.
- 15. Ashok Kumar, Sahendra Ram, Arun Kumar Singh, Amit Kumar Singh, Rakesh Kumar and Rajendra Singh (2016). A numerical modelling approach for rib/snook design in mechanised depillaring. 6<sup>th</sup> Asian Mining Congress, , Kolkata, India, The Mining Geological & Metallurgical Institute of India, pp. 87-96: 23-26 February, 2016.
- 16. Ashok Kumar, Sahendra Ram and Rajendra Singh (2015). Rock mechanics considerations for rib/snook design in mechanised depillaring. International Conference on *Engineering Geology in New Millennium* (EGNM-2015), Indian Institute of Technology, New Delhi, India, 27-29 October, 2015, Special Publication, Journal of Engineering Geology, pp. 394-409

- 17. Rajendra Singh, Sahendra Ram, Arun Kumar Singh, Rakesh Kumar and Amit Kumar Singh (2014). Strata control investigations during fully mechanized coal pillar extraction in Indian coalfields. 33<sup>rd</sup> International Conference on Ground Control in Mining (ICGCM), Morgantown, USA, pp. 158-164: July 29-31, 2014.
- Sahendra Ram, Arun Kumar Singh, Dheeraj Kumar and Rajendra Singh (2014). Roof bolt based breaker-line design during underground coal pillar extraction. 5th International Colloquium, Mountain Hotel Solan, Ostrava, June, pp. 25-27: 2014
- Arun Kumar Singh, Prabhat Kumar Mandal, Sahendra Ram, Amit Kumar Singh, Rakesh Kumar and Rajendra Singh (2011). Influences of geo-mining conditions on strata control studies during underground pillar extraction: some Indian experiences. *International Conference on "Underground Space Technology"*, Bangalore - India, pp. CM-01-1- 19: 17- 19 January, 2011.
- 20. Rajendra Singh, Prabhat Kumar Mandal, Arun Kumar Singh, Amit Kumar Singh, Sahendra Ram and Nirmal Kumar (2004). Mechanisation to meet the challenges of underground coal mining in India: a success story. *International conference on Future* of Indian Mineral Industry: Challenges and Opportunities, Organised by MGMI, India, pp. 21-28: 17 - 18 September, 2004.
- 21. Arun Kumar Singh, Rakesh Kumar, Sahendra Ram, Amit Kumar Singh and Rajendra Singh (2013). Rock mechanics considerations during continuous miner based coal pillar extraction in Indian coalfields. *National Workshop on Continuous Miner*, DGMS, Dhanbad, 1-2 August, 2013, pp. 107-118.
- 22. राजेद सिंह, अरुण कुमार सिंह, अशोक कुमार, राकेश कुमार एवं सहेन्द्र राम (2015). भूमिंगत कोयला गैसीकरण के दौरान चट्टानी परतों के यात्रिकी अध्ययन के लिए मॉडलिंग चुनौतिया और मुद्दे। भारत में कोयला आधारित गैस उद्योग की चुनौतियां एवं विकल्प. National seminar on issues and challenges for the underground coal gasification in India, 11<sup>th</sup> May, 2015, CSIR-CIMFR, Dhanbad, pp.41-46.
- 23. Rajendra Singh, Arun K. Singh, Rakesh Kumar, Sahendra Ram, Amit K. Singh (2014). Cuttability Assessment for Safety in Underground Coal Mining Environment. Recent Trends in Design, Development, Testing and Certification of Ex-equipment. Flame and Explosion Laboratory, CSIR-Central Institute of Mining and Fuel Research, Dhanbad (India), pp. 305-320.
- 24. Rakesh Kumar, Nirmal Kumar and **Sahendra Ram** (2006). Instrumentation and monitoring of strata movement during underground winning of coal. National workshop and brain storming session on *Underground coal mines challenges and technical options*, April 27-28, SECL, Bilashpur, pp.174-188.
- 25. Arun Kumar Singh, Prabhat Kumar Mandal, Rakesh Kumar, Rajendra Singh, **Sahendra Ram** and Amit Kumar Singh (2005). Recent developments to meet the challenges of underground coal mining in India. *National Conference on Technological Advancements and Environmental Challenges in Mining and Allied Industries in the 21<sup>st</sup> Century (TECMAC-2005), February 5-06, 2005, N.I.T., Rourkela.*

26. Arun Kumar Singh, Prabhat Kumar Mandal, Rakesh Kumar, Rajendra Singh and Sahendra Ram (2002). Stability investigations during inclined slicing of thick coal seam by longwall method – A case study. *National Symposium on Sustainable Mining Technology: Present and Future, March 14-15, 2002, Organised by Anna University, Chennai, (Editors: K. Srinivas & K. V. Shanker), pp. 274-284:2002.* 

# R&D Projects

SI. No.	Title of R&D Project	Funding Agency	Date of start	Date of completio n	Role
1	Laboratory experimentations based design of goaf edge support using high capacity roof bolts	CSIR-CIMFR	July, 2017	May, 2019	Principal Investigator
2	An analysis of mining induced stress over the position of a Roof bolt based breaker line support (RBBLS) in mechanized depillaring (MD)	CSIR-CIMFR	April, 2016	March, 2018	Principal Investigator
3	An analysis of caving models for manner of pillar extraction and rib design during CM based mechanised depillaring	CSIR-CIMFR	April, 2014	February, 2016	Principal Investigator
4	Strata movement study during widening, heightening and depillaring of panel no. A- 1A and A-1B in No 1 Seam at GDK11 Incline with CM technology	SCCL	March, 2015	August, 2019	Principal Investigator
5	Mining method for final extraction of a critically thick coal seam standing on pillars and the development made along the roof horizon	Ministry of Coal, Government of India and SCCL	Novem ber, 2003	September, 2006	Team Member
6	Development of a model vis-à-vis study of parameters influencing abutment loading of pillars at a depillaring face of shallow depth cover and under massive strata	Ministry of Coal, Government of India	July, 1999	March, 2003	Team Member
7	Rock mechanics investigations to meet challenges of strata control of deep underground coal mining	Collaborative project between CSIR-CIMFR, India and Institute of Geonics, Czech Republic		December, 2015	Team Member

# **cp** Consultancy Projects

Worked as a <u>Project Leader/Principal Investigator</u> in the following <u>seventeen projects</u> at CSIR-CIMFR, Dhanbad.

SI. No	Title of Project	Sponsoring Agency	Date of start	Completion date
1	Advice for preparation of Strata Control Monitoring Plan (SCAMP) for one panel in each Bogra R-VI and Narayankuri R-VII seams of Amritnagar Colliery, Kunustoria Area, ECL.	Eastern Coalfields Limited (ECL)	January, 2020	August, 2020
2	Advice for driving of 6.5m wide galleries with continuous cutting technology (Roadheader or CM) during development in both thick seam bottom and thick seam top of Kondapuram UG Coal Mine, Manuguru Area	SMS Infrastructur e Limited (SMSIL)	July, 2019	Worked up to 15th December, 2020
3	Advice for strata control and safe depillaring in continuous miner panels CM-2 and CM-3 (including CM-3A) of L1B seam at Vindhya Mine, SECL on the basis of field data supplied by the mine	SMSIL	June, 2017	June, 2020
4	Scientific study for the design of a mechanised depillaring scheme for continuous miner package in CM1 panel and surrounding areas of L1B seam at Vindhya mine, Johila Area, SECL	SMSIL	November, 2016	November, 2018
5	Advice for strata control and safe depillaring in Continuous Miner panel CM-9 (CM-9A and CM-9B panels) of L1B seam at Pinoura Mine, SECL on the basis of field data	SMSIL	May, 2016	May, 2019
6	Scientific study of strata movement during widening and heightening of existing galleries and depillaring of CM panels A1-A and A1-B of No. 1 at GDK-11 Incline mine, RG-1 area, SCCL through underground instrumentation and monitoring	Singareni Collieries Company Limited (SCCL)	January, 2016	January, 2019
7	Advice for safe depillaring of the panel LK-6 of Lower Kajora seam at Central Kajora Colliery by cable bolting based depillaring method through underground instrumentation and monitoring	ECL	May, 2016	May, 2019
8	Advice for safe depillaring of the panel LK-7 of Lower Kajora seam at Central Kajora Colliery by cable bolting based depillaring method through underground instrumentation and monitoring	ECL	May, 2016	May, 2019
9	Scientific study for designing safe method of extraction of depillaring panels in the developed galleries of Block-A area with CM technology in No. 1 seam at GDK-11 Incline mine, RG1 Area, SCCL	SCCL	March, 2015	March, 2018
10	Design of suitable method of depillaring including widening and heightening of existing galleries for working of panel B7 of No. 1 seam at GDK-11 Incline mine, RG-I Area, SCCL along with underground instrumentation and monitoring during extraction of the panel.	SCCL	September, 2014	August, 2017
11	Strata control studies based advice for safe depillaring in Continuous Miner panel CM-3 of L1B seam at Pinoura Mine, SECL.	SMSIL	May, 2014	April, 2017
12	Scientific study for extraction of Johila Bottom seam at Vindhya underground mine, Johila Area, SECL, which is lying under extremely adverse geo-mining conditions.	SECL	February, 2014	February, 2015

Sl.	Title of Project	Sponsoring	Date of	Completion
No.		Agency	start	date
13	Performance evaluation of cable bolting based depillaring	ECL	March, 2013	March,
	method for underground extraction of panel K-6(A) of			2016
	Kajora top seam through underground instrumentation and			
	monitoring at Madhusudanpur 7 Pit and Incline Colliery,			
	ECL			
14	Strata control studies based advice for safe depillaring in	SMSIL	September,	September,
	Continuous Miner panel CM1B of L-1B seam at Pinoura		2012	2014
	Min e, Johilla Area, SECL.			
15	Performance evaluation of cable bolting based depillaring	ECL	July, 2012	July, 2014
	method for underground extraction of panel K-20(A) of			
	Kajora top seam through underground instrumentation and			
	monitoring at Madhusudanpur 7 Pit and Incline Colliery,			
	ECL			
16	Design of suitable method of depillaring including widening	Bucyrus	January,	March,
	and heightening of existing galleries for working of panel B4	Europe	2012	2014
	of No. 1 seam at GDK-11 Incline mine, RG-I Area, SCCL	GmbH-IPO		
	along with underground instrumentation and monitoring			
	during extraction of the panel.			
17	Stability analysis of ground below Usha Talkies, Thana	Usha	January,	July, 2012
	Road, Jharia	Talkies,	2012	
		Jharia		

# Worked as a <u>Team Member</u> in the following <u>seventy one</u> projects at CSIR-CIMFR, Dhanbad.

Sl. No.	Title of Project	Sponsoring Agency	Date of start	Completion date
1	Advice for preparation and formulation of Strata Control Monitoring Plan (SCAMP) of 7 Depillaring and 10 developed panels in different mines of Satgram Area, ECL	ECL	June, 2019	August, 2020
2	Advice for mechanised depillaring of CM6 panel in L-18 seam using continuous miner with suitable support design, Strata management plan and manner of extraction at Vindhya Mine, Johilla Area, SECL.	SMSIL	February, 2019	Continuing
3	Advice for strata control and safe depillaring in continuous miner panels CM-2 and CM-3 (including CM-3A) of L1B seam at Vindhya Mine, SECL on the basis of field data supplied by the mine.	SMSIL	June, 2017	June, 2020
4	Scientific study to assess the efficiency of the support system during the working of the panel and thereafter continuously monitor the strata movement at Sarni UG mines E3 panel of Pathakhera Area, WCL	Western Coalfields Limited (WCL)	January, 2020	Continuing
5	Advice for development of 34LW panel in L-1B seam below Dagdowa village using Continuous Miner with suitable support design, cut out distance and preparation of strata management plan for long term stability of the workings at Vindhya Mine, Johila Area.	SMSIL	January, 2019	July, 2020
6	Advice for ground stability over the underground galleries lying beneath and within 45m of railway acquired land and working in low cover area (Standing on pillars) at Durgapur Rayatwari Colliery (DRC), Chandrapur Area, WCL.	WCL	July, 2018	July, 2020
7	Scientific study to access the cavability of hanging overlying massive Deccan trap in the inbye goaves and its effect at Mathani UG, Pench Area, WCL and advice thereof.	WCL	December, 2018	June, 2020

SI.	Title of Project	Sponsoring	Date of	Completion
<u>INO.</u> 8	Advice for strate control based safe avtraction of seel from the	Agency	January	January
0	CM panels A1-A and A1-B of No. 1 seam during its depillaring including widening and heightening of existing galleries at GDK-11 Incline mine, RG-I Area, SCCL on the basis of field data.	SCCL	2016	2019
9	Scientific study for working of thick seam top and thick seam bottom with continuous miner technology at Kondapuram CM project SCCL	SCCL	February, 2017	February, 2019
10	Advice for safe depillaring and limit for strata control parameters in C-16 panel of No.1 seam at KTK Incline Mine, Bhupalpalli Area on the basis of field data supplied by the mine.	SCCL	March, 2015	March, 2018
11	Advice for strata control based safe extraction of coal from the CM panel A2 of No. 1 seam during its depillaring including widening and heightening of existing galleries at GDK-11 Incline mine, RG-1 Area, SCCL on the basis field data.	SCCL	November, 2017	November, 2020
12	Advice for strata control and safe depillaring in Continuous Miner panel CM-8 of L1B seam at Pinoura Mine, SECL on the basis of field data.	SMSIL	December, 2015	December, 2018
13	Scientific study for monitoring of strata during extraction of Blasting gallery panel No. BG-J(2) in 3 seam at GDK-11 Incline, RG 1 Area SCCL	SCCL	April, 2014	March, 2017
14	Advice for safe depillaring of panel K-9 (F) of Kajora top seam by cable bolting based depillaring method through underground instrumentation and monitoring at Madhusudanpur Colliery, ECL on the basis of data supplied by the mine.	ECL	March, 2016	March, 2019
15	Advice for safe depillaring of the panel LK-8 of Lower Kajora seam at Central Kajora Colliery by cable bolting based depillaring method through underground monitoring	ECL	May, 2016	May, 2019
16	Advice for suitable method of extraction of CM-10 panel of L1B seam with CM technology at Pinoura Mine, Johila Area, SECL	SMSIL	August, 2016	August, 2018
17	Strata control based advice for safe depillaring in continuous miner panel CM-7 of L1B seam at Pinoura Mine, SECL on the basis of field data.	SMSIL	March, 2015	March, 2018
18	Advice for safe depillaring of the LK-4 of Lower Kajora seam at Central Kajora Colliery by cable bolting based depillaring method on the basis of field data	ECL	February, 2015	February, 2018
19	Strata control based advice for safe depillaring of panel K-20 (B) of Kajora top seam by cable bolting based depillaring method at Madhusudanpur 7 pit and Incline Colliery, ECL on the basis of field data.	ECL	February, 2015	February, 2018
20	Design of suitable method for extraction of coal pillars in Kajora (R-IX) seam at Madhusudanpur 7 pit and Incline colliery, Kajora Area, ECL under surface features like pond, HT line houses dwelling etc at a depth of 35 to 50m	ECL	March, 2015	March, 2017
21	Strata control studies based advice for safe depillaring in Continuous Miner panel CM-6 of L1B seam at Pinoura Mine, SECL.	SMSIL	August, 2014	August, 2017
22	Strata control based advice for safe depillaring of panel K-9 (E) of Kajora top seam by cable bolting based depillaring method at Madhusudanpur 7 pit and Incline colliery, ECL on the basis of data data	ECL	July, 2015	July, 2018

SI.	Title of Project	Sponsoring	Date of	Completion
<u>NO.</u>		Agency	start	date
23	Scientific study for estimation of cut out distance, stand-up	SMSIL	August,	August,
	time and support density during development of No.II seam of		2015	2016
	Rain Alari nine, Chininin Alea, SECL using Low Coal autting Machine (LCCM) on the basis of the data provide by			
	the mine.			
24	Advice for safe depillaring of the LK-5 of Lower Kajora seam	ECL	August,	August,
	at Central Kajora Colliery by cable bolting based depillaring		2015	2018
	method on the basis of field data provided by the mine			
	management			
25	Strata control studies based advice for safe depillaring in	SMSIL	September,	August,
	Continuous Miner panel CM-4 of L1B seam at Pinoura Mine,		2014	2017
	SECL.		<u> </u>	
26	Advice for safe depillaring of BG-5B panel of Queen seam at	SCCL	December,	December,
	21 Incline mine, Yellandu Area, SCCL by Blasting Gallery		2013	2013
- 27	method through underground instrumentation and monitoring.	C) (CH	x	
27	Strata control studies based advice for safe depillaring in	SMSIL	January,	January,
	Continuous Miner panel CM-2 of L1B seam at Pinoura Mine,		2014	2017
20	Secontific study in PC (I) PC need in 2 seem and 488.2 seed	SCCI	April	Marah 2017
20	stowing panel in 4 seam at GDK-11 Incline . SCCL	SCCL	2014	March, 2017
29	Performance evaluation of cable bolting based depillaring	ECL	June, 2014	June, 2017
	method for underground extraction of panel K-5(A) of Kajora		,	,
	top seam through undergruond instrumentation and monitoring			
	at Madhusudanpur 7 pit and incline colliery, ECL			
30	Performance evaluation of cable bolting based depillaring	ECL	June, 2014	June, 2017
	method for underground extraction of panel K-20(C) of Kajora			
	top seam through underground instrumentation and monitoring			
	at Madhusudanpur 7 pit and Incline Colliery, ECL			
31	Design of suitable method of depillaring including widening	Catterpillar	February,	February,
	and heightening of existing galleries for working of panels B5	Global	2013	2015
	and B6 of No. 1 seam at GDK-11 Incline mine, RG-I Area,	Mining		
	SCCL along with underground instrumentation and monitoring	Europe		
	during extraction of the panel.	GmbH-IPO		
32	Performance evaluation of cable bolting based depillaring	ECL	November,	November,
	Keigen soom through underground instrumentation and		2014	2014
	monitoring at Central Kajora Colliery ECI			
33	Strata control studies based advice for safe depillaring in	SMSIL	December	December
55	Continuous Miner panel CM-5 of L1B seam at Pinoura Mine.	SNBL	2013	2016
	SECL.		2013	2010
34	Performance evaluation of cable bolting based depillaring	ECL	December,	November,
	method for underground extraction of panel K-6(B) of Kajora		2014	2017
	top seam through underground instrumentation and monitoring			
	at Madhusudanpur 7 pit and Incline Colliery, ECL			
35	Scientific study for support plan and instrumentation in	SECL	December,	November,
	superimposed depillaring panels 49LW (Top section) of L-0		2014	2017
	seam and 49LW (Bottom section) of L-1B seam at Vindhya			
	Mine Johilla Area, SECL	~~~~		
36	Advice for safe depillaring in three panels at Bhatgaon colliery	SECL	February,	February,
	connery and one panel at mahamaya underground mine of		2013	2016
	Bhaigaon Sub-Area under Bhaigaon Area, SECL through			
27	Convergence monitoring studies.	CMCII	Contomi	Sontomb
51	Miner package in CM1 papel and surrounding area of L 1D	SIMPLE	September,	September,
	seam at Pinoura Mine SFCI		2012	2013
38	Advice on precise measurement 3D modeling of coal heaps	MCL	March	March 2015
	and coal volume computation at open cast mines of MCL.		2013	

SI. No.	Title of Project	Sponsoring Agency	Date of start	Completion date
39	Performance evaluation of cable bolting based depillaring	ECL	May, 2013	May, 2016
	method for underground extraction of panel LK-2 of Lower			
	Kajora seam through underground instrumentation and monitoring at Central Kajora Colliery, ECL			
40	Advice on precise measurement, 3D modeling of coal heaps and coal volume computation at Bhubneswari OCP, MCL.	MCL	June, 2013	June, 2015
41	Strata control studies based advice for safe depillaring in continuous miner panel CM1 of L1B seam at Pinoura Mine,	SMSIL	June, 2013	June, 2016
	SECL			
42	Performance evaluation of cable bolting based depillaring	ECL	December,	December,
	Kajora seam through underground instrumentation and		2015	2010
	monitoring at Central Kajora Colliery, ECL			
43	Scientific study for suggesting a suitable method of	SECL	March,	March, 2014
	development of seam No. IV at Umaria Colliery, Johila Area, SECL		2012	
44	Performance evaluation of cable bolting based depillaring		July, 2012	July, 2014
	method for underground extraction of panel LK-3 of Lower			
	Kajora seam through underground instrumentation and			
15	monitoring at Central Kajora Colliery, ECL	WCI	Iomuomi	Tompony
43	railway acquired land at New Mairi Colliery No. 3 of Mairi	WCL	2010	2011
	Area. WCL		2010	2011
46	Advice for safe working of Continuous Miner panel of No. 1	SCCL	August,	September,
	seam at GDK-11 Incline mine, RG-I Area, SCCL through		2008	2011
	underground instrumentation and monitoring.			
47	Scientific studies for safe depillaring of Panel No. 4SSC-1 of	SCCL	September,	September,
	No. 4 seam at GDK-10 Incline mine, RG-III Area, SCCL		2008	2012
48	Advice for safe working of Continuous Miner depillaring panel	SCCL	December	September
10	B3 of No. 1 seam at GDK-11 Incline mine, RG-I Area, SCCL	SCOL	2010	2012
_	through underground instrumentation and monitoring.			
49	Advice for safe depillaring of panel C with Continuous Miner	SECL	April,	December,
	& Shuttle Car of Zero Seam through underground		2003	2003
	instrumentation and monitoring at Anjan Hill Mine, Chirimiri			
50	Advice for safe depillaring of panel B with Continuous Miner	SECL	July 2002	July 2004
50	& Shuttle Car of Zero Seam through underground	SECE	<i>vary</i> , 2002	<i>valy</i> , 2001
	instrumentation and monitoring at Anjan Hill Mine, Chirimiri			
	Area, SECL.			
51	Advice for safe depillaring of panel A with Continuous Miner	SECL	April,	December,
	a Shuttle Car of Zero Seam through underground instrumentation and monitoring at Anian Hill Mine Chirimiti		2004	2007
	Area. SECL.			
52	Experimental trial for depillaring of thick contiguous sections	SECL	October,	October,
	of Zero seam at Chirimiri Colliery by underpinning panel C1		1999	2002
	and E4, Chirimiri Area, SECL.			
53	Strata behaviour study in panels C2 and E5 of Zero seam of	SECL	October,	October,
<i>E</i> 1	Chirimiri Colliery, Chirimiri Area, SECL.	SECI	1999	2002 Marsh 2002
54	Chirimiri Colliery, Chirimiri Area, SECL.	SECL	2000	March, 2005
55	Strata behaviour study in panels K1 and K2 of Zero seam of Chirimiri Colliery, Chirimiri Area, SECL.	SECL	April, 2000	March, 2003
56	Strata behaviour study in panels K5 and H1 of Zero seam of Chirimiri Colliery, Chirimiri Area, SECL.	SECL	July, 2001	June, 2005
57	Strata behaviour study in panels A, H2, and K6 of Zero seam	SECL	August,	July, 2006
	of Chirimiri Colliery, Chirimiri Area, SECL .		2002	

SI.	Title of Project	Sponsoring	Date of	Completion
No.		Agency	start	date
58	Strata behaviour study in panels H3, and K7 of Zero seam of Chirimiri Colliery, Chirimiri Area, SECL.	SECL	February, 2003	January, 2008
59	Strata behaviour study in panels I1, F4, G2, J1 and G3 of Zero seam of Bartunga Hill Mine, Chirimiri Area, SECL.	SECL	June, 2003	May, 2007
60	Advice for safe depillaring of BG panel II/6 of No. 3 seam and its influence on underlying panel 4S/6 of No. 4 seam at GDK-8	SCCL	June, 2007	June, 2010
	incline RG-II Area, SCCL inrough underground			
61	Safe depillaring of BC papels 1B and 1C of CDK 11A Incline	SCCI	May 2007	June 2010
01	mine RG-1 Area SCCL by blasting gallery method through	SCCL	Way, 2007	Julie, 2010
	underground instrumentation and monitoring.			
62	Safe depillaring of BG panels 1D and 1E of GDK-11 Incline	SCCL	June, 2008	October, 2010
	mine, RG-1 Area, SCCL by blasting gallery method through		,	,
	underground instrumentation and monitoring.			
63	Advice for safe depillaring of BG panel 26 of VK-7 Incline	SCCL	July, 2007	June, 2010
	mine, Kothagundam Area, SCCL through underground			
	instrumentation and monitoring.	<b>E</b> OT		
64	Advice for safe depillaring of Kajora top seam by cable bolting	ECL	January,	August,
	based depillaring method through underground instrumentation and monitoring at Madhusudannur Colliery [nanols $K_{11}(\Lambda)$ ]		2003	2006
	K-11 K-11 (B) and K-101 Kajora Area ECI			
65	Advice for safe depillaring of Kajora top seam by cable bolting	ECL	January.	August.
00	based depillaring method through underground instrumentation	202	2005	2011
	and monitoring at Madhusudanpur Colliery [panels K-11(C),			
	K-11(D), K-11(G) and K-11(H)], Kajora Area, ECL.			
66	Systematic strata monitoring and study of roof behaviour for	SCCL	June, 2002	June, 2005
	safe working/extraction of thick seam by Blasting Gallery			
	method in the panel 1/12 of GDK-8 and 2C of GDK-10 Incline			
67	Mine, KG-II Area, SCCL.	SCCI	Juna 2002	Juna 2005
07	safe working/extraction of thick seam by Blasting Gallery	SCCL	June, 2002	Julie, 2003
	method in the panel II/3 of GDK-8 and 2B of GDK-10 Incline			
	mine, RG-II Area, SCCL.			
68	Advice for safe depillaring of BG panel II/4 of GDK-8 and 2E	SCCL	April,	August,
	of GDK-10 Incline mine, RG-II area, SCCL by blasting gallery		2005	2007
	method through underground instrumentation and monitoring.			
69	Advice for safe depillaring of BG panel II/5 of GDK-8 and 2F	SCCL	April,	August,
	of GDK-10 Incline mine, RG-II Area, SCCL by blasting		2005	2007
	gallery method through underground instrumentation and			
70	Advice for safe depillaring of BG papel 1C of GDK 10 Incline	SCCI	December	November
10	mine RG-II Area SCCL by blasting gallery method through	JUL	2003	2006
	underground instrumentation and monitoring.		2005	2000
71	Designing of support pattern for BG panels 1A, 2A AND 3A	SCCL	March,	February,
	of GDK- 11 Incline Mine (6B Integrated Mine Block).		2003	2006